Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [4119-None]

Opening Ceremony followed by Welcome Reception

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632

Session: Opening Ceremony followed by Welcome Reception
Monday 2010/05/10 | 10:30 - 12:00

Congress Lecture [4081-None]

Welcoming Speech

Author
Forst, Raimund (Erlangen DE) | Prof. Dr.
Orthopädische Universitätsklinik der FAU Erlangen-Nürnberg - Lehrstuhl für Orthopädie mit Orthopädischer Chirurgie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632/cg2956657

Session: Opening Ceremony followed by Welcome Reception
Monday 2010/05/10 | 10:30 - 12:00

Congress Lecture [4082-None]

Greeting

Author
Jung, Burkhard (Leipzig DE)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632/cg2957060

Session: Opening Ceremony followed by Welcome Reception
Monday 2010/05/10 | 10:30 - 12:00

Congress Lecture [4083-None]

Greeting

Author
Jüttner, Frank (Dortmund DE)
Bundesinnungsverband für Orthopädie-Technik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632/cg2957329

Session: Opening Ceremony followed by Welcome Reception
Monday 2010/05/10 | 10:30 - 12:00

Congress Lecture [4084-None]

Oration

Author
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632/cg2957732

Session: Opening Ceremony followed by Welcome Reception
Monday 2010/05/10 | 10:30 - 12:00

Congress Lecture [3621-None]

ISPO and USAIDs Leahy War Victims Fund - A Fifteen Year Partnership to Strengthen P&O Services in Developing Countries

Author
Feinberg, Lloyd (Washington, DC US)
USAID United States Agency for International Development

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3588632/cg117672

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3620-934]

Learning Systems

Keynote Author
Riedmiller, Martin (Freiburg DE) | Prof. Dr.
Albert-Ludwigs-Universität Freiburg - Technische Fakultät, Institut für Informatik, AG Maschinelles Lernen

Abstract
When technical systems encounter more and more complex real world environments, the classical paradigm of pre-programming their behaviour clearly reaches its limits. Therefore, there is a growing need for intelligent learning systems: software systems, that can adapt and improve their behaviour based on experience - just like humans do.

Introduction
In this talk, I will give an overview over methods and principles that enable technical systems to learn new things and adapt to new environments. I will illustrate the current state of research by discussing applications from learning to predict sales to learning to play soccer with autonomous robots.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg117132

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3498-None]

Customized Upper-limb Prostheses: Art, Design, and Rapid Manufacturing

Session Chair
Heckathorne, Craig (Chicago, IL US)
Northwestern University - Rehabilitation Engineering Research Center

Session Chair
Meier, Margrit (Glasgow UK) | Dr.
University of Strathclyde National Centre for Prosthetics and Orthotics

Abstract
Customization of upper-limb prostheses is a crossroads of art, design, and fabrication technology. It addresses the functional needs of the user from aesthetics to manipulation. This symposium will present examples of custom upper-limb prostheses, both anthropomorphic and non-anthropomorphic, drawn from a variety of disciplines, including art, industrial design, engineering research, product development, and clinical prosthetics. Rapid prototyping and rapid manufacturing techniques will be examined for their role in customization and impact on the future of upper-limb prostheses.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46560

Symposium: Customized Upper-limb Prostheses: Art, Design, and Rapid Manufacturing
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3523-694]

High Performance in Upper Extremity Prosthetics

Author
Radocy, Robert (Boulder, Colorado US)
TRS Inc.

Coauthors
Robert (Bob) Radocy

Abstract
High Performance in Upper Extremity Prosthetics:
Surpassing the Limitations Imposed by Purely Anthropomorphic Design
High performance activities are possible and achievable for persons wearing an upper extremity prostheses if the prosthesiss design is allowed to expand beyond the limitations imposed by trying to imitate human morphology.

Introduction
Advanced prosthetic designs in arm prostheses have focused primarily on electromechanical solutions and replications of an anatomically correct human hand. Replicating the functional and anatomically aesthetic characteristics of the forearm and hand are a significant technological challenge.
However, focusing on non-anthropomorphic product design has provided the creative freedom to design and build high performance, activity specific prosthetic “terminal devices”. This approach provides the opportunity to explore unique designs and materials that an anthropomorphic approach would be forced to ignore.
Rapid prototyping and rapid manufacturing technologies allow these non-anthropomorphic designs to be constructed, tested, revised and refined in much shorter times and at less expense than designs that are forced to replicate accurate anatomical shapes, details and movements. Material technologies exist that eliminate expensive tooling but that still yield high performance physical characteristics.

Methods
Prosthetic designs for specific activities like golf, baseball and ice hockey have been created utilizing a non-anthropomorphic design approach, rapid prototyping and technologies that provide allow for economical, small volume manufacturing capability.

Results
Specialized prosthetic tools and accessories have been successfully created and are being manufactured for persons with a hand absence. These persons fit with simple, reliable and functional prosthetic "tools" that utilize a non-anthropomorphic design and unique high performance polymers have the capability to be competitive with their two handed peers in specific activities like swing a golf club, swing a baseball bat or bi-manually maneuvering and controlling a hockey stick.

Conclusion
Normal, able-bodied populations, their cultures and social norms often dictate what are considered and afforded as “acceptable” prostheses. These “standards” may in fact be inadvertently limiting the prosthetic user’s capability and performance. Increased function and high performance are technologically achievable now if prosthetic designers and manufacturers can work outside the restrictive realm of purely

anthropomorphically correct prostheses. The time has come to recognize the limitations imposed by purely anthropomorphic design and release the potentials that non-anthropomorphic design has for those that are challenged with a hand absence(s).

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46560/cg55654

Symposium: Customized Upper-limb Prostheses: Art, Design, and Rapid Manufacturing
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3500-729]

Customized Upper-limb Prostheses: Art, Design, and Rapid Manufacturing, Designing and Fitting Custom Prostheses

Author
Uellendahl, Jack (Scottsdale US) | CPO
Hanger Prosthetics and Orthotics, Inc. - Prosthetics

Abstract
Despite our best efforts to replicate the human hand and arm, current prostheses fall far short of this goal. Current upper limb prostheses may best be categorized as assistive tools. These may serve the purpose of providing a more natural appearance and/or provide manipulation functions.

Introduction
Typical upper limb prostheses, whether passive, body-powered or electric, can provide many functions but may not be “best” suited for a specific function. In these cases it is up to the creativity and imagination of the user and prosthetist to design and develop a prosthesis or prosthetic component to address this unmet need.

Methods
When faced with the challenge of producing an assistive device for specialized function it is useful to consider non-anthropomophic designs. This thought process opens new approaches that may otherwise be overlooked. To minimize cost and production time it is also useful to consider repurposing of existing components; e.g. use of a locking wrist unit as a humeral rotation device.

Results
Specialized prostheses are usually well accepted and well used.

Conclusion
These prostheses are the result of a user requesting a non-standard prosthetic design and then participating in the evolution of that design. Through this participation in the development of specialized prostheses the user becomes invested in the design and will usually make good use of the tool.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46560/cg46637

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3243-None]

Virtual Reality Based Training and Assessment in Persons with a Lower Extremity Amputation

Session Chair
Gailey, Robert (Miami US) | PhD, PT
University of Miami Miller School of Medicine - Department of Physical Therapy

Abstract
The use of virtual reality (VR) and gaming systems during rehabilitation has increased dramatically in recent years as clinicians seek to improve outcomes beyond that obtained using conventional techniques. VR technologies allow the ability to provide controlled physical and cognitive challenges while simultaneously obtaining quantitative feedback on patient performance. Although such technologies show great promise for enhancing physical rehabilitation, and may present an opportunity to enhance prosthetics and orthotics care, data supporting their use in a clinical setting is limited. The presentation will provide an overview of recent developments within the field of virtual reality based rehabilitation, highlight ongoing efforts to improve care for individuals with lower extremity amputation and discuss potential implications for clinical care independent of such advanced technology.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg41329

Symposium: Virtual Reality Based Training and Assessment in Persons with a Lower Extremity Amputation
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3259-751]

Virtual Reality Based Training and Assessment in Persons with a Lower Extremity Amputation

Author
Darter, Benjamin (Fort Sam Houston, TX US) | Dr.
Center for the Intrepid- Brooke Army Medical Center

Author
Wilken, Jason (Fort Sam Houston, TX US) | Dr.
Center for the Intrepid- Brooke Army Medical Center

Author
Fergason, John (Fort Sam Houston, TX US)
Center for the Intrepid- Brooke Army Medical Center

Coauthors
Wilken, JM, Fergason, J

Introduction
The application of virtual reality technology to enhance the care of U.S. Service members with amputation will be highlighted using a case-report approach. The lecture will focus predominantly on efforts underway in the Military Performance Lab (MPL) at the Center for the Intrepid (CFI), Brooke Army Medical Center (BAMC) using the Computer Assisted Rehabilitation Environment (CAREN) (Figure 1). The state of the art virtual reality system
provides the ability to develop a wide range of patient training and assessment applications. Data will be presented with a focus on standing balance training early in the rehabilitation process, gait training (providing real-time feedback and external focus of attention to improve quality of walking) and assessment and training of dynamic stability. Significant training results include up to a 15% reduction in metabolic cost and marked improvements in trunk motion symmetry (for individuals with transtibial or transfemoral amputation). Ongoing efforts which include evaluatio

Methods
The advantages and disadvantages of virtual reality will then be discussed from a clinical perspective. Using specific patient examples and previously discussed technology, guidance will be provided with respect to matching patient and intervention to maximize clinical utility of VR technology.

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Image: darter_751.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg41329/cg43000

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3670-None]

Orthotics - Knee and Arthrosis

Session Chair
Laube, Wolfgang (Feldkirch AT) | PD Dr. med. sc.
Landeskrankenhaus Feldkirch / Rankweil

Session Chair
Bernhardt, Kathie (Rochester, MN US)
Mayo Clinic - Motion Analysis Laboratory

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2882-80]

Effects of a Knee Soft Orthosis on Function and Performance in Jumping Tasks in Patients Five Years after ACL Reconstruction

Author
Laube, Wolfgang (Feldkirch AT) | PD Dr. med. sc.
Landeskrankenhaus Feldkirch / Rankweil

Coauthors
Kannenberg A

Abstract
Research on orthoses in rehabilitation after knee surgery has shown inconsistent results. This study with 54 patients after ACL surgery demonstrated significant clinical benefits such as increased muscle force, power, and sports performance when wearing a knee soft orthosis.

Introduction
Research on the effectiveness of soft orthoses has shown inconsistent results. Laboratory studies have demonstrated positive biomechanical and sensorimotor effects including improved position and joint angle sense, balance as well as perception of joint stability. However, clinically significant patient benefits of soft orthoses remain uncertain. Patients after ACL tear and reconstruction suffer from a so called partial functional paresis of the quadriceps muscle due to a lack of proprioceptive information from mechanoreceptors in the injured cruciate ligament resulting in a decrease of #-motoneuron activation (1). Therefore the subject of this study was to investigate whether a knee soft orthosis delivers a clinically relevant motor function benefit to patients after ACL reconstruction surgery.

Methods
In this study 54 patients five years after ACL reconstruction were enrolled to investigate the effect of a knee soft orthosis (Genu Direxa Stable Long, Otto Bock Healthcare GmbH, Germany) on performance and muscle function in a simple two leg jump and a reactive jump to reach maximum height. Both jumps were carried out with and without wearing the orthosis. The biomechanical parameters maximum height of the center of mass (jump height), maximum value of muscle force (kN), muscle power (kW) and jump speed (m/s) were measured with the Leonardo Mechanograph® GRFP. Muscle force and power were calculated separately for the left and right leg. In addition, maximum power was normalized to body weight (kg) and age (yrs) to calculate the Esslingen Fitness Index. Statistical analyses were done on the basis of mean values and standard deviations using the dependent t-test for paired samples.

Results
Simple two leg jump: While wearing the soft knee orthosis the females demonstrate a significant increase in the produced maximum two leg force, force produced by the injured leg, and the maximum force normalized to body weight (kN/kg) compared to the jump without the orthosis. The males show a significant increase in the produced maximum two leg force, the maximum force produced by the injured and sound legs as well as maximum force normalized to body weight when jumping with the orthosis.
Reactive jump: With the orthosis the females demonstrate a significant increase in jump speed, maximum two leg power, power produced by the sound leg, maximum power normalized to body weight, and the Esslingen Fitness Index. The males show a significant increase in jump speed, jump height, maximum two

leg power, power produced by the sound and injured legs, maximum power normalized to body weight, and the Esslingen Fitness Index when jumping with the orthosis.

Conclusion

In a systematic review Wright et al. (2) did not find any differences between long-term outcomes in patients who had used or not used a knee orthosis after ACL reconstruction. Other studies showed positive sensorimotor effects of knee orthoses (e.g. 3). This study demonstrates an improved sensorimotor movement control by a soft knee orthosis with clinically relevant benefits such as increased muscle force, power, and performance in sports activities. The beneficial effects of the orthosis seem to be the more pronounced the more challenging the intended movement pattern is from the sensorimotor perspective. However, the mechanism of action of soft orthoses remains unclear. The neurophysiological effect of the amount of pressure exerted, the skin area covered, and the combination of both requires further studies in the future. Even if the exact mechanism of action remains to be elucidated soft knee orthoses may be used to support the sports capacities of patients after ACL surgery.

References

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg33665

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3019-217]

Evaluation of Orthotic Treatment for Osteoarthritis Knee by Pressure Mapping and WOMAC Osteoarthritis Score

Author
Wong, Kenneth Wai Hing (HK)
Hospital Authority, Hong Kong - Department of Prosthetic & Orthotic, Queen Mary Hospital

Coauthors
Chen,KW

Abstract
The peak plantar force during stance phase is significantly reduced by using lateral wedged insole with scaphoid pad. From the results of WOMACTM 3.1 Index of osteoarthritis(OA), knee pain of patients was reduced and their daily functions were improved by the orthotic treatment.

Introduction
The knee adduction moment during the stance phase increases the risk of medial osteoarthritis progression. This adduction moment is generated by the ground reaction force during the stance phase. Thus, reducing the ground reaction force would theoretically reduce the knee adduction moment. The orthotic treatment aims at realigning the knee in order to reduce the knee adduction moment and shift the load away from the medial compartment. Two types of orthosis are commonly used in clinical treatment: the lateral wedged insole and the valgus knee brace.

Methods
41 patients who suffered from medial osteoarthritis knee were referred to the Department of Prosthetic and Orthotic of Queen Mary Hospital for orthotic treatment. 12 patients who suffered from mild to moderate bilateral OA knee were randomly chosen and treated with 10 different combinations of the orthoses which include 1) 10° lateral wedged insole 2) scaphoid pads 3) Subtalar straps and 4) valgus knee brace. Pressure mapping was performed by using the Tekscan mobile research TAM. The data were captured in random sequence of different combinations of the above orthoses. Western Ontario and McMaster University (WOMAC) 3.1 Index of OA were completed by all 12 patients before and after the first orthotic treatment, and also by 12 normal subjects. This study provided an objective measurement of the function of the orthoses by analysis of foot pressure distribution and plantar force during stance phase, and subjective measurement by WOMACTM 3.1 Index of OA.

Results
The mean WOMAC OA index was significantly different from 5(S.D.=5.31) and 53.55(S.D.=13.52) ($p<0.0001$)for the normal group and OA group respectively. With the use of the above orthoses, the results of WOMAC score showed that for osteoarthritis patient, the orthotic treatments were effective in relieving knee pain. The mean score of WOMAC was reduced from 53.55(S.D.=13.52) to 41.09(S.D.=11.94) ($p<0.001$). When considering different combination of the orthoses, using the lateral wedged insole with scaphoid pad, the peak loading during both heel strike, mid stance and push off were significantly reduced by 25.6%, 9% and 23.5%, with $p<0.005$, 0.05 and 0.005 respectively. There was no significant difference in the peak loading when using the lateral wedged insole with subtalar strap or using the valgus knee brace alone($p>0.05$)

Conclusion

This study was designed to evaluate the effects of the orthotic treatment from both subjective and objective information. The use of scaphoid pad resulted in a significant reduction of plantar force and pressure during stance phase. Improvement in the pain relief and gait symmetry were evident after wearing the valgus knee brace, as measured by pressure mapping. This study will continue to be conducted and 3D motion analysis will be involved in the future study.

References

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg35231

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2944-142]

Biomechanical Effectiveness of a Valgus-inducing Knee Orthosis for Arthritis of the Knee

Author
Schmalz, Thomas (Göttingen DE) | Dr.
Otto Bock HealthCare GmbH - Research

Coauthors
Drewitz H, Knopf E, Blumentritt S

Abstract
The presentation offers evidence of the biomechanical efficiency of a gonarthrosis orthosis with valgus effect on 16 patients. The orthosis compensates for approximately 9% of the external load resulting in pain reduction and an improved gait pattern.

Introduction
Nearly 5 – 6% of the population older than 30 years is affected by knee joint arthrosis [1]. Within the scope of non-operative treatment strategies, fitting with knee orthoses is increasingly important [2]. Their clinical efficiency is generally accepted [3], however, insufficient objective and measurable proof has been provided to date. A new method for quantitative determination of knee joint relief by an orthosis will be discussed.

Methods
The method is based on the idea that an orthosis for treating varus gonarthrosis generates a valgus moment in frontal plane that can be determined quantitatively to provide proof of efficiency. For this purpose, the correlation between reaction force of the orthosis producing the valgus moment and its related physical deformation was defined using a specially developed calibration method [4]. Following this, a gait analysis was conducted (kinematic system VICON 460, VICONPEAK, UK and 2 force plates, KISTLER AG, CH). In addition to the standard parameters of gait, the orthotic deformation resulting from the reaction force and the orthotic moment were calculated from the measured data. For comparison, a second gait analysis without orthosis was conducted. For the test procedure, 16 patients with unilateral medial gonarthrosis were recruited wearing the prescribed orthosis as part of their individual treatment plan (age: 56±10 y, height 172±9 cm, mass 83±12 kg, arthrosis level 2 - 3).

Results
Compared to the intact joint, sagittal motion of the loaded arthritic knee joint in flexion as well as in extension was reduced by approximately 3°, in both investigated situations. For the external flexion moment of the sound joint acting in early stance phase, a mean value of 0.45 Nm/kg was measured in both situations. Without orthosis, the arthritic knee showed a significant reduction to 0.23 Nm/kg. With orthosis, the value increased to 0.33 Nm/kg. For the external varus moment on the sound knee joint, a maximum mean value of 0.53 Nm/kg was recorded corresponding to known physiological values [5]. For the arthritic knee joint, in both situations a value of 0.63 Nm/kg was determined, which is significantly increased compared with the intact side. The calculation of the valgus moment generated by the orthosis suggests significant individual differences in magnitude and timing of this parameter. The mean curve shows a continuous gradual increase during stance phase lasting until stance phase extension of the knee. The values for all

patients were analysed to calculate a mean orthotic valgus moment amounting to 0.04 Nm/kg (mean stance phase value) and 0.053 Nm/kg (maximum value) respectively. These values indicate that the orthotic valgus moment reaches approximately 9% of the external varus moment.

Conclusion

Having the corrective orthotic moment reach approximately 9% of the external knee moment appears to be the essential action mechanism leading to the positive clinical results (e.g. significant pain reduction [6]). Ths biomechanical effect occurs because part of the external varus moment is compensated by the orthotic moment thereby reducing the joint force in the medial compartment and consequently joint loading [7]. The sagittal characteristics of the knee joint (range of motion and external flexion moment) reflect this therapeutic loading of the arthritic joint. When the orthosis is used, reduced protective behaviour and an improved gait pattern are demonstrated.

References

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg34775

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3057-255]

Relieving the Unicompartmental Arthritic Knee Joint with an Ankle Foot Orthosis

Author
Drewitz, Heiko (Göttingen DE)
Otto Bock HealthCare GmbH - Workshop R&D

Coauthors
Schmalz T, Blumentritt S

Abstract
This paper introduces a novel orthosis concept in which relief for the knee joint can be provided in either the lateral or the medial compartment with the implementation of a special AFO. This provides an alternative treatment method for unicompartmental knee disorders with great patient compliance.

Introduction
Fittings with KOs have now become firmly established for the conservative treatment of unicompartmental disorders and their positive clinical effect is undisputed [1, 2, 3]. However, orthoses that encompass the knee sometimes cause problems with handling and restrict day-to-day patient activities [4]. This presentation introduces a novel orthosis concept which relieves the knee joint with the help of an AFO. A rigid frontal bridging element for the ankle and a special adjustment mechanism are used to apply force in the area of the lower leg in order to influence in the desired manner the frontal torque acting externally on the knee joint. Initial fitting experience and measurements taken on 6 unicompartmental knee patients are presented.

Methods
The orthosis structure consists of a foot section with ankle joint and a lower leg component which is adjustable in the frontal plane. A hook-and-loop closure on the lower leg is used to hold the orthosis in place. The effects of the new design were objectively measured on 6 patients (3 with medial compartment involvement and 3 with lateral compartment involvement: age: 60±20y, height: 172±8cm, mass: 85±15kg, severity of arthritis 2-3, fitting period at least 3 weeks) using both static and gait analysis measuring procedures. Joint strain measurements while standing were taken with the L.A.S.A.R. Posture (Laser Assisted Static Alignment Reference by Otto Bock, Germany) [5]. The biomechanical gait parameters were recorded with an optoelectronic camera system (VICONPEAK, Oxford, GB) in combination with two force plates (KISTLER AG, Wintherthur, CH). Each patient completed a stance and a gait analysis, first without and then with an individually optimized fitting.

Results
All patients indicated that they wore the orthosis at least 8 hours per day. Regarding the effects of the orthosis, significant pain relief resulted in all cases and the level of wearer comfort was described as particularly high. In terms of the static load, the individually optimized orthosis clearly had an influence on frontal knee strain. When using orthoses with a valgum thrust effect, the load line made visible with the L.A.S.A.R. Posture (visualisation of the point of load incidence of the ground reaction force acting under a leg) [5 underwent an average lateral shift of 5 mm compared with the situation without the orthosis. But when using orthoses with a varum thrust effect, the load line underwent a medial shift of 8 mm on average.

The gait analysis results show that the orthosis also clearly changed frontal knee strain while walking. The valgum thrust orthoses significantly reduced the maximum values of the external varus moment from an average of 0.71 Nm/kg without the orthosis to 0.66 Nm/kg (reference range of physiological strain: 0.40 … 0.65 Nm/kg [6]). Using the varum thrust orthoses resulted in a significant increase from 0.28 Nm/kg without the orthosis to 0.36 Nm/kg with the orthosis.

Conclusion

The measurements constitute clear empirical evidence of the knee relief effect of this novel principle. A reduction of the external genu varum moment, which is frequently elevated in medial compartment disorders, is clearly correlated with a reduction of the joint force in the medial compartment [7]. On the other hand, the increase of the values for lateral compartment disorders caused by the design reduces the joint forces in the lateral compartment [7]. These changes in the biomechanical parameters can be considered the major cause of pain relief. Initial fitting experience also leads to the expectation that the novel orthosis concept will increase patient acceptance thanks to easy handling, compact size, and high level of wearer comfort compared with knee orthoses.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg36426

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2974-172]

Knee Joint Loads on a Knee Ankle Foot Orthosis

Author
Bernhardt, Kathie (Rochester, MN US)
Mayo Clinic - Motion Analysis Laboratory

Coauthors
Bernhardt KA, Kaufman KR

Abstract
This is the first report of knee joint loads in patients prescribed a KAFO. Peak loads were highest in the sagittal plane. Malalignment contributed to higher loads. All subjects demonstrated flexion moments at toe off. It is important to look at multiple factors when choosing orthotic components.

Introduction
There currently is little information on the load that goes through the uprights of a KAFO during gait. Consequently, all component prescription criteria are merely educated guesses with ultimate decisions left up to the practitioner. One previous study reported on the pistoning forces in orthotic knee joints (Lew, 1982), while a second study examined forces in a prophylactic knee brace as a measure of brace-knee motion mismatch (Regalbuto, 1989). However, neither of these studies are fully applicable to locked KAFO's or Stance Control Orthoses (SCO's). We have previously reported on KAFO upright loads on an able bodied subject (Kaufman, 2009). This report is the first of its kind to directly measure the load on a knee joint in a KAFO while it is being used by patients who require a KAFO for ambulation.

Methods
Three subjects (2 M, 1F, average age 55) that required a KAFO for ambulation were tested. The lateral knee joint was replaced with a six component load sensor (model MC2.5-6-1.2K-4670, Advanced Mechanical Technology, Inc., Watertown, MA). Gait and load sensor data were collected simultaneously using EvaRT 5.04 (Motion Analysis Corporation, Santa Rosa, CA). The KAFO was locked in full extension. All trials were collected with the sensor in the lateral upright and the medial upright intact. Moments from the load sensor data were calculated using custom Matlab programming (The MathWorks, Inc., Natick, MA). Peak values as well as loads at toe off were determined. All data was expressed as percent gait cycle. Data were the average of at least six gait cycles for each subject.

Results
For two of the three subjects, the highest load was in the sagittal plane (Table 1). This was expected because all three subjects wore a KAFO for knee extensor weakness. Subject 2 had the highest load in the frontal plane, presumably because her KAFO prescription was for valgus instability in addition to extensor weakness. Transverse loads for all three subjects were low, but transverse and frontal peaks for Subject 3 were nearly equal. Interestingly, loads in all three planes did not simply increase as subject weight increased. The lightest weight subject, Subject 1, had higher sagittal and transverse loads than the middle weight subject, Subject 2. The heaviest subject, Subject 3, had the largest sagittal and transverse loads but the lowest frontal plane loads on the knee joint. Also, all three subjects exhibited an external knee flexion moment at toe off (Table 1), ranging from 30 to 80 percent of the absolute peak sagittal load measured for that subject.

Conclusion

This is the first report of orthotic knee joint loads in patients who are prescribed a KAFO. Peak loads varied among the subjects tested but were not related solely to body weight, as proven by the fact that the lightest subject demonstrated some of the higher loads. Similarly, the middle weight subject, Subject 2, exhibited higher frontal loads than the other subjects because of valgus instability. This data provides evidence that orthotic prescriptions cannot be based on body weight alone. Instead, practitioners need to look at the entire presentation of the patient, taking into account strength of the limb, presence of flexion contractures, and frontal plane alignment. Stance control orthoses are gaining in popularity. However, the various devices have differing criteria for load at toe off. It is important to note that all three of our subjects demonstrated a significant sagittal load on the upright at toe off that would bind the joint and render some SCO designs impractical.

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Image: BernhardtKA_Table1_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg35027

Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3432-607]

Evaluation of Short Term Effects of a Valgus Orthosis on Knee Moments, Pain and Physical Capacity in Patients with Medial Compartment Osteoarthritis

Author
Brüggemann, Gert Peter (Köln DE) | Prof. Dr.
Institut für Biomechanik und Orthopädie - Deutsche Sporthochschule

Coauthors
Böhle C, Fantini Pagani CH, Rembitzki I

Abstract
The knee orthosis GenuArthro is designed to apply a valgus moment to the knee joint and to re-distribute the intra-articular load of the knee. The results of a short term intervention indicate an increase in walking distance and speed; pain (WOMAC, stiffness and the adduction moments decreased.

Introduction
Osteoarthritis of the knee is a common form of degenerative diseases of the articular cartilage. Knee osteoarthritis increases with age. Osteoarthritis of the knee is most often located in the medial compartment because of the predominant adduction moment (varus moment) during normal gait. The external adduction moment to the knee increase the medial compartment load. The goal of the valgus bracing by the GenuArthro orthosis is to reduce the resultant moment to the knee in the frontal plane and thus to decrease the medial compartment load. The hypothesis is that a decreased medial compartment loading is related to pain relief of the patient and an increasing physical activity. The purpose of the clinical intervention study was to investigate whether the GenuArthro valgus brace effects the resultant adduction moments to the knee, the pain and the physical function in patients with medial compartment osteoarthritis of the knee.

Methods
Sixteen patients (age: 57.6±4.9 years, BMI: 26.4±2.5kg/m2) with symptomatic medial compartment osteoarthritis of the knee were investigated in a four weeks prospective cross-over placebo controlled trial. The patients wear the two orthosis modes for two weeks for the valgus and two weeks for the placebo brace in a random order. The placebo brace looked completely same as the experimental (valgus) brace but was engineered to apply only a minimum valgus moment to the knee. The duration of wearing, the pain severity and the location of pain were documented in a daily report. The physical function was measured by the 6-minutes walk test and the stair-measure test. The WOMAC index was used to assess self-reported physical function, pain and joint stiffness. To determine the external and the resultant adduction moment to the knee ground reaction forces and 3D kinematic data were collected simultaneously. Additionally the instrumented brace measure to orthosis valgus moment.

Results
With both of the braces the walking distance and the walking speed during the stair-measure test did not alter significantly ($p<0.05$). At baseline the walking speed without the brace was significantly slower ($p<0.005$) than with the valgus brace. The means of the WOMAC and the external and the resultant adduction moments showed significant differences between the measures with and without both braces. The valgus brace (GenuArthro) significantly reduced the resultant adduction moment. The valgus moment

of the valgus brace was higher than that of the placebo. Self reported pain and physical activity increased during the intervention with the orthoses.

Conclusion

Valgus bracing was effective in reducing the resultant adduction moment to the knee. Both orthoses had a significant effect on pain, stiffness and physical function. These differences were not highly significant ($p<0.01$) between the two orthoses. In addition walking speed and distance showed no significant differences between the conditions expect for comparison of walking speed between without placebo brace and without valgus brace. One can conclude that even applying a minimum valgus stress to the knee and probably some compression to shank and thigh through the attachments of the brace may trigger muscular control and increase muscle function to re-position and re-distribute the load of the knee during gait. Due to these results, valgus bracing is a beneficial treatment for medial osteoarthritis of the knee.

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Session: Orthotics - Knee and Arthrosis
Monday 2010/05/10 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3239-421]

Clinical Trial Examining the Effect of a Unloading Knee-brace on a Varus Knee with Osteoarthritis

Author
Herold, Klaus (Bayreuth DE)
medi GmbH & Co. KG - Orthopaedics

Coauthors
Müller-Rath R, Cho Hae-Yeon, Miltner O

Abstract
The study should show the effect of different kinds of treatment to a knee with osteoarthritis. There have been three groups (without treatment/knee soft support/unloading knee brace) and different clinical scores to evaluate the effect.

Introduction
The conservative treatments of osteoarthritis in the knee are limited. Aim of this study is to show the effect of a unloading knee brace.

Methods
33 patients had been divided into three groups by randomization. Group 1 with a M.4 OA, unloading-knee brace of medi GmbH & CO. KG, 1 group with a Genumedi, knee soft-support of medi GmbH & CO. KG, and 1 group without a orthotic device (control group). At the start and after 16 weeks there have been a standardized clinical trial with subjective and objective scores (VAS, Tegner, Insall, Lequesne, Womac, HSS-Score). Additional there was an instrumental analysis to show the motion of the knee.

Results
In the non-treated control group have been no significant changes. The group with the soft-support showed significant improvement of Tegner and Insall. In the group with the unloading brace have been significant improvement of the following scores: Tegner, Insall, Lequesne, Womac and VAS.

Conclusion
The treatment with an unloading knee brace like M.4 OA guides to a subjective and objective improvement. The treatment with an unloading knee brace shows more benefit than a knee soft support.

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no references

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg226834/cg40943

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3777-None]

Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG

Session Chair

Kern, Kai-Uwe (Wiesbaden DE) | Dr. med. / MD
Schmerz - und Palliativzentrum Wiesbaden - Center for pain management and palliative care

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg405598

Symposium: Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3778-753]

Epidemiology of Phantom Pain and Phantom Sensations in Germany

Author
Kern, Kai-Uwe (Wiesbaden DE) | Dr. med. / MD
Schmerz - und Palliativzentrum Wiesbaden - Center for pain management and palliative care

Abstract
The lecture will present data of a current survey of 537 amputees, discuss new aspects of phantom pain and feelings as well as connections between pain and prothesis use and explains the pathophysiology in video-examples.

Introduction
Phantom pain is a still unsolved problem, pathophysiology is understood insufficiently.

Methods
Supported by an artificial limb-producing manufacturer (medi Bayreuth,Germany) and press notices, we were able to get in touch with amputees, 537 of them were interviewed by questionnaire.

Results
537 of 1088 amputees filled in the questionnaire (62 questions). 14.8% were painfree; 74.5% indicated PLP, 45.2% stump pain (SP) and 35.5% a combination of both. 62.4% of all these amputees reported disturbed sleep; those with PLP among them coming up to 77.3% even. 66.8% of the patients with PLP and difficulties to maintain sleep woke up several times a night.
The prevailing features of PLP included: Burning 13.6%, cramps 15.3%, lancinating 23.4%, electrization, tingling 20.4%. 73. 4% indeed felt the phantom, PLS were characterized as mobile (66,8%), of normal temperature (64%), warm (19.5%), cold (16.5%), bare (35.9%), clothed (13.6%), unpleasant (31.7%), pressed (29.6%), contorted (7.5%), and blown-up (5.8%). 35.7% of the patients with PLP described its location to be mostly ventrally, 26.7% mostly dorsally. Significantly more PLP was found in the presence of PLS versus their absence ($p>0.001$), but unrelated to the type of PLS, to demographic factors, or to the level or side of amputation. Perception of the artificial limb being a “foreign body” was highly significantly more often associated with PLP than with a sensation of „fusing with the body“ ($p<0.0001$).

Conclusion
To our knowledge, the present study constitutes the largest field interview on phantom limb pain in Europe and corroborates the high prevalence and intensity of PLP, unusual PLS and amputation-related disturbances of sleep. The significance (and manageability) of PLP
and its risk factors is in need of further research.

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Symposium: Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3779-752]

Management of Phantom Pain

Author
Kern, Kai-Uwe (Wiesbaden DE) | Dr. med. / MD
Schmerz - und Palliativzentrum Wiesbaden - Center for pain management and palliative care

Abstract
New Concepts and Results of a Nationwide Survey in Germany will be presented.

Introduction
Therapy of phantom pain (PLP) is still difficult, since pathophysiological mechanisms are not clarified. Our nationwide survey investigated the worth of different therapies and medical health care from a patients point of view, another presented studie the management of PLP with a electromagnetically acting stump liner (medipro®Liner RELAX, UMBRELLAN®).

Methods
First study: Supported by an artificial limb-producing manufacturer (medi Company, Bayreuth, Germany) 537 amputees (400 with PLP) were interviewed by questionnaire (62 questions). The second study was a double-blind, randomized crossover study over a six week-period. After two weeks of basic documentation half of the patients received the experimental liner with Umbrellan® , the other half got a dummy liner, this system was changed cross over two weeks later.

Results
First study:Patients feeled the doctors knowledge in PLP to be ‘very good’ only in 3,8% (bad: 18,6%). 41,6% never had any explanation for PLP, only 9,1% got enlightenment before surgery. 71,1% never tried any therapy, pain reduction > 50% could only be achieved in 12,7 %. The best subjective therapeutic success was reported from opiates (67,4 % success of 100 % treatments), anticonvulsants (51,7 %), relaxation exercise (41,7 %) and warm application (39,4 %).
Second study: 27 of 30 patients completed the 6 weeks’ study, 22 documentations proved valid. The Umbrellan-Liner (VL) versus Placebo-Liner reduced permanent PLP significantly more often (p=0.008), the odds ratio being 5.95. VL also led to significant amelioration of general well-being (p = 0.037).

Conclusion
As PLP can be triggered in many ways, this justifies diverging therapeutic approaches such as mirror therapy, stumpf triggerpoint injections, virtual imaging, botulinum toxin injections, medication, psychological techniques and stump shielding with UmbrellanR. Health care for PLP seemes to be insufficient, best therapies were opiates, relaxation techniques, anticonvulsants and warm application.

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Management of Phantom Pain with a Textile, Electromagnetically-Acting Stump Liner: A randomized, Double-Blind, Crossover Study
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Symposium: Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3780-789]

Residual Limb Pain

Author
Reichhalter, Robert (Wien AT) | Dr. med.
Wilhelminenspital Wien

Abstract
Epidemiology, Reasons and orthopaedic/surgical management

Introduction
Although pain after amputation commonly is associated with phantom pain, residual limb pain is frequently difficult too. Considering that the reasons and methods of treatment are different, it is necessary to distinguish exactly for a successful treatment. Phantom pain is a painful sensation perceived in the region of the missing limb, while residual limb pain arises from the residual limb rather than from the area of the missing body part.
The reported incidence of residual limb pain in the first week after the amputation has been found to range form 50% to 60%. In the following weeks and years the incidence has been found to range from 10% to 76% by different authors. Although earlyer studies showed a
decrease of incidence with time, later studies could not confirm this. Additionally a third of those experiencing residual limb pain have occurences which interferes with daily lifestyle from ‘moderat’ to ‘a lot’ and experience their pain for longer periods.

Methods
The most common cause of residual limb pain is improper prosthetic fit which leads to minor acceptance of the prosthesis and further to less mobilisation and arthrogenic problems. Another reason is the formation of neurinomas of the transected nerve. Neurinoma pain has a
sharp, shooting quality that can be produced by tapping over the area. The neurinoma may
also generate pain spontaneously without any external stimulus. A third reason is
sympathogenic pain which is commonly referred as reflex sympathetic dystophy or chronic
regional pain syndrom. Additional reasons are pain from a joint from the surrounding tissue,
infection, ischemia, ulceration, or referred pain form radiculopathy, facet syndrom or
myofascial pain.
The best protection for residual limb pain is aggressive perioperative pain management. Regional anaesthesia, local anaesthesia and appropriate pharmacological therapie with opioids and nonsteroidal anti-inflammatory drugs should be used. Early psychological and psychosocial care is as

Conclusion
Residual limb pain is a great problem for amputated patients even after years, which leads to inacceptance of prosthesis, decreased mobilisation, fewer social contacts and depression. For
prevention early intervention and appropriate pain management is necessary. If pain has
persisted after years there are many possibilities of successful treatment after exact diagnosis.

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Symposium: Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3781-923]

Prosthetic Supply in the Case of Phantom Pain and Residual Limb Pain

Author
Bitter, Elmar (Bad Oeynnhausen DE) | Dipl. Ing.
Technische Orthopädie Auguste Viktoria Klinik

Abstract
Basic Principles, Snares and Prospects

Introduction
In many cases, the onset of phantom and residual limb pain poses a problem for prosthetic supply that must not be underestimated. Apart from purely medicamentous treatment, conservative treatment options have become increasingly popular over the last few years. In the meantime the spectrum spans from physiotherapeutic approaches to harden the residual limb to the supply of special liners and stump socks by orthopaedic technicians.

Methods
The findings presented in this lecture stem not only from personal experience, but also from the rehabilitation standard of the Association of Mühlenkreis Clinics, especially the AWMF (Association of Scientific Medical Societies in Germany) guidelines, and the findings from the crossover study by Dr. Kern. As this study evaluated 537 amputees, it is one of the worlds largest surveys in the field of the provision of medical aids.

Results
In many cases, the use of suitable conservative treatment methods for residual limb and phantom pain is a useful complement to medicamentous treatment for these pain patients. Although not all pain patterns can be treated conservatively, considerable reductions in the use of analgesics are associated with such treatment.

Conclusion
Treatment to control pain in amputees is an essential element of rehabilitation because every type of pain in the locomotor apparatus, especially in the amputated limb, can have permanent negative effects on the outcome of rehabilitation. Conservative treatment methods have proved to be useful and complementary adjuncts to medicamentous treatment. Such combination treatment should be initiated as early as possible in the postoperative phase to prevent the pain perceived manifesting as the so-called "pain memory".

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Symposium: Phantom Pain and Residual Limb Pain supported by medi GmbH & Co. KG
Monday 2010/05/10 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3782-None]

Imaging of Phantom Pain

Author
Wiech, Katja (Headington UK) | Dr.
John Radcliffe Hospital - OxfordCentre for Functional Magnetic Resonance Imaging of the Brain (FMRIB)

Abstract
Current Status of Research

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg405598/cg407874

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3655-None]

Upper Extremity Prosthetics - / Socket Prostheses Control

Session Chair
Miller, Laura (Chicago US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Session Chair
Egger, Hubert (Wien AT)
Otto Bock HealthCare Products Ges.m.b.H, Wien

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg215095

Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2901-99]

Targeted Reinnervation—Surgical Outcome of 30 Patients

Author
Miller, Laura (Chicago US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Coauthors
Kuiken TA, Dumanian G, Wilson, C, Hebert, J

Abstract
Targeted Muscle Reinnervation (TMR) is a surgical technique that creates myoelectric control signals in the residual limb of amputees using the remaining nerve and remnant musculature in the residual limb. Outcomes of 30 TMR patients will be presented.

Introduction
Targeted Muscle Reinnervation (TMR) is a surgical technique that enables improved control of myoelectric prostheses.(1) Residual nerves in the amputated arm are transferred to remaining muscle. Once these target muscles are reinnervated they provide myoelectric signals that correlate to the original nerves function. This allows intuitive and simultaneous control of elbow and hand function in transhumeral and shoulder disarticulation amputees.
TMR surgery is very reliable in producing additional myoelectric sites for hand and elbow control. Post operative complications are minimal and consist primarily of rare failed nerve transfers and frequent transient increases in phantom limb pain. A skilled team of clinicians can successfully fit TMR patients with myoelectric arms that enable intuitive and simultaneous elbow and hand function. Here we review the surgical outcomes of the first 30 patients.

Methods
TMR results were reviewed for available patient data at six centers around the world. Cases were reviewed for level of amputation, number of nerve transfers and whether the patients were successfully fit with a prosthesis. Complications are also noted.
Between 2002 and 2009 TMR procedures were performed on 30 patients; 11 with shoulder disarticulation (SD) and 19 with transhumeral (TH) level amputations. Five of the patients were bilateral amputees. Generally, 4 nerve transfers were performed on SD patients and 2 or 3 on the TH amputees.

Results
Final surgical outcome was available on 27 patients as 2 were in recovery and one was lost to follow-up. Only one TH patient had failure of both nerve transfers; peripheral nerve damage was discovered in the operating room consistent with brachial plexopathy. Three patients had one nerve transfer that failed. In total 76 of 81 transfers (94%) were successful at producing surface EMG. Of the 27 patients with successful reinnervation, 22 have been successfully fit with a prosthesis: they were fit with devices and able to demonstrate control of the hand and elbow. Four patients are still in the process of being fit with prostheses and one patient have not, as of yet, followed through with final fitting.
Beyond the 4 patients with failed nerve transfers there were no major complications. Several patients had routine surgical issues such as hematoma and a mild post-operative cellulitis. Many patients had a transient increase in their phantom limb pain (PLP). In patients with a history of PLP, many experienced an increase in their base line PLP. It increased to levels that were less than their initial PLP after amputation

and the pain returned to baseline within 4-6 weeks. One patient reported a significant increase in phantom limb pain several months after surgery. Five patients had painful neuromas prior to TMR surgery and all experienced marked relief of their neuroma pain. The neuroma pain returned after 6 months in one patient.

Conclusion

TMR has demonstrated to be successful and reliable. The success of TMR is likely due to hyper-reinnervation: large nerves are transferred on to relatively small regions of muscle.(2) With an excessive number of motor nerve fibers placed on the target muscle the chance that any given muscle fiber is reinnervated is greatly increased, compared to reinnervating a muscle with its own nerve and native number of fibers. Only 5 transfers failed. Two were likely due to brachial plexopathy impairing the transferred nerves. One was likely do to vascular compromise of the target muscle. In 2 TH cases the radial nerve transfer to the lateral triceps failed clinically. The reason for these failures is unknown.
In this analysis we use only the most primitive definition of ‘a successful fitting’: patients demonstrated they could use TMR control to operate the hand & elbow. Functional testing has been reported on a small subset of patients (3); however, a broader analysis of use over time is needed.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3429-604]

EMG Sensor and Controller Design for a Multifunction Hand Prosthesis System - The UNB Hand

Author
Wilson, Adam (Fredericton CA)
University of New Brunswick - Institute of Biomedical Engineering

Coauthors
Losier Y., Kyberd P., Parker P., Lovely D.F.

Abstract
A controller and EMG sensors are being developed to control a three axis hand that can perform six basic grip patterns. The modular system communicates via CAN bus using a standardised bus protocol. The main controller incorporates several control strategies including pattern classification of EMG.

Introduction
The design of an anthropomorphic hand is the balance between level of complexity and practicality. While the natural hand has many degrees of freedom and is capable of six basic grip patterns[1], until recently the majority of devices in the field have only a single grip form. To add further motions requires more degrees of freedom. The UNB hand project seeks to build a hand with greater functional range while being practical. It seeks to perform all six grip types with the fewest independent motions.
These additional motions need to be controlled. While natural control is broadly subconscious, much of the control of a prosthesis is conscious, so for users it can become slow and tiresome to use, and so rejection of the device is more likely. Two compatible solutions exist: The first uses the patterns in subconscious grasping to gather intent[2] which requires now available, fast, compact microprocessors. The second uses the context of the hand and object to dictate the grip shape[3].

Methods
The UNB hand aims to maximise the capabilities of the hand while minimizing production costs. This paper describes development of the first sensor prototypes.
If all the processing in a prosthesis is done with a single device, many wires must run from the sensors. The processor would also need to run at a high clock rate to perform all the tasks, using considerable power. If the control is spread across many processors, linked by a serial bus, the processors can run at a much lower power level and switched off when not in use. This has a significant impact on the power consumption.
Since the hand was designed to use pattern recognition of EMG signals, EMG sensors were developed. These incorporate the electrode, amplification and processing, so that the digitised signal is streamed across a serial bus to the central processor, using a standardised bus protocol[4]. Up to eight EMG sensors can be placed on the bus. Another serial bus is used to connect to the finger sensors and motors.

Results
The central controller can take information from sensors within the hand and on the forearm and co-ordinate the information to determine the correct grip shape and force in response to the user’s intents and the object to be held.

The developed EMG sensors are bandpass filtered between 16Hz and 350Hz, with selectable gain from 150 to 12750, a CMRR of 100dB and an input impedance of 100G#. The signal is sampled at 1000Hz via a 12bit ADC. The processor at the sensor allows signal processing (filtering, feature extraction, etc) to be performed in a distributed fashion reducing the load on the central processor. This processor also allows aggressive power saving techniques such as putting the sensor into a sleep state, in which the EMG sensor consumes 800µA, when EMG activity is below a user defined threshold and waking the device when the threshold is exceeded. The eight EMG sensors are connected to the central processor via a single 4 wire CAN bus. To further reduce power the CAN transceiver is enabled only when transmitting, this achieves a current consumption of 3.5mA when the sensor is actively sampling and transmitting. To allow communication to the sensor from the central processor, a periodic beacon signal is sent from each sensor at which time the CAN bus transceiver is enabled and the central processor is given an opportunity to communicate.
The motor control and hand feedback modules will communicate in a similar manner over a separate CAN control bus.

Conclusion

It is possible to produce a design of a multi-axis adaptive hand prosthesis that can perform all six basic hand grasps within the space for a trans-carpel hand. This includes the localised processing to control the hand. Intelligent EMG sensors were built that can combine the local amplifying and processing of the signal so that the data is streamed to a central pattern recognition node keeping the interconnections to a minimum and helping to make the resulting system reliable enough to be a practical prosthesis. Power consumption measurements have shown that this approach is feasible for use in a prosthesis.
Miniaturization efforts have not yet been completed for the prototype version of the EMG sensors, but the circuit components have been chosen such that they will require a package similar in size to that of a commercially available electrode.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2940-138]

Feedback Integration in the Control Loop of Prosthetics

Author
Ninu, Andrei (Wien AT) | DI/Ph.D. student
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Kevin K, Rattay F, van Vliet JW

Abstract
The study addresses the TMR transradial/transhumeral amputation. The impression that the prosthesis is following the desired intent and providing correspondent feedback motivates the wearer during the training sessions and daily life, thereby increasing the acceptance rate.

Introduction
Technology is improving rapidly and prosthetic devices are much more complex than before. Only a natural limb is integrated directly into the nervous system and provides direct feedback to the brain. With a myo-prosthesis a large cognitive effort is required for the amputee working with a high level of perception (vision).
To make the prosthesis “a part of self” (prosthesis embodiment) two main challenges are faced. First, the interface between the nervous system and the prosthesis must allow the limb to be controlled in a natural, intuitive manner. Secondly, there needs to be a method to provide the sensory system with information coming from the prosthesis in such a way that the brain will be able to interpret it and generate commands, closing the control loop of the somatic nervous system.

Methods
In order to study the mechanism of prosthesis embodiment we make use of a closed box having two holes into which the amputee introduces the healthy and the residual limb. Inside, a video camera captures live the movements of the healthy hand and with the help of computer image processing algorithms a new image is generated having both the healthy hand and a mirrored image of the healthy hand. The resulting image is transmitted live as feedback to the subject in a head mounted visual display. The amputee is asked to perform identical, simultaneous synchronized tasks using both hands, and the virtual reality observed by the amputee induces the feeling of having two healthy hands.
While the prosthesis is acting sensors measure various parameters to provide afferent feedback. A haptic device will transmit the collected information to the mechanical receptors in the residual limb to sites previously prepared by a surgical procedure which closes the control loop of the somatic nervous system

Results
The entire study revolves around the mechanism underlying “phantom limb phenomenon”. The results have shown that through immersion in the augmented reality, the transposition of the intact limb’s movement to the amputated side facilitates the development of phantom limb sensation. In this manner we reproduced the results of mirror box studies performed by V.S. Ramachandran and the more immersing virtual reality studies performed by the University of Manchester concerning phantom pain alleviation.
When both paths (afferent and efferent) between the somatic-nervous system and prosthesis are linked together the amputee is ready to leave the box and enter the real world. Then, the box no longer sustains the phantom limb illusion, but the haptics, trained through the box multimodal feedback, assume the entire

virtual limb proprioception. This training phase is represented by the real prosthesis fitting, in which the movement intent and prosthesis response are linked together. Wearing the prosthesis in the real world the amputee performs the same tasks as in the box. We measured the reaction time in cyclic gripping/ moving tasks and the results suggest that the visual illusion successfully shifts the virtual limb sensations toward the residual limb.

Conclusion

We have built a new augmented reality environment for phantom limb research, based on the latest scientific and rehabilitation principles. Phantom Limb Phenomenon presents an opportunity for amputees to control the prosthesis in an intuitive manner, the prosthesis being experienced like a glove covering the phantom. In our experiments the beneficial effects of conventional Mirror Therapy in alleviating phantom pain is expanded through our augmented reality therapy to provide much more – intuitive control. From our point of view, possessing a healthy and controllable phantom is a necessary condition to reach prosthesis embodiment.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3060-258]

Multidegree of Freedom Simultaneous Control of Arm Prosthesis - a Natural Motion Case Study

Author
Egger, Hubert (Wien AT)
Otto Bock HealthCare Products Ges.m.b.H, Wien

Coauthors
van Vliet JW

Abstract
Current myoelectrical prostheses allow single control of the joints only. The aim of this work is to enable a new control. In a unique pan-European case study a 17 year old shoulder-ex-amputatee underwent surgery in order to achieve a novel prosthesis-control: “thought-controlled prosthesis”.

Introduction
Typically, there are two rudimentarily muscle groups, the flexor- and the extensor muscle group, in the stump of an amputee that control flexion and extension of a myoelectrically controlled prosthesis. State of the art arm prostheses have up to three active joints. By co-contraction control switches to another joint. In a unique pan-European case study a patient with shoulder-ex-amputation underwent surgery in order to achieve intuitive prostheses control by re-use of his hand nerves: targeted muscle reinnervation (TMR). The benefits of this approach are significant for high amputation levels. With special pattern recognition procedures, based on artificial intelligence methodologies, prostheses control becomes intuitive as the prosthesis executes exactly the same movements as intended in the phantom limb. Tis leads to an unprecedented improvement of a patients life quality.

Methods
The Patient (17 years) lost both of his arms due to a high voltage accident: Left shoulder-ex-amputation, right transhumeral amputation. The neural supply of M. Pectoralis major, which had lost its original function to bend the upper arm, was dissected and replaced by the four essential arm nerves: N. Radialis, N. Ulnaris, N. Merdianus und N. Musculocutaneus. Additionally, the muscle itself has been divided into appropriate segments. When the reinnervation of the M. Pectoralis major with the new nerves was completed EMG-Signals were measured by surface electrodes. In the first training step the patient was shown videos such as open/close the hand, flexion/extension the wrist, supination/pronation the hand, flexion/extension the elbow, flexion/extension the shoulder, innerrotation/ outerrotation the upper arm. In the second training step the patient had to cope with the task to imitate the videos only by moving his phantom arm while the EMG-patterns were stored in the prostheses.

Results
First results of the case study indicated that TMR leads to a significant improvement of the rehabilitation of arm amputees. The phantom limb movement could be recognized on-line by analyzing the corresponding EMG-pattern in signal processing procedures based on pattern recognition methods. The first impression was described by the patient as follows: “the arm prosthesis follows the movement of my phantom arm. I find it is a part of my body”. The pattern recognition system has to be trained prior to each use of the prosthesis. A daily training program was started. At the end of the program the patient was able to eat,

to dress up, to go to the bathroom without any help. It was intended to use the prototype of multidegree of freedom arm prosthesis -7DOF- only in the laboratory of Otto Bock. Actually, the patient is fitted with a 3DOF prosthesis for his daily use at home based on the same intuitive control strategy as the 7DOF prototype for the laboratory.

Conclusion

The case study showed a promising outcome for an improved prosthesis control, resulting in a better quality of life for the patient. It showed also that in every day life a series of additional challenges had been met for a successful fitting. But some challenges still remain. These include that more than two electrodes have to be integrated into the socket to record the EMG-pattern. Furthermore, for successful daily use the training process has to be simplified, the training frequency has to be minimized and electrode placement must be reliable. The medical requirements for such a fitting, the fitting process itself and especially the physiotherapeutic training have been defined so that the unique prosthesis control satisfies the needs of a wide range of people.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3362-537]

Moving Towards an Open Standard: The UNB Prosthetic Device Communication Protocol

Author
Losier, Yves (Fredericton CA)
University of New Brunswick - Institute of Biomedical Engineering

Coauthors
Wilson AW

Abstract
UNB has released a draft protocol to the Standardised Communication Interface for Prosthetics group in the hopes that it could further advance the initiative's goal of developing an open standard for the communication of prosthetic limb components. The benefits of its implementation are highlighted.

Introduction
The creation of an open standard for intercomponent communication in the prosthetic field was proposed several years ago [1]. Meetings and Workshops to discuss the open standard efforts were held during MEC05, ISPO 2007 [2] and MEC08 in an attempt to advance the initiative. While several manufacturers and research organizations were very receptive to the movement, many lacked the necessary resources to contribute to its advancement. Some research institutions, which were developing bus protocols for existing projects, offered to share technical details of their communication systems once available.
The recently distributed UNB draft protocol is the first of such documents to emerge and explains the UNB protocols characterization of module identifiers, message structure, commands, and presents implementation examples. The protocol is flexible and can support multi-master systems with high bandwidth and low power consumption requirements.

Methods
The hardware communications platform chosen is a CAN 2.0A differential bus running at a rate of 1Mbps. The selection of this standard was made after carefully evaluating the benefits and limitations of existing communication standards as well as their ability to meet the requirements of present and future prosthetic systems.
The UNB protocol divides the standard identifier field into 3 subsections (Message Priority, Message Mode, and Node Identifier fields) in order to allow the specification of the destination/origin and priority of a message while removing any potential of arbitration issues. Furthermore, the protocol relies on a small set of low-level function commands to perform the various activities found within an embedded system for a prosthetic limb. Desirable features, such as power saving techniques, can be easily implemented with a good understanding of the device hardware and careful planning.

Results
A preliminary version of the communication protocol has been implemented between a master controller and multiple EMG sensors. Since battery longevity is a major concern in a prosthesis, several methods were attempted to reduce power consumption. Given that a CAN transceiver requires considerable power, it was shown that power was actually decreased by running the microprocessor at a high clock rate sufficient to operate the CAN bus at its full 1Mbps speed which minimized the time the CAN transceiver was

enabled. Then, placing the processor in a sleep mode between data sampling and transmission resulted in the lowest power consumption. With the CAN transceiver disabled between transmissions, the master controller is no longer able to communicate with the sensor. To facilitate a return communication path to the sensor, a periodic beacon is sent to the master controller at which time the sensor allows a return transmission. This implementation of the protocol has been shown to simultaneously support at least 8 EMG sensors sampling at 1kHz while consuming only 3.5mA of current per sensor.
When multiple messages are placed on the bus simultaneously, the CAN bus uses a bus arbitration scheme to allow each of the messages to communicate successively based on priority. To ensure that the CAN transceivers are not enabled for an extended period while waiting for the bus arbitration to occur, it is planned to have all sensors communicate during separate time slices.

Conclusion

A communication protocol has been designed with the open standardisation of both communication and power supply aspects of the interconnection of artificial limb components in mind. Its successful implementation in an ongoing low power prosthetic limb design, which requires a higher data transmission bandwidth than current commercially available systems, highlights some of the standards significant advantages.
The adoption of such a protocol by various manufacturers and research institutions would allow for interoperability and improved interchangeability of prosthetic devices from different manufacturers. Such flexibility would be highly beneficial for researchers, manufacturers, prosthetists, technicians, and perhaps more importantly, the end users of these devices.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3221-403]

EMG Pattern Recognition Based Control of a Two Degree of Freedom Powered Prosthetic Wrist

Author
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Coauthors
MacPhail C, Kyberd P, Bush G, Hill W, Lemaire E, Goudreau L, Brookeshaw M

Abstract
A myoelectric pattern recognition based control scheme was modified to control a novel two degree of freedom (DOF) powered wrist design in conjunction with a conventional electric hand design and was successfully tested by a trans-radial amputee.

Introduction
Current prosthetic wrist designs are generally limited to a single degree of freedom. Increasingly, designs with extra passive motions are being introduced to reduce the need for excessive compensatory motions. Currently, powered flexion is limited to the combined action in the Kesheng and Centri hands and only the Sven hand has both powered pronation/supination and flexion/extension with independent control [1,2]. Observations of users with the additional motions have shown that the ability to flex the wrist enables the hand to be placed in a more effective position for grasping objects [3]. Previously, the addition of more powered motions to prostheses has required slow and non-intuitive means of switching between the different motions. Pattern recognition of multi-channel myoelectric signals (MES) has the potential to make this selection simpler and more intuitive. This paper describes work towards this goal.

Methods
A mid-level trans-radial amputee was fitted with a condylar suspension socket. Four pairs of dome electrodes were embedded in the socket, distributed around the remnant limb. A modified, more compact version of 2 DOF ToMPAW wrist [4] was mounted on the end of the socket with a Motion Control trans-carpal hand attached distally.
UNB's ACE software [5] was modified to provide real-time control outputs to the wrist through a custom translator board. The control system was trained to recognize the seven types of contractions (wrist pro/supination, flexion/extension, hand open/close, and no motion) needed to drive the 3 DOFs of the wrist and hand. Rather than using simple amplitude measures, pattern recognition uses spatial and temporal patterns in the multi-channel EMG. The simplest and most intuitive arrangement is therefore to have the user elicit physiologically appropriate contractions which are recognized by the controller and used to drive the corresponding motion of the prosthesis.

Results
The latest design iteration of the wrist is 60mm x 60mm x 30mm and occupies 40mm of length within the hand shell, but only 20mm on the proximal side of the joint axis, broadening the potential user population [6]. Integration of the wrist with the socket and commercially available hand was simple and straightforward. There was no noticeable deterioration in signal quality when using the electrodes embedded in the socket, as compared to previously tested adhesive Duotrode electrodes. Offline classification accuracy metrics

used to quantify the expected efficacy of the pattern recognition control system were above 95% for all classes. Calibration of the controller took only a few minutes, requiring a brief data collection session and training of the pattern classification algorithm, and was reproducible from trial to trial. The subject was able to elicit the seven contractions repeatedly and in desired sequences.
The user subjectively reported accurate and usable control of all three DOFs, and exhibited less compensatory motions during pick and place tasks than without the new 2 DOF wrist. Figure 1 shows the prosthesis in use. Further quantitative analysis is ongoing and will include a comparative study between the subject's conventional myoelectric device and the new three-DOF device. The devices will be compared using the SHAP (Southampton Hand Assessment Protocol) [6] test while being recorded using a seven camera Vicon motion analysis system.

Conclusion
This artificial wrist design provided a compact and functional design which was easily integrated with an existing hand. Coupled with physiologically appropriate pattern recognition based control, initial results were promising and indicated that the system could form the basis of a viable prosthetic option for trans-radial amputees. Ongoing research involves further testing of the device and controller package, and embedding of the pattern recognition controller into a compact microprocessor node on the network of the arm controller.

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Session: Upper Extremity Prosthetics - / Socket Prostheses Control
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3462-637]

Multimodal Sensor Control for Orientating the Hand of a 3-DOF Transradial Myoelectric Prosthesis

Author
Ohnishi, Kengo (Souja, Okayama JP)
Okayama Prefectural University - Faculty of Computer Science and Systems Engineering

Coauthors
Kengo Ohnishi, Isamu Kajitani

Abstract
The development of our multimodal sensor control for a 3 degrees-of-freedom hand is reported. An accelerometer is installed to compute the posture angles of the residual arm and drive the pronation joint and the wrist flexion joint. The experiments showed that it naturally reduces compensating shoul

Introduction
Multifunctional prostheses control has been one of the challenging demands of the upper limb amputees. The lack of wrist joint in conventional transradial prosthesis requires compensation by the shoulder and trunk posture when orientating the fingertip for prehension. The unnatural postures are energy consuming and require additional training to perform precision tasks. Furthermore, myoelectric control lacks sensory feedback of the postural state of the prosthesis.

Methods
In this research, we applied acceleration sensor to add signal source to the conventional myoelectric hand controller. The sensor is added to compute the gravitational force angles which represent the arm posture. This information is used to trigger the wrist joint movements of a 3 degrees-of-freedom transradial prosthesis. Our multimodal sensor controller and software are developed on an embeddable microcomputer system and tested as a quasi-prosthetic device, which are assembled to be donned by non-amputated subjects. Tests were conducted under two control interfaces: the conventional two-site two-functions on/off control with a locked wrist and forearm, and our multimodal sensor control. The two myoelectric sensor signals and the x- and y-axis acceleration sensor signals were instrumented, computed, and recorded. The sensor signals are processed on the microprocessor to control the prosthetic hand unit while the sensor signals are transmitted and logged on a PC.

Results
In this research, we applied acceleration sensor to add signal source to the conventional myoelectric hand controller. The sensor is added to compute the gravitational force angles which represent the arm posture. This information is used to trigger the wrist joint movements of a 3 degrees-of-freedom transradial prosthesis. Our multimodal sensor controller and software are developed on an embeddable microcomputer system and tested as a quasi-prosthetic device, which are assembled to be donned by non-amputated subjects. Tests were conducted under two control interfaces: the conventional two-site two-functions on/off control with a locked wrist and forearm, and our multimodal sensor control. The two myoelectric sensor signals and the x- and y-axis acceleration sensor signals were instrumented, computed, and recorded. The sensor signals are processed on the microprocessor to control the prosthetic hand unit

while the sensor signal and motor command logs are transmitted to a personal computer, where they are monitored and recorded.

Conclusion

A concept of multimodal sensor control for 3-DOF transradial prosthesis is proposed and tested with a prototype device. The method combines the conventional myoelectric control of the prosthetic hand with an acceleration sensor-based control. The acceleration sensor signals represent forearm orientation angle and the component of the longitudinal direction is read as the elbow flexion angle. Based on this information, the wrist flexion and forearm pronation/supination is triggered in relation to the elbow posture. The data gained using multimodal sensor control showed reduced shoulder abduction angle, when compared to conventional locked-wrist myoelectric hand control.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [4001-None]

Hindfoot

Session Chair
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1900161

Symposium: Hindfoot
Monday 2010/05/10 | 17:00 - 18:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [4002-872]

Hindfoot Amputations in Diabetic Patients with Vascular Disfunction

Author
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Introduction
Rehabilitation results are much superior in hindfoot than in transtibial amputations, especially in patients with diabetes and peripheral vascular diseases. The tip of the stump is able to tolerate full weight bearing. This also preserves the proprioception. There is none or only little leg length shortening. The patient should even be able to walk barefooted when at home. The operative techniques presented have to be as atraumatic as possible with regard to the etiology. Tendon transfers and bone fusions are not recommended because of a higher risk of complications and a prolonged time of healing. The bulbous stump shape permits a comfortable tight fit of the prosthesis without any laces and straps. Donning and doffing of the prosthesis must be easy. Comfort and cosmesis are important for geriatric patients as well. In Chopart amputation, the prosthesis should leave the limited range of motion to the ankle joint.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1900161/cg1900549

Symposium: Hindfoot
Monday 2010/05/10 | 17:00 - 18:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [4003-897]

Hindfoot Amputation - Tendomyoplastic Procedure for Maintenance of Balance

Author
Neff, Georg (Berlin DE) | Univ-Prof. em. Dr. med.
Oskar-Helene-Heim, Freie Universität Berlin

Abstract
To avoid varus-equinus deformity after original Chopart disarticulation additional surgical methods are recommended. Marquardts tenomyoplastic Chopart disarticulation, however, avoids contracture, maintains full ROM of the ankle joint and allows for total weight bearing.

Introduction
The original Chopart-disarticulation results after soon in a fixed varus-equinus deformity with additional length of limb and reduced weight bearing capacity due to loss of all extensor forces but full power of the calf muscles. For these reasons original Chopart hind foot stumps are condemned. To prevent this lengthening of Achilles tendon, reinsertion of tibialis tendons at the talus, chamferizing of the plantar calcaneus and/or arthrodesis are recommended.

Methods
The tenomyoplastic Chopart-disarticulation developed by E. Marquardt proved to be superior to those power- and ROM-reducing procedures. Extensor tendons and a foot sole flap containing the plantar muscles are preserved. After disarticulation two notches in the talus head and one in the calcaneus guide the extensor tendons for fixation with the plantar capsule, the muscle-skin flap is sewed to the fascia at the ankle joint converting flexors into additional extensors.

Results
As a result pain free plantigrad weight bearing of these Chopart stumps, entire length of talus lever arm and full physiological ROM of the upper ankle joint are maintained durably for modern prosthetic supply, e.g. silicon prostheses. X-rays and clinical images demonstrate full extension and plantar flexion - even after years.

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Symposium: Hindfoot
Monday 2010/05/10 | 17:00 - 18:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [4004-879]

Tendon Transfers in Balancing Amputation Stumps

Author
Roukis, Thomas S. (Tacoma US) | DPM, PhD, FACFAS
Madigan Army Medical Center - Department of Surgery

Introduction
Soft-tissue and osseous balancing of forefoot and midfoot amputations is imperative to provide the patient with a stable, durable, and functional residual foot.

Methods
This presentation discusses reproducible methods for balancing Transmetatarsal, Lisfranc, and Chopart amputations with detailed explanations of the recommended surgical techniques.

Results
Clinical examples are employed to demonstrate successful limb salvage following Transmetatarsal, Lisfranc, and Chopart amputations which have undergone tendon balancing procedures.

Conclusion
In addition to performing the appropriate procedures for the individual patient, careful attention to the peri-operative management of this patient population, with a multi-disciplinary approach, is mandatory for long-term success.

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Symposium: Hindfoot
Monday 2010/05/10 | 17:00 - 18:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [4005-880]

Possibilities of a Prosthetic Fitting After Amputations in the Hindfoot Area

Author
Schäfer, Michael (Traunstein DE)
Pohlig GmbH

Coauthors
Olaf Gawron, Josef Stahl

Introduction
The prosthetic fitting after amputations in the hindfoot area should take into consideration – besides the best possible restoration of the walking and standing ability - also the frequently expressed desire for a slim outer shape.

Methods
The saving of the loadable skin of the sole after Chopart and Pirogoff-Amputations makes it in many cases possible to reduce the prosthetic construction to the pure biomechanical specifications of the fitting.
The same attention must be paid to the prevailing muscular imbalance, which is caused by the amputation of muscular insertion points. While stumps of the Chopart foot tend to develop into a talipes equinus and varus heel malposition in the residual parts of the ankle joint we often find more stable axes with the more proximal types of amputations in the hindfoot area.
Depending on the clinical demands and the desires of the patient concerned, quite different solutions of fitting may be asked for. The integration of a minimum construction height of the prosthetic foot systems applied must be considered as well as the demands for the best possible correction of the axes and an adequate shape.

Results
The prosthetic fitting of amputations in the hindfoot area must meet different criteria. At first the forefoot lever, which has been lost through the amputation, must be adequately restored. This is difficult in so far as in both the Chopart and the Pirogoff-Amputations only very low construction heights can be allowed for. The minimization of the frictional forces working onto the end of the stump should be effected through an embedding technique the length of the lower leg with a ventral support on the tibial plate. The following methods are presented as proven fitting systems depending on the amputation level:
- Silicone foot prosthesis with high socket embedding and supplementary shank-length Prepreg adaptional orthosis for use under high strain.
- hindfoot prosthesis in carbon-frame socket technology
- hindfoot prosthesis in container socket technology with partial soft wall liner
Ideally the prosthetic construction should meet the biomechanical demands of a painfree rolling of the foot and show a design which should be as slim as possible and eventually make the wearing of ready-made shoes possible.

Conclusion
If the functions of the upper ankle joint have been saved everything should be done to make this mobility possible in the prosthetic construction. This has a lasting positive effect on the blood circulation as well

as the gait. Here combined silicone/Prepreg-prostheses could secure themselves an efficient field of application.
The frame socket technology according to Pierre Botta also represents an active fitting variant, which shows a very good outcome with regard to function as well as cosmetics.
The combination of function and aesthetics, especially in the field of hindfoot prosthetics, demand a permanent search for low-volume functional fittings. That the orthopaedic technologist, particularly in this field, has to make use of a whole variety of the most different manufacturing techniques enables him to find a wide range of individual, patient-oriented solutions.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3671-None]

Orthotics - Stroke and Central Disorders

Session Chair
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Session Chair
Bregman, Daan J.J. (Amsterdam NL) | Drs.
VU University Medical Center - Rehabilitation Medicine

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3104-302]

Randomized Cross-over Study of AFO Ankle Components in Adults with Post-Stroke Hemiplegia

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Coauthors
Stine R, Gard S

Abstract
A randomized cross-over study comparing the effect of ankle components on the gait of 21 adults with post-stroke hemiplegia wearing 3 differently articulated polymer ankle foot orthoses (AFO).

Introduction
Over 4 million Americans use orthoses, with Ankle Foot Orthoses (AFOs) being the most widely used. [1,2] When pathologies such as hemiplegia are present, ankle-foot function is disrupted and an AFO may be worn to restore function. The function imparted by AFOs relies largely upon the degree of resistance provided to rotation about the ankle.[3] There are a number of ankle joints and motion control devices currently available for use in thermoplastic AFOs, but functional evaluation of orthotic ankle components is limited.[4-6] The purpose of this randomized cross-over study was to assess the effect of different ankle components on the gait of adults with post-stroke hemiplegia who wore articulated AFOs.

Methods
Northwestern University's Institutional Review Board approved this study and subjects gave informed consent. 3 articulated AFOs with full length foot plates were custom made of 3/16" polypropylene from the same cast by a single orthotist. Each AFO was worn for 2 weeks in random order: 90° plantarflexion stop/ free dorsiflexion (AFO1); plantarflexion limiter/free dorsiflexion (AFO2); 90° plantarflexion stop/dorsiflexion assist (AFO3). Tamarack Flexure Joints were used. A baseline condition (NoAFO) was recorded using standardized footwear. Durometer selection for the motion limiter and dorsiflexion assist joints were based on clinical evaluation. Gait analyses were conducted using the Helen Hayes marker set, an 8 camera motion capture system, and 6 force plates set into a 10m level walkway. 3 trials were averaged for each subject at a normal speed. Data were analyzed using non-parametric tests with $p<0.05$ for main effects and $p<0.008$ for post hoc comparisons (after Bonferoni correction).

Results
Data were analyzed for 21 subjects, 9 males and 12 females (mean age: 54.0 ± 7.7 years, mean mass: 81.7 ± 18.8kg, mean height: 169.3 ± 10.5cm). Mean time since stroke was 6.6 ± 5.8 years (12 left, 9 right hemiplegia). Subjects were broken into two groups depending on whether or not knee hyperextension was present during gait without an AFO. Temporospatial variables did not differ between groups, but peak knee moment during loading response was significantly different for all conditions; knee angle during loading response were significantly different for all but the AFO2 and AFO3 conditions; and ankle angle at mid swing and initial contact was significantly different for all but the AFO2 conditions. There was no difference between conditions with regards to the load transfer transient. Table 1 shows the results as median (interquartile range) for all subjects and for the group with knee hyperextension.

Conclusion

For all subjects, all AFO conditions significantly increased walking speed and step length on the involved side to the same extent compared to NoAFO. In general, all AFOs had a more substantial effect on gait in persons with hemiplegia who exhibited knee hyperextension when walking without an AFO. Dorsiflexion assist joints did not provide additional dorsiflexion during swing when compared to AFOs without dorsiflexion assist. Results suggest that a larger sample size is needed to detect post hoc differences for peak knee angle during loading response and load transfer transients.

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Image: Fatone Table 1_None.jpg (see online)

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3016-214]

The Effect of the Flexibility of an Ankle-foot Orthosis (AFO) on Lower Limb and Trunk Kinematics in Stroke Hemiplegics

Author
Kobayashi, Toshiki (HK)
The Hong Kong Polytechnic University - Health Technology and Informatics

Coauthors
Boone DA, Leung AKL

Abstract
Investigation on the effect of the flexibility of an AFO on the kinematics of stroke hemiplegic gait using an experimental AFO with adjustable flexibility suggested that its effect on kinematics would depend on the individual, but be diminished toward the proximal joints and trunk in general.

Introduction
The flexibility of an ankle-foot orthosis (AFO) must be appropriate for the spasticity and weakness experienced by each stroke patient to achieve best treatment outcomes. The plantarflexion resistive torque required to be generated by an AFO to prevent foot-slap at initial contact was claimed by Yamamoto et al. (1993) to be the most important function of an AFO and more significant than that required during swing phase to prevent drop-foot. On the other hand, the dorsiflexion resistive torque generated by an AFO is thought to be required to support the insufficient push-off in stroke hemiplegic patients due to its propulsive force at terminal stance (Lehmann et al., 1982), but has the disadvantage of restricting ankle dorsiflexion at mid-to-late stance (Yamamoto et al., 1997). The purpose of this study was to investigate the influence of dorsi- and plantarflexion flexibility of an AFO on kinematics of stroke hemiplegic gait using a custom-made experimental AFO (EAFO).

Methods
Ten hemiplegic subjects (10 males; aged 54.3 (8.4)-year-old) who suffered from a stroke for more than three years (duration of 3.7- to 16.5-year) participated in this study. EAFO was designed with two oil-damper joints (Yokoyama et al., 2005) on a modular type double-upright AFO, so that one side of the orthosis would generate a plantarflexion resistance and the other a dorsiflexion one. Gait analysis was conducted with a 3D motion capture system. Markers were placed on anatomical landmarks and the EAFO. Each subject was subsequently instructed to walk under a nine degree of EAFO flexibility conditions. Lower limb joint (flexion or extension in sagittal plane) and trunk (ROM in three planes) kinematics were further analyzed. Between-condition comparisons of each gait parameter were made using one-way ANOVA followed by Turkey post-hoc procedure in each subject. Significant level was set at $p<0.05$. The study was approved by the ethics committee of The Hong Kong Polytechnic University.

Results
The alternations of the dorsi- or plantarflexion resistance of the EAFO significantly influenced the sagittal plane kinematics of the ankle joint in all subjects. The increase in plantarflexion resistance of the EAFO significantly increased the maximum flexion of the knee at stance phase in two subjects, while it significantly reduced the maximum flexion angle at swing phase in four subjects. The increase in dorsiflexion resistance of the EAFO significantly increased the maximum knee extension angles at stance phase in four subjects,

while it significantly increased maximum flexion angles at swing phase in three subjects. The increase in plantarflexion resistance of the EAFO did not significantly increase the extension or flexion range of the hip joint, while the increase in dorsiflexion resistance significantly increased the maximum extension angles of the hip joint in three subjects. Finally, the increase in plantarflexion resistance of the EAFO significantly increased ROM of the trunk in sagittal plane in one subject and in transverse plane in another. The increase in dorsiflexion resistance of the EAFO did not reveal any significant effect on trunk kinematics. The results were summarized in Table 1.

Conclusion

It was demonstrated that alternations to the flexibility of the EAFO instigated significant differences in sagittal plane ankle kinematics in all subjects. It was suggested that increased plantarflexion resistance of the EAFO induced increased flexion of the knee in early stance phase in two subjects due to excessive plantarflexion resistance, while reduced plantarflexion angle of the ankle due to increased plantarflexion resistance allowed four subjects to flex their knee for toe-clearance more easily in swing phase. It was also suggested that hip joint kinematics might be more responsive to the dorsiflexion resistance of the EAFO and dorsiflexion resistance might assist to increase the extension of the hip joint in particular group of patients. Finally, the effect of the flexibility of the EAFO on trunk kinematics appeared to be minute. Therefore, the effect of the flexibility of an AFO depends on the individual, but be diminished toward proximal joints and trunk in general.

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Image: Kobayashi_abstract1_None.png (see online)

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2849-64]

Treatment of Foot Drop Combined with Genu Recurvatum

Author
Decataldo, Vincent (Fairlawn, New Jersey US)
Rinko Orthopedic

Coauthors
Stenström Anders MD, PhD, Professor

Abstract
When treating Patients with Stroke, CMT, Post Polio, we are involved with the results of nerve- and muscle failure such as Foot Drop, which we will recognize soon after the incident. On longer term we can be confronted with other problems resulting from the muscle weakness, such as Genu Recurvatum.

Introduction
Severe Genu Recurvatum we cannot allow to continue; not only due to the arising pain resulting from the bad-loading; but moreover since the degree of Recurvatum increases over time. Furthermore the walking speed will decrease and the asymmetry will cause multiple traumas in the rest of the body.
Another reason for dealing with the situation is the position of the ankle and foot in relation to the position of the lower leg and thigh. This position does not allow us to treat the foot drop with a dynamic-response-floor-reaction AFO like for instance the ToeOFF. A normal leg has the knee in a slight flexion of 8°. A knee in Recurvatum of 15° has the lower leg in approx. 80° in relation to the floor. The orthosis therefore will no longer be in neutral position and will force the foot in dorsal flexion, resulting in poor dynamics for walking activity.

Methods
Patients were presented to us wearing a dynamic-floor-reaction /AAFO to prevent foot drop and wearing a number of different braces and bandages to overcome the negative effects of Genu Recurvatum.
A new type of knee brace will be presented, specially designed to be combined with a floor-reaction AFO, which can dynamically control the over-extended knee, while not interfering with the dorsal flexion assist offered by the AFO for management of foot drop.
This new knee brace consist of free moving double axis joints combined with a thigh cuff designed to control the inner rotation and a shin connector band to be fixated at the AFO.

Results
At delivery of this application we have fitted 18 patients with the combination of AFO and knee brace with satisfying results. Pain has been minimized, walking- speed and time has been increased. Evaluations and fittings will be continuing. By the time of the presentation a full report may be expected.

Conclusion
Clinical evaluations of patients fitted with an AFO combined with a knee brace have provided sufficient evidence for the positive outcome of this treatment method. In order to be capable of helping more patients in a cost-effective way a decision has been established to modify the prototype knee brace into a modular system that can interact safely with an Ankle-Foot-Orthosis.

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Image: AFO + Knee Brace_None.JPG (see online)

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3335-510]

The Effect of Ankle-foot Orthoses on Quality of Life and Psychological Well-being in the Management of Stroke: a Review of the Literature

Author
McMonagle, Christine (Glasgow UK) | Miss
University of Strathclyde - National Centre for Prosthetics and Orthotics

Coauthors
Dr. Rasmussen, S Dr. Eliot, M

Abstract
This paper describes a review of the literature carried out to determine the effect of ankle-foot orthoses (AFOs) on quality of life (QoL) and psychological well-being for people with stroke and suggests avenues for further research in this area.

Introduction
AFOs have been recognised as a treatment option for people with stroke for many years (Condie et al 2004). Use of AFOs in stroke has the potential to reduce activity limitations, increase participation in activities and society and therefore improve psychological well-being and quality of life.
Most AFO literature generally considers outcomes that can be easily measured such as the effect on temporal and spatial parameters of gait, and additional kinetic and kinematic measures of gait. However there is a growing recognition that psychological factors such as emotional, cognitive and social factors not only can impact on functional outcome, but may also have value in predicting outcomes. An understanding of these factors may also offer opportunities for designing interventions that can influence use of AFOs and their perceived benefits. This aim of this literature review is to identify the effect of AFOs on quality of life and psychological well-being for people with stroke.

Methods
A review of the literature was carried out during July to September 2009, using the following databases: Medline; CINAHL; EMBASE; Recal Legacy; and APA PsychNET. Search terms used were: ankle-foot orthosis; AFO; psychology; stroke; quality of life; and well- being. Due to the dearth of literature identified in the initial search, the search was expanded to include measurement of quality of life and psychological well being related to any lower limb orthotic intervention and any pathology.
A hand search of journals was also carried out.In addition,references in key texts were searched to identify any other relevant articles. Abstracts were then sourced and papers were selected according to the inclusion criteria. Inclusion criteria included peer reviewed publications between 1980- 2009, written in English, which involved measurement of quality of life or psychological well-being in relation to orthotic management. Literature reviews and consensus statements were also included.

Results
While a considerable number of papers suggested orthoses can improve quality of life, only 14 papers have attempted to quantify this, and only one study was specifically related to orthoses and stroke (Fernandes, 2006) Foot orthoses were the most commonly studied intervention covering a wide range of conditions. Several other papers were identified that considered a wider rehabilitation programme including orthoses.

There was no consensus regarding use of instruments to quantify effect of orthoses on quality of life, although SF 36, a short 36 item generic measure of subjective health status (Ware et al, 1992) was the most commonly used measure.
Only 4 studies attempted to measure psychological outcomes relating to orthotic management, with only one study reporting measures of psychological well-being related to AFOs in stroke management(NHS QIS, 2009). All four studies identified used different instruments. However there was evidence in the literature of an increasing use of outcome measures which capture the patient experience. This offers opportunities for a greater understanding of the cognitive processes affecting use and usefulness of orthoses.

Conclusion

There is a need for more evidence relating to effect of AFOs on quality of life and psychological well-being in stroke. AFOs offer the potential to improve quality of life and psychological well-being but there is a need to understand the cognitive processes by which this occurs. Psychological effects of AFOs are particularly useful to measure because they offer opportunities to develop interventions that can improve functional outcome through AFO use and may also allow specific targeting of patients who, because of their psychological profile are less likely to benefit from orthotic management.
A greater knowledge of cognitive processes that may influence use of orthoses will enable allied health professionals to offer improved support to users and the possibility to influence user perceptions that may decrease disability. This has implications in orthotic management where psychological input is currently under utilised.

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3142-340]

Pilot Investigation of Movement Smoothness in Post-stroke Hemiplegia: Evaluations with and without Ankle-Foot-Orthoses

Author
Zissimopoulos, Angelika (Chicago US)
Northwestern University - Biomedical Engineering

Coauthors
Gard SA

Abstract
One goal of body movements may be to maximize smoothness. In people with post-stroke hemiplegia, an ankle-foot-orthosis (AFO) may partially restore movement smoothness. Center of mass and center of pressure movement smoothness during gait were evaluated in this population with and without an AFO.

Introduction
Stroke is the leading cause of long term disability in the US (1). Unilateral hemiplegia, the most common side effect, leaves many with gait difficulties. An ankle-foot-orthosis (AFO) is often prescribed to assist gait, but its functional impact is still unclear. It has been suggested that movements are planned to maximize smoothness. This has been examined in the upper limb, but limited research exists on lower limb or total body movements (2; 3; 4; 5). The effects of stroke or an AFO on movement smoothness are unknown. This study characterized center of mass (COM) and center of pressure (COP) movement smoothness in a chronic post-stroke population with and without an AFO. Results may indicate whether movement smoothness can be used to characterize gait changes due to stroke or use of an AFO, providing an alternative metric for post-stroke gait disability and the functional effects of an AFO, and may identify the portion of the gait cycle most sensitive to these changes.

Methods
Data from 5 subjects with post-stroke hemiplegia were collected at the Veteran's Affairs Chicago Motion Analysis Laboratory (VACMARL). Kinematic data were collected using 8 Eagle Real-Time cameras with retroreflective markers at anatomical landmarks according to the Helen Hayes marker set. Kinetic data were collected from 6 AMTI force plates embedded in the 8 m walkway. Inclusion criteria were: >24 mos. post-stroke, presence of unilateral hemiplegia, age 40-70 years, and current user of an AFO. Subjects walked in a shoes only condition at their self-selected walking speed across the walkway until 5 clean force plate strikes were collected for each foot. This procedure was repeated while subjects wore a conventional articulated AFO (plantarflexion stop at 90 degrees). Jerk (3rd derivative of position) and jerk cost (time integral of jerk squared) of COM and COP data were calculated for each subject. For comparison, data from 10 able-bodied age and speed-matched subjects were analyzed.

Results
Small differences were noted for COM jerk among the three cases (AFO, No AFO, and able-bodied). The most notable difference was in early stance (double support), with the No AFO condition being the least smooth movement followed by the AFO condition and finally the able-bodied condition. The jerk cost analysis revealed that the No AFO condition had the highest jerk cost, followed by the AFO condition and finally the able-bodied condition. More pronounced differences were observed for the COP data,

specifically during early stance (see figure). The affected side in the No AFO condition had the highest jerk. When analyzing jerk cost, similar trends were revealed with the No AFO condition having the highest jerk cost, followed by the AFO condition and finally the able-bodied condition.

Conclusion

Changes in movement smoothness were most evident in COP data. Jerk and jerk cost can be used to distinguish between COP movement with and without an AFO and between hemiplegic gait and able-bodied gait. The results suggest that COP and COM movement smoothness increases with use of an AFO, particularly during early stance on the affected side. Weight transfer, which may be an especially challenging task to the locomotor system, occurs during this double support phase so it may be a significant finding that this part of the gait cycle is sensitive to external biomechanical influences. It is possible that rehabilitation strategies should focus on influencing this portion of the gait cycle. Additionally, it is unclear how ML stability during double support may be affected by changes in movement smoothness. Therefore, future work should analyze a larger pool of subjects and should investigate whether there is a link between movement smoothness and mediolateral stability.

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Image: ISPO_Zissimopoulos_None.jpg (see online)

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Session: Orthotics - Stroke and Central Disorders
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3597-676]

Polypropelyne Ankle Foot Orthosis in Central Neurological Patients: A Mechanical and Functional Evaluation

Author
Bregman, Daan J.J. (Amsterdam NL) | Drs.
VU University Medical Center - Rehabilitation Medicine

Coauthors
V. de Groot, P. van Diggele, H. Meulman, H. Houdijk, J.Harlaar

Abstract
We assessed the functional benefit and the mechanical contribution of AFOs prescribed to overcome drop foot gait in central neurological patients. The AFO was functionally beneficial in 4 out of 7 patients. This result could be explained by the mechanical
contribution of the AFO.

Introduction
Patients with central neurological disorders, Ankle Foot Orthoses (AFOs) are frequently prescribed to treat gait related problems, including “drop foot” gait[1,2]. The AFO will have a beneficial effect for the patient, depends on how the mechanical characteristics of an AFO interfere with the patient’s ankle function. The development of a device that can measure AFO characteristics reliably[3], it is now possible to fully characterize the AFO mechanically, and quantify its effect throughout the gait cycle. The aim is to measure both the functional effect of the AFO (change in energy cost of walking) and the mechanical contribution of the AFO (joint moments and powers that can be attributed to the AFO) in gait of patients to whom an AFO is prescribed to assist the foot during the swing phase. The suboptimal functional effects of the AFO are caused by either insufficient contribution of the AFO during the swing phase or unwanted constraining of the ankle during the stance phase.

Methods
Four chronic stroke patients and three multiple sclerosis (MS) patients participated in this study. To all seven patients, a polypropylene AFO to assist the foot during swing was prescribed during the last three years. The functional benefit of the AFO, defined as the change in Energy Cost (EC) of walking, was determined using a portable oxygen consumption measurement system[4]. Patients were regarded to benefit from their AFO, when the AFO resulted in a decrease in EC>10%. The stiffness and neutral angles of the AFOs were tested using the BRUCE device[3]. An instrumented gait analysis was performed with the patients walking on shoes and walking on the combination of shoes and AFO. Subsequently, the combined information from the instrumented gait analysis and the AFO characteristics was used to calculate the contribution of the AFO to the ankle joint moment and ankle joint power of the affected limb.
Results

Results
The prescribed AFOs had a mean stiffness of .19 Nm/deg and a mean neutral position of 1.0 degree dorsal flexion. On average for the whole group, the AFO resulted in a 12.1 %

decrease in EC of walking. The mean walking speed was 0.10 m/s higher when walking with the AFO. However, it appeared that the AFO was only beneficial in four out the seven patients, i.e the benefit group.
Walking with the AFO resulted in changes in the ankle kinematics in the benefit group, whereas in the non-benefit group the ankle kinematics remained constant (Fig. 1, Table 1). In the benefit group, the ankle angle during swing shifted towards a more dorsal flexed position, as did the ankle angle during initial contact. For both the benefit group and the non-benefit group, the kinematics in the knee and the hip joint did not differ between the conditions with and without the AFO.
In both the benefit and the non-benefit group the major part of the ankle moment during stance was provided by the subject rather than the AFO (Fig. 2). The mean contribution of the AFO was low during stance and swing. For both groups, the contribution of the AFO to the total power about the ankle joint was marginal. No changes in peak ankle power were found as a result of wearing the AFO. Furthermore, no changes in the ankle joint work were found as a result of wearing the AFO, indicating that the AFO did not hamper the role of the ankle during stance.

Conclusion
We found that wearing an AFO resulted in a significant improvement of walking speed and energy cost, only when the mechanical characteristics of the AFO matched the ankle mechanical deficiencies during gait. During the stance phase, the contribution of the AFO was negligible compared to the ankle joint moment generated by the patient. Likewise, the powers attributable to the AFO were small. Logically, the functioning of the ankle throughout the stance phase, and more specifically the ability to dorsal flex the ankle and generate a subsequent push off with the ankle, was not hampered. During swing, the mechanical contribution of the AFO was low, yet enough to keep the foot in neutral position. The absence of functional effects of the AFO in three out of seven patients may be attributed to non compliance to the indication for the AFO, since in non-benefit patients no plantar flexed position of the ankle during swing was observed when walking without the AFO.

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Image: ISPO DBregman Abstract 1_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg227276/cg93948

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3684-None]

Rehabilitation - Quality of Life

Session Chair
Rommers, Gerardus M (Clemens) (Groningen NL) | MD, PhD
University Medical Center Groningen, University of Groningen - Center for Rehabilitation

Session Chair
Burger, Helena (Ljubljana, Slovenia SI)
Institute for Rehabilitation, Republic of Slovenia - Centre for P&O

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Session: Rehabilitation - Quality of Life
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Rehabilitation Science | Subtopic/Track: Rehabilitation

Congress Lecture [3137-335]

Epidemiology of Lower Limb Amputations in the Netherlands: an Overview of 25 Years of National Registration

Author
Rommers, Gerardus M (Clemens) (Groningen NL) | MD, PhD
University Medical Center Groningen, University of Groningen - Center for Rehabilitation

Coauthors
Beks LJM, Groothoff JW

Abstract
In W-Europe about 80% of all lower limb amputations (LLA) are caused by vascular pathology. The majority of people is over 65 years of age. In de period 1982-2006 there are major changes in amputation level and age cohorts. There is a decrease in amputation incidence in the more elderly population.

Introduction
In the Netherlands with a population of 16,3 million people (in 2008) there are about 14% of people over 65 years of age. It is expected that in 2035 about 25% of all people will be between 65-95 years of age. In a more elderly population it is expected that the influence of vascular disease, diabetes mellitus and advanced age may cause an increase in elderly lower limb amputations. National data in the Netherlands show that especially in the 80+ age group there is an increase to be expected over the next 25 years. The number of amputees in the elderly age group can give an extra burden towards healthcare demands.

Methods
During the period 1982-2006 there were annually reports of major lower limb amputations (LLA) recorded in the Netherlands. 99,5% of all hospitals reported about their major lower limb amputations to the national register. All major lower limb amputations from transmetataral to hemi-pelvectomy level were registered. For all major amputations sex, age and amputation level were entered into the national register. Yearly updates were received from the national register of all operations performed. This to study changes over time. For incidence calculations the total number of inhabitants per January 1 st of every year was the denominator of the incidence calculations.

Results
In the studied period: 70700 lower limb amputations were performed in the Netherlands
On average there is an amputation incidence of 18.7 / 100.000 over the studied period.
In 1982: The transfemoral (TF))/ transtibial (TT) ratio: 1.0; In 2006: TF/TT ratio: 0.6 showing an increase of transtibial amputations. The number of knee disarticulation (KD) amputations was constant with an incidence of 9-12 per 100.000 inhabitants. The number of (partial) foot amputations increased from 2 to 3 per 100.000 inhabitants. The gender distribution: male/female is 2:1. About 80% of all amputations is performed in the age group 65+ years.
In the different age groups it was noted that there was a decrease of the incidence rate of the age group 80+ .

Conclusion

Between 1982- 2006 in the Netherlands there were 70700 LLA amputations performed in a population of 16 million people. The overall incidence was 18.7 / 100.000 people. 80% of people with a LLA is over 65 years of age. There is an important change in amputation level over the 25 years reported. The TF/ TT ratio changed from 1.0 to 0.6. KD amputations were seen in about 10% of all cases. There was an increase of amputations at footlevel. In the different age groups especially the decrease of amputations in the 80+ age group is remarkable.

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Image: LLA in the Netherlands GM Rommers_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234527/cg38733

Session: Rehabilitation - Quality of Life
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Rehabilitation Science | Subtopic/Track: Rehabilitation

Congress Lecture [2939-137]

Impact of Different Levels of Amputation on Quality of Life (QoL)of Iraqi Amputees

Author
Alobaidi, Alaa S. H. (Baghdad IQ) | Dr.
College of Health and Medical Technology - Medical Rehabilitation

Abstract
An Arabic version of WHOQoL-BREF was administered to four groups of limb amputees (n=179)to determine and compare the impact of different levels of amputation on amputeesQoL.It is found that the QoL of amputee population is poor in Iraq,with the effect being greatest for AK and less for UL amput.

Introduction
Amputation can often be associated with anxiety, isolation and depression, which may change the social and free-time activities of the person with limb amputation. QoL assessments are rarely implemented in routine clinical practice and there is a notable absence of guidance regarding QoL assessment in the field of prosthetics.
Over the past three decades, Iraq had faced three wars (with their following acts of violence), which resulted in about 200,000 amputees of different levels and depletion of financial, psychological and medical resources of the country. To date, there is no published data showing the effect of different levels of amputation on the QoL of amputees of this country, therefore the present study was conducted in June 2009 with the aim of assessing and comparing the impact of different levels of amputation on QoL of the amputees, regardless the etiology of amputation.

Methods
An Arabic version of WHOQoL-BREF was administered to four groups of amputees (n= 179 total) attending the three governmental prosthetic workshops in Baghdad city from June the 1st 2009 till July the 31st 2009 regardless the etiology of amputation and referral.
1- Below Knee (BK) amputees (n=70) includes Trans-Tibial (TT), Symes and Partial Foot (PF).
2- Above Knee (AK) amputees (n=59) includes Through- Knee (TK), Trans-Femoral (TF) and Hip Disarticulation (HD).
3- Upper Limb (UL) amputees (n=21) includes Partial-Hand (PH), Through-Wrist (TW), Below-Elbow (BE), Above-Elbow (AE) and Through- Shoulder (TS).
4- More than one limb amputees (n=29), which also includes bilateral amputees.
152 Males and 27 Females of 20 years of age and above who had been discharged for more than 4 months following amputation were selected. All the participants demographic and questionnaire response data were coded, input to SPSS version 10 software, checked and analyzed.

Results
Table 1 details the participants profiles. About 28% of the study population described QoL as bad or very bad, 40% as acceptable and 32% considered their QoL to be good or very good (Table 2).
About 23% of the study population described their health as bad or very bad, 19% as acceptable and 58% considered their health to be good or very good (Table 3). Mean scores of different levels of amputations for each of the four domains of QoL are summarized in Table 4, while Table 5 shows the comparison significance (P-value) of multiple pair-wise procedures by Mann-Whitney test.

With respect to Domain 1 (Physical capacity), UL group was found to be significantly better than other three groups.
In Domain 2 (Psychological relationship), UL group scored significantly better than BK group and AK group, but a non significant score (P>0.05) was recorded with respect to More than one limb group.
For Domain 3 (Social relationship), More than one limb group was found to be significantly better than AK group, but non significant scores were recorded with respect to UL group and BK group.
For Domain 4 (Environment), again UL group scored the highest and it was significantly better than those for BK group and AK group, but a non significant score was recorded with respect to More than one limb group.

Conclusion

Incorporating the patients perspective is a central component in amputation rehabilitation and assessing quality of life is an important aspect of this endeavour. There is an increasing awareness that the inclusion of QoL as an outcome measure is important in ensuring a client-centered and holistic post-amputation assessment. To concentrate solely on physical indicators belies the complexity of the individuals experience.This study examined and compared the QoL of different levels of amputation in an amputee population.
The QoL of an amputee is poor in Iraq with the effect being less for UL amputees and greater for AK amputees.Overall, a coordinated approach by health care professionals in the prosthetic team is necessary to insure the inclusion of QoL as an outcome measure that should not be overlooked.

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Session: Rehabilitation - Quality of Life
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Rehabilitation Science | Subtopic/Track: Rehabilitation

Congress Lecture [3254-435]

Effects of Lower Limb Prosthesis on Daily Living – A Systematic Review

Author
Töytäri, Outi (FI-00271 Helsinki FI) | Researcher
National Institute for Health and Welfare - Injuries and Functional Capacity Unit

Coauthors
Samuelsson K, brandt Å and Salminen A-L

Abstract
This systematic review determined the effectiveness of lower limb prosthesis in terms of activity, participation and quality of life in real-life contexts. From 818 references, nine studies were suitable for inclusion. Four studies reported significant improvements in the above-mentioned outcomes.

Introduction
Amputations of the lower limbs are a life-altering event with an obvious effect on the person's ability to perform many different activities needed for independent living. Prosthetic use might compensate for a lost ability to perform different activities provided that the prosthetic fitting process is successful. The scientific literature in general focuses on the development of new technical solutions, e.g. microprocessor-controlled prosthesis, new orthopaedic surgery methods, new socket solutions and custom-designed solutions. Outcomes of this research are most often expressed in terms of use of the prosthesis or walked distance, whereas it is equally important to report outcomes in terms of individuals' daily living and quality of life (QoL).
The aim of this study was to review and evaluate the quality of existing research in the area of leg prostheses targeting adults, in terms of activity, participation and quality of life in real-life contexts.

Methods
A search for studies on lower limb prosthesis interventions was performed in 12 databases. The search covered the period January 1998 until May 2009. The primary search focus was on studies with outcomes of lower limb prosthetic systems in terms of activity and/or participation and/or quality of life. The inclusion criteria were: 1) participants # 18 years with one or two lower limb prostheses, 2) controlled studies and all types of experimental studies with baseline and follow-up data and 3) studies with an outcome in terms of activity and/or participation and/or QoL.
Two reviewers independently selected and three reviewers independently assessed the included studies. Disagreements were resolved by consensus. Internal validity assessment was performed according to criteria by Borghouts et al. (1998), and external validity and applicability were assessment according to criteria by Shekelle et al. (1994).

Results
We screened 818 references and assessed the full text of 81 documents. Nine studies met our inclusion criteria. Eight studies were experimental studies and one was an observational study. Seven studies had a within-group comparison design and the remaining two had a between-group comparison design. Five studies had a Microprocessor-controlled knee prosthesis as the intervention, while in other studies the

interventions were silicon cover prosthesis, an ossiointegrated prosthesis, a special suspension liner, a total surface-bearing socket and a shock-absorbing pylon.
The internal validity evaluation process resulted in a mean score of 6.6 points (range 5-9, max 10 points) and the evaluation of external validity and applicability resulted in a mean score of 3.6 points (range 3-4, max 4 points).
Fourteen different outcome evaluation instruments were used. Four studies reported significant improvements in activity and/or participation. One of these studies obtained a high score on both internal - and external validity. Two studies reported no change, and two studies did not report activity and/or participation outcomes. Four studies reported increased QoL. Two of these studies were high quality trials concerning both internal and external validity. Two studies reported no difference and three studies did not report on QoL.

Conclusion
Interventions and outcome measurement methods varied between the studies. However some evidence was found, suggesting that certain lower limb prostheses systems could improve user activity and participation and increase quality of life. Only two of these studies obtained a high score in both internal and external validity. More well-designed research is needed.

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Session: Rehabilitation - Quality of Life
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Rehabilitation Science | Subtopic/Track: Rehabilitation

Congress Lecture [3158-355]

Creating Consensus on the Important Outcomes and Predictors of Lower Limb Prosthetic Prescription

Author
Schaffalitzky, Elisabeth (Dublin IE)
Dublin City University - School of Nursing

Coauthors
Gallagher P, MacLachlan M

Abstract
A 3-round Delphi study surveying experts in prosthetic prescription to identify the important outcomes of lower limb prosthetic prescription, important predictors of prescription and important items to consider when optimising prosthesis use to improve user satisfaction, usage rates and the service.

Introduction
There is currently no consensus on the most important outcomes to measure in lower limb prosthetic rehabilitation, or on the specific outcome measures to be consistently used in prosthetic rehabilitation. Continued efforts are needed to improve prosthesis prescription as a means of preventing non-use of prosthetic technology and waste of medical resources, and to increase user satisfaction. The aim of this study is to optimise lower limb prosthetic prescription by gaining a consensus on what lower limb prosthetic users and practitioners consider the most important outcomes and predictors of using a prosthetic limb while also gaining a consensus on the factors which may have an effect on optimising use of the prosthesis. Formal consensus methods have become more common as tools for solving problems in health and medicine, and a Delphi study method, involving successive surveying of a group of experts, was used in this study.

Methods
The Delphi study had 3 rounds completed by 22 experts (prosthetic users and rehab professionals). Data on prosthetic outcomes and predictors from a previous qualitative study created the 1st round of an E-Delphi. Each item was rated on a Likert scale(1-5)in terms of importance as an outcome or predictor and in terms of usefulness to consider when optimising prosthesis use. Participants left explanatory comments when giving a negative rating (<3.0)and suggested missing items. Items with an average rating #4.5 and no negative ratings were considered to have met consensus along with factors with an average rating #4.0 and 80%+ agreement on that rating(Whitehead,2008, Petry et al,2007). The 2nd survey included items that did not reach consensus with participant comments and average ratings. New suggested items were also included for rating. Results were collated and the same consensus levels applied. A 3rd survey was then created with items that had not reached consensus in the 2nd round.

Results
Consensus was reached on a number of items in relation to their importance in prosthetic prescription. Important outcomes identified included ‘Improved Quality of Life’, ‘Walking with Safety’, and ‘Self-reliance’. The physical predictors where consensus was reached included: ‘Condition of the Residual Limb’, ‘Condition of the Contralateral Limb’ and ‘Current Physical Ability’. Psychological and social predictors

where consensus was reached included: ‘Social Support’, ‘Avoiding Acknowledging the Situation’ and ‘Optimistic Outlook/Positive Thinking’.
In terms of optimising the use of the prosthesis, consensus on the usefulness of considering the following items was identified: ‘Family Accept the Amputation’, ‘Confidence in Walking Ability and Using Prosthesis’, ‘Patient Involvement in Prosthetic Choice’, ‘Accountability for Service (e.g. complaints service available)’, Access to all Members of Multidisciplinary Team if Needed’ and Making Sure Expected Goals are Achievable.

Conclusion

By combining user and practitioner knowledge to gain a consensus, this research has developed a list of key elements to be monitored in lower limb prosthetic prescription to improve satisfaction and user rates with the prosthesis. This research indicates how fitting centres can potentially improve upon the service as it is now and reduce the waste of medical resources on non-use of prosthetic technology. By identifying the most important factors, it is hoped that the time spent with prosthesis users in rehabilitation and prescription consultations is used effectively and for the most gain.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234527/cg38955

Session: Rehabilitation - Quality of Life
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Rehabilitation Science | Subtopic/Track: Rehabilitation

Congress Lecture [3023-221]

Factors Influencing Return to Work after Amputation

Author
Burger, Helena (Ljubljana, Slovenia SI)
Institute for Rehabilitation, Republic of Slovenia - Centre for P&O

Abstract
The aim of the study was to find out how many people after amputation return to work. A questionnaire was sent to all (400) patients visiting the outpatient clinic. We received 230 filled-in questionnaires. Ninety-three (40.4%, 80.9% of those working before amputation) worked after amputation.

Introduction
The main objective in the rehabilitation of people following amputation is to restore or improve their functioning, which includes their return to work. Full-time employment leads to beneficial health effects, enhances self-esteem and reduces social isolation (1).
The percentage of people who return to work successfully following amputation differs from study to study and depends on the chosen definition (2). Some may return to the same work, others have to change their occupation (3). Authors reported on several factors influencing return to work, but results differ from study to study (2). There are also differences between people following upper and lower limb amputation.
The aim of the present study was to find out how many people after amputation return to work and which are the main factors favouring it in Slovenia.

Methods
A questionnaire including general data (gender, age, age at the time of amputation, amputation level, cause of amputation, other diseases, stump and phantom pain, skin problems, vocational rehabilitation and prosthetic use) and questions about work (education, profession before amputation, work after amputation, attitude of colleagues, superiors and inferiors and need for adaptations) was designed and sent to all (400) patients visiting the outpatient clinic for people after amputation at the Institute for Rehabilitation in Ljubljana in the years 2007 and 2008 who were younger that 66 years at the time of visit.
The data from the returned questionnaires were analysed using SPSS for Windows 15.0 software (SPSS Inc., Chicago, IL). Descriptive statistics and univariate comparisons were used.

Results
We received 230 filled-in questionnaires (57.5%). The majority of the respondents (68.8%) were men. They have been 10 to 65 years old (51 on average) and 0 to 64 years old at the time of amputation (36 on average). The education level was low: 88.4% finished only elementary or elementary and secondary school. The majority (115, 61.5%) worked before amputation. Ninety-six (44.7%) had been included into vocational rehabilitation (having at least one interview).
Ninety-three (40.4%, 80.9% of those working before amputation) worked after amputation (from 1 to 41 years). 30 (13%) retired immediately after amputation. Thirteen (5.6%) returned to the same job full-time, 40 (17.4%) returned to other full-time work, 20 (8.7%) finished the school and started to work, 24 (10.4%) retired due to amputation and 27 (11.7%) retired due to amputation and other diseases. Sixty-six (71.0%) of those who returned to work after amputation returned to physically less demanding work.
There was no difference in percentage of people following upper or lower limb amputation who worked after amputation. People who returned to work were 15 years younger on average and had less intensive

phantom pain than those who did not return to work. Age at the time of study, stump pain and number of other diseases were not associated with return to work.

Conclusion

In spite that we sent questionnaire only to people younger than 66 years, many of them did not work after amputation or retired immediately after it. Our return-to-work rate is lower that the lowest published so far, but it doubled and is among the highest if we calculated it only for these working before amputation (2).
Factors that appeared to have most influence on return to work were age at the time of amputation, phantom pain, daily walking distance and inclusion into vocational rehabilitation. Younger people who have less severe phantom pain and walk longer distances per day had better return-to-work rate. Co-morbidity, stump pain, skin problems due to use of prosthesis, amputation level and gender did not appear to influence return to work.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3682-None]

Open Topics 1

Session Chair
Verschuren, Jesse (Groningen NL)
UMCG Groningen - Rehabilitation Medicine

Session Chair
Lineham, Marion (Wellington NZ) | MPP
New Zealand Artificial Limb Board - None

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233168

Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3047-245]

General Joint Hypermobility in Chinese School Children Aged 6-11

Author
Li, Nga Mei (HK)
The Hong Kong Polytechnic University - The Department of Health Technology and Informatics

Coauthors
LEUNG Aaron KL

Abstract
General joint hypermobility of 442 children aged 6 to 11 were examined using Beighton Score. The cut-off scores for each age group were defined as the nearest score at the 95% of the studied population. The general joint hypermobility of the studied group is age specific but not gender specific.

Introduction
Joint hypermobility condition occurs when the joint range of motion of individuals exceeds the norms. This condition is specific to genders, ages and ethnic groups. Females exhibit a higher degree of ligament hypermobility than age-matched males. The range of joint movements declines slowly as age increases. The prevalence of joint hypermobility varies widely in different populations and the Asian population has a higher prevalence of possessing hypermobile joints than Caucasians (Cheng et al., 1991). Beighton Score has been widely adopted clinically in joint mobility assessment in children. However, the cut-offs have not been documented in Chinese pediatric populations. The aim of the study was to study the prevalence of general joint hypermobility of Chinese children aged 6 to 11 using Beighton Scoring System, and to suggest cut-off points for hypermobility in each age group.

Methods
Four hundred and forty-two children (253 boys and 189 girls) aged 6 to 11 were examined. General joint hypermobility was measured by the nine-point scaled Beighton Score (Fig. 1) (Beighton et al., 1973). Each child was instructed to perform the maneuvers without evoking pain. A higher score indicates a higher degree of hypermobility.
Kappa coefficient was used to determine the intra-examiner reliability of the method. Mann-Whitney U-test was performed to examine the difference in Beighton Score between genders. The cut-off score for the determination of hypermobility of each age group were defined as the nearest score at the 95% of the studied population. A level of significance of $P<0.05$ was selected in all analyses to limit the chance of a type-I error to 5%.

Results
A good intra-examiner reliability was determined by Kappa coefficient (0.989, $P <0.05$). There were age-related but not gender-related differences ($P> 0.05$) in the general joint hypermobility in children aged 6 to 11. The median score was 4 in age 6; 4 in age 7; 3 in age 8; 2 in age 9; 2 in age 10; and 2 in age 11. The cut-off scores were suggested to be 7 in age 6; 8 in age 7; 7 in age 8; 7 in age 9; 6 in age 10 and 6 in age 11.

Conclusion
The general joint hypermobility in Chinese children aged 6 to 11 is age specific but not gender specific. It is necessary to distinguish hypermobility using appropriate cut-off scores for different age groups in children within a population, before understanding its true association with various neuromusculoskeletal problems.

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Image: fig1_None.jpg (see online)

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Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3035-233]

The Care for Upper Limb Amputees in the Netherlands

Author
Poelma, Margriet (Nijmegen NL) | MD
Sint Maartenskliniek - Nijmegen

Abstract
Apart from a multidisciplinairy checkup for upper limb amputees in one day the organisation of other activities where patients can meet fellow patients is of great importance. Meeting fellowpatients and the importance of this is presented.

Introduction
Because the number of patients in the Netherlands with an upper-limb amputation or upper-limb congenital deformity is relatively small, it is important that the care for these patients is concentrated and that patients have the possibility to meet fellow-patients.

Methods
In the Maartenskliniek Nijmegen the care for children with a congenital defect of the upper extremity, who need or have a prosthesis, is organised on one day.
On this day in the special clinic hours of the team the child and his/her parents see the rehabilitation physician, the occupational therapist and physical therapist, the prosthetist one after the other for a multidisciplinairy check-up.
In between the professional contacts the parents and children meet each other informally and communicate with each other. Children see other children with the same problem and parents can ask more experienced parents questions about technical and practical aids or the way of living with or without a prosthesis.

Results
This way of organising the care has led to other activities to have more possibilities to meet one another and to see each other active with or without the prosthesis.
Twice a year we organise an arts,- and crafts activity for the younger children and a sports activity for the older children.(climbing).
Parents and patients are very inspired about this way of meeting each other and they even suggested to organise a dinner afterwards to see the aspects of eating with or without a prosthesis also.
The aspects of meeting fellow-patients and its influence on patients and parents well being is presented.

Conclusion
Its not only important to organise the multidisciplinairy check up in upper limb amputees, but its also very important to take care of the possibility for patients and their parents/family to meet fellow patients.

References
Hacking et al; Eur. J. Phys. Med. Rehab. 1997

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233168/cg35379

Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3080-278]

Sexuality and Limb Amputation: a Systematic Literature Review

Author
Verschuren, Jesse (Groningen NL)
UMCG Groningen - Rehabilitation Medicine

Coauthors
Verschuren JEA, Geertzen JHB, van Es CG, Dijkstra PU

Abstract
The purpose of this literature review is to systematically examine the state of research on sexuality and limb amputees. Five publication databases were searched. Eleven eligible studies were found. All studies found an impact of the amputation on some part of sexual functioning to some degree.

Introduction
In the Netherlands, 3000 major limb amputations are performed annually (1.9 per 10.0000). A limb amputation induces several limitations in performing professional, leisure, social and marital activities, including sexual activities. In literature concerning amputation, limitations in sexual activities of amputees are discussed. In these papers it is assumed that problems in performing sexual activities are hindered in different ways, related to the type and level of the amputation and the cause of the amputation.

Methods
A total of five publication databases were searched: Pubmed, Cinahl, Embase, Psychinfo and Recall. Papers were included in this review if they described research in which the sexual (dys)functioning of a cohort of limb amputees was investigated. Excluded were reviews, expert opinions, case studies ($n < 10$) as well as papers not dealing with limb amputees.

Results
A total of 11 cross-sectional studies were found. The studies were published between 1945 and 2002. The studies were characterised by a diversity of study populations, sampling methods, gender and age distributions, assessment methods, and outcome measures.
The mean age ranged from 26 years to 57 years. The time interval between amputation and research ranged from 6 months to more than 20 years. All studies found an impact of a limb amputation on some part of sexual functioning (or concerns about sexual functioning) to some degree.
In general, single amputees experienced more impact of the amputation on (concerns about) sexual functioning compared to married amputees (1,2,3). Additionally elder amputees experienced a larger impact of the amputation on sexual functioning compared to younger amputees (1,4).
For male amputees the impact on sexual functioning was larger than for female amputees (3,5). A transfemoral amputation has a larger impact on sexual functioning than a transtibial amputation (3,6,7). Amputees who suffered from amputation related pain experienced a larger impact on sexual functioning compared to those who did not experience this pain (1,3,5).
Also some contradicting findings were found. In some studies sexual functioning after an amputation was not a serious problem (4), or only a minority of amputees reported problems (5,6). In other studies a substantial amount of amputees reported some kind of problem in sexual functioning (1,3,4,8).

Conclusion
In the last 60 years, only 11 studies concerning sexuality and amputations of extremities could be identified. Factors influencing impact of an amputation on sexual functioning in limb amputees were being single, higher age, being male, a larger amputation, and pain. However these results should be regarded with caution because of the great clinical diversity in the studies, the cross-sectional design and recall bias.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233168/cg37517

Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3269-444]

Health-Related Quality-of-life in Swedish Children and Adolescents with Limb Reduction Deficiency Present at Birth

Author
Ylimäinen, Kari (Örebro SE) | Psychologist
Örebro University Hospital - Department of Paediatrics

Coauthors
Nachemson A, Sommerstein K, Stockselius A, Norling Hermansson L

Abstract
Health-related quality-of-life (HRQoL) was studied in 140 children and adolescents with limb reduction deficiency present at birth. The results show that, except for in the Social exclusion subscale, these children have a significantly higher HRQoL compared to children with other chronic conditions.

Introduction
The consequence of limb reduction deficiency present at birth (LRD) is only partly understood though it has been studied from different points of view. Perceived physical appearance [1] and unexpected attention [2] seem to have an impact on psychosocial wellbeing leading to more behavioural and emotional problems and lower social competence in children with LRD than their peers [3]. A contradicting study [4] shows that children with upper LRD exhibit as good mental health as their able-bodied peers but girls and older children display wider variety of problems than the group as a whole. In most previous studies the instruments used are symptom oriented and measures psychiatric problems. They may not capture the whole range of consequences of LRD. Health-related quality-of-life (HRQoL) is another way of conceptualizing the consequence of a health condition and it has been studied in many conditions but not LRD. The aim of this study was to investigate HRQoL in young persons with LRD.

Methods
Participants in this cross-sectional multi-centre study were 140 children with LRD (51% boys) aged 8-17 (mean age boys 11.7 y, girls 11.8 y). The sample comprised all patients eligible at the participating units during the 18 months study period. 69% of the participants had a transversal and 31% had a longitudinal type of LRD; 86% had upper limb, 8% lower, and 6% both upper and lower LRD. The participants completed a multi-cultural European questionnaire measuring health-related quality-of-life, DISABKIDS [5]. In addition, 137 parents answered a corresponding questionnaire concerning their child. The results were compared to European data from children with other chronic conditions [5]. To study the impact of perceived physical appearance and unexpected attention on HRQoL two study-specific questions were used. Student's one sample t-tests, one-way analyses of variance and intraclass correlation coefficients were performed. P-values <0.05 were accepted as statistically significant.

Results
In comparison to children with other chronic conditions the children, adolescents and their parents reported significantly higher generic HRQoL and higher scores in all subscales but Social exclusion (Table 1). This corresponds to earlier findings of psychosocial adjustment in this group of children. There were no differences in HRQoL related to gender or age, and there were no effects of type, extent, site and level of

deficiency on HRQoL. Nor was there any significant effect on HRQoL in children with unilateral upper LRD based on level of deficiency. However, girls with longitudinal, bilateral, or lower LRD reported significantly lower HRQoL in most subscales than girls with other forms of LRD.
Unexpected attention and perception of own physical appearance had a significant impact on HRQoL in both genders. Boys who “never” or “seldom” perceive themselves as good-looking as others displayed significantly lower generic HRQoL and lower scores in all sub-scales than those who “always” find themselves as good-looking as others. A similar effect was found in girls who “never” think they are as good-looking as others, with significantly lower scores in the Emotion subscale than girls who “always” find themselves as good looking as others.
There was a poor agreement between parent and child report of the child’s health-related quality-of-life (ICC 0.224 – 0.537) with parents reporting lower scores particularly in adolescents.

Conclusion

In conclusion, children and adolescents with LRD display an overall higher HRQoL than children with other chronic health conditions. There are, however, subgroups of children with LRD that experience a significantly lower HRQoL than their peers that need to be evaluated and treated more carefully. The present study also supports previous results showing that, because of its salient nature, LRD has a strong psychosocial impact on the person. An holistic rehabilitation with a multi-professional team may support the family and prevent the child from future psychosocial stress. The difference between parent and child ratings should be considered in clinical practice.

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Image: Table 1 _None.doc (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233168/cg43538

Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3337-512]

Current Opinions of Clinicians and Rate of Implementation of Evidence Based Practice (EBP) within Prosthetic and Orthotic Facilities in Canada

Author
Christensen, James (Toronto CA)
George Brown College - School of Health and Wellness

Coauthors
Christensen, JW
Andrysek, J
Glasford, S
Steinnagel, B
Matthews, K

Abstract
Our current understanding of evidence based practices (EBP) in prosthetics and orthotics is limited due to a lack of studies. This abstract outlines the important initial first step in this process, namely the development of a survey tool designed to collect data about EBP.

Introduction
A thorough search of current literature produced few journal articles about EBP in the field of prosthetics and orthotics [1,2]. Some have suggested that the prosthetics and orthotics profession has fallen behind other health professions in terms of the implementation of EBP [1]. To date there is no evidence of an attempt to document the sources of information that clinicians access in their daily practices, and more specifically the extent to which they access information that is derived from research. Moreover, there has been no attempt to assess the barriers to EBP that affect the prosthetic and orthotic industries, as has been done in other healthcare professions [3-5]. The objective of this study was to design and develop a survey tool to examine where and when clinicians look for information, what they perceive the barriers to be that discourage them from implementing EBP in their clinics, and the general beliefs in prosthetics and orthotics with respect to EBP.

Methods
The first draft of the survey was generated by completing a thorough review of surveys focusing on EBP across multiple healthcare industries. A question bank was created using the questions in these surveys. Questions were eliminated from the bank if they were duplicates or if they were specific to the healthcare sector targeted by the survey (i.e. unrelated to prosthetics and orthotics). As well, some unique questions were generated to investigate the various sources of information specific to the prosthetic and orthotic industries. A meeting of clinical and industry experts was conducted to discuss the format and content of the survey with the goal being to produce a second draft. Finally, the survey was converted into a web-based format to prepare for distribution using a commercial online survey tool. Pilot testing of the survey is currently underway.

Results

The survey consists of four sections: demographics, sources of information, barriers to the implementation of EBP and beliefs. The demographics section contains basic demographic data such as sex and age but also includes industry specific demographic questions such as whether the clinician's practice is in a public or private setting or whether or not the clinician has ever authored or coauthored an article in a peer-reviewed publication. The sources of information section addresses the types of information sources the clinicians have access to as well as which ones they are likely to use and how often they use them. The barriers section has a series of statements that the respondents can agree or disagree with on a 5-point Likert scale. These statements address the reasons why the clinicians may or may not choose to implement EBP at their clinic. An example of a statement is "I don't feel I have the skills to properly use an online database to search for articles". The beliefs section again has a series of statements to which the respondents are to note the extent to which they agree. This section examines the subjective opinions of the clinicians concerning the perceived importance of EBP in clinical practice, for example, "I am sure that using results from research in clinical practice will improve the care that I deliver to my patients".

Conclusion

The goal of this project is to gain a better understanding of the extent to which EBP is applied in the prosthetic and orthotic industry. This abstract presents the important first step in this process, namely the systematic development of the survey tool. The survey is nearly completed, upon which time it will be administered to over 300 clinicians across Canada from whom we anticipate a response of approximately 50%. We expect to receive the responses by the end of the calendar year leaving sufficient time to analyze the data and prepare and present these additional results at ISPO 2010. As such our presentation will not only include the development of the survey but important information about EBP in the field of prosthetic and orthotics. We feel that not only will the results that come out of this study be beneficial and educational in themselves but that we have also created a framework for other groups to follow in an effort to generate similar surveys in other countries.

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Session: Open Topics 1
Monday 2010/05/10 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [2867-67]

Organisational Outcomes Measures for a Prosthetics Service - a Framework and Key Performance Indicators

Author
Lineham, Marion (Wellington NZ) | MPP
New Zealand Artificial Limb Board - None

Abstract
The New Zealand Artificial Limb Board, caring for 4,300 amputees, now measures these outcomes: mobility, independence, health related quality of life, and employability.
High level key performance indicators were introduced.
This paper describes the methodology, and results. The project has been successful clinically and organisationally.

Introduction
The New Zealand Artificial Limb Board (NZALB) is a government body that provides a free national prosthetic service in New Zealand. From July 2006, Government required it to include non-financial outcomes measures in its annual Statement of Intent.
The non-financial measures would indicate how well the agency was performing. The NZALB would accordingly be publicly accountable for its contribution to achieving wider government goals.
The NZALB engaged a contractor, Pricewaterhouse Coopers, in a project to develop high level outcomes and high level performance indicators. This paper outlines the project methodology, and describes the non-financial measures and package of tools chosen to measure outcomes.

Methods
The method chosen was to undertake a literature review, to develop outcomes, devise a framework, to recommend outcome measurement tools and how they would contribute to measuring the outcomes of the organization. Internationally, no single measurement tool had been identified as appropriate, but a “basket” might.
The NZALB then applied criteria to choose its “basket”. The implementation date was 1 July 2006, and final results were analysed in December 2008.
The high level outcomes and measures chosen, in order of priority, and the measurement tools chosen to test new lower limb primary amputees for each, were:
1. Mobility: Timed Up and Go test (walking test), Locomotor Capability Index 5 (LCI5 – questionnaire)
2. Independence – as above
3. Health related quality of life – SF12 (questionnaire)
4. Employability – Client survey
5. All: three yearly client random survey, which could be adapted as required.
In addition, national amputation statistics were introduced and annually collated.
From this

Results
The Key Performance Indicators (KPIs) were chosen to track the whole patient experience of being an amputee.

The first was to maximize the amputees' opportunity to be fitted with prostheses through referral to the service.
1. Ratio amputations/referrals 79%. To derive this ratio, national amputation statistics were established through the Ministry of Health.
The next KPIs measured progress in mobility in the first crucial year after referral.
2. Two key performance indicators were based on the LCI5. 73% of the base population completed two measures with these results:
a. Increase in medians of assessment scores of mobility and independence of primary lower limb amputees over a six month period after initial limb fitting - 27% increase.
b. Level of mobility and independence achieved at 6 months after the initial limb fitting as a percentage of the optimal level of mobility and independence (maximum possible combined score for mobility and independence) - 76%.
The last KPI was retrospective and measured client satisfaction, which could be based on many years of experience with the NZALB service.
3. Client satisfaction rate: 92% satisfaction with overall service, 87% satisfaction with limbs. The client survey questionnaire randomly sent to a 1,600 sample (51% response) has been undertaken 4 times over 12 years and explores issues of satisfaction levels relating to e.g. service; timeliness; limbs: comfort, quality, appearance, reliability; premises, performance of staff, travel to and from limb ce

Conclusion

The experience of introducing organizational outcomes measures in the NZALB has:
• met the obligations of the NZALB for non-financial reporting as required by Government;
• measured the organisation's service along the amputee pathway;
• provided a national resource of amputee data for research and evaluation;
• provided accurate data on non-referrals of hospital amputees;
• provided the basis for benchmarking for the future;
• provided quality data for funding negotiations for the future.
Further research is required to show the link between the aggregation of individual outcomes measures and agency performance.

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New Zealand Artificial Limb Board Statements of Intent and Annual Reports, www.nzalb.govt.nz

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233168/cg33096

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3599-None]

Rehabilitation of Amputees I

Session Chair
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Abstract
Rehabilitation of amputees is a real challenge. A multidisciplinary approach in an indisciplinary working team is the base to overcome impairments and to reduce disabilities. The use of the ICF is of basic importance. The instructional courses gives an overview of the possibilities of rehabilitation in these patients.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg96831

Basic Instructional Course: Rehabilitation of Amputees I
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3600-863]

Rehabilitation of Amputated Patients, ICF System, Rehabilitation in France

Author
Menager, Domenico (Paris FR) | Dr.
Rehazentrum Valonton

Introduction
The aim of the International Classification of Functioning, Disability and Health (ICF), developed by the World Health organization (WHO), is to propose a multipurpose classification to be used by different actors in different sectors for application to various aspects of health.
It can be summarized as follows:
- To provide a common scientific basis for understanding and studying health related states
- To establish a common language for describing health related states
- To allow comparison of data
- To provide a systematic coding scheme for health information systems.
ICF has two parts each one divided in two components.
Part 1: Functioning and disability divided in:
a) Body Functions and Structures
b) Activities and participation
Part 2: Contextual Factors divided in:
a) Environmental factors
b) Personal factors

Methods
It is one of the United Nations classifications and is referred to in and incorporates The Standard Rules on the Equalization of Opportunities for Persons with Disabilities. In our practice, ICF should be used as a clinical tool to structure assessments, rehabilitation and outcome evaluations. However, despite many improvements in the last years, it has not yet been completely understood and thus incorporated in the routine procedures. In Rehabilitation Structures, ICF is, at least partially, referred to as an assessment, evaluation and outcome tool.
Following the Standard Rules on the Equalization of Opportunities for Persons with Disabilities, “La Maison Départementale du Handicap” is organized to assess the needs related to the contextual factors of the persons with disabilities and to fund them, in a “one position” system.

Results
Unfortunately the results depend on the wealth of the region as the funding is, in fact, limited and regionally structured. More generally, many good intentions are stated but not practically implemented by lack of financial means. Public buildings as well as public transportation network for example are not all accessible.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg96831/cg97176

Basic Instructional Course: Rehabilitation of Amputees I
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3601-693]

Rehabilitation of Amputated Patients in Germany

Author
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Introduction
Rehabilitation of amputated patients is a challenging task. In Germany rehabilitation is orientated on ICF (International Classification of Functioning, Disability and Health) with the focus on reintegration. The main reasons for amputations are in about 80-90% disvascular diseases or/and diabetes mellitus, more rarely trauma or tumor surgery. After discharge out of acute hospital the patient is transfered to a rehab hospital or clinic where the treatment is done by a therapeutic team under holistic approach. The main focus lies on reduction of oedema, early decision of prosthetic fitting, gait training, psychological treatment, occupational therapy orientated on the behavioural needs. A special problem in Germany is the splitted social care system with diveded responsibilities for incurance companies or the pension funds. The typical development, the problems during the different stages in the social system are described in detail.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg96831/cg97225

Basic Instructional Course: Rehabilitation of Amputees I
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3602-704]

The Role of Psychology in Rehabilitation of Amputees

Author
Panning, Stephan (Bad Rothenfelde DE)
Klinik Münsterland

Introduction
An amputation is a major event in the life of a human being and is related to many physical, social and psychological restrictions.

Results
After amputation about one third of all the patients suffer from clinically relevant symptoms of fear and depression. Moreover, the development of psychiatric disturbances seems do depend on psychological (coping), medical (pain-relief) and functional variables (degree of mobilisation). On the other hand several studies have shown, that psychosocial adjustment influences the results of the rehabilitation process

Conclusion
So the Rehabilitation of the amputee is an interdisciplinary challenge. With the help of a new developed group-programme concerning coping of illness it is demonstrated in which way individual psychological resources can be demanded within a interdisciplinary concept.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg96831/cg97346

Basic Instructional Course: Rehabilitation of Amputees I
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3603-717]

Rehabilitation Problems Caused by Stump Problems

Author
Brückner, Lutz (Bad Klosterlausnitz DE) | Priv.-Doz. Dr. med. habil.
Moritz-Klinik Gmbh & Co. KG - Orthopädie / Unfallchirurgie

Introduction
A successful rehabilitation outcome following lower extremity amputation depends amongst other issues on the condition of the stump.Unfortunately ,even today
amputations are routinely performed without expert experience.This can lead in a short period of time to essential stump revisions, necessary to allow rehabilitation in the first place.

Results
We will demonstrate the intraoperational management and
the handling of diverse tissues during amputation and show the problems caused through inexpert approaches.
1. Judgment of vascularity and dealing with vessels
2. Treatment of bone and cartilage
3. Treatment of nerves
4. Treatment of tendons
5. The intraoperative handling of musculature and the
development of phantom pain
6. Intraoperative care of skin
7. Post-operative care

Conclusion
Our principle is:"Bad stumps handicap the handicapped".

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg96831/cg97539

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3713-None]

Spinal Deformity

Session Chair
Wong, Man-Sang (Hong Kong HK) | PhD
The Hong Kong Polytechnic University - Department of Health Technology & Informatics, ST418,

Session Chair
Landauer, Franz (Salzburg AT) | Dr.
Universitätsklink für Orthopädie Paracelsus Medizinische Privatuniversität

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg274492

Advanced Instructional Course: Spinal Deformity
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3715-772]

Epidemiology and Screening Programs

Author
Grivas, Theodoros B (Brilissia GR) | Dr.
“Tzanio” General Hospital of Piraeus, Piraeus, Greece - Trauma and Orthopaedic Department

Coauthors
Theodoros B. GRIVAS

Abstract
This advanced ICL presents the current knowledge and research outcome on Epidemiology for Idiopathic Scoliosis (IS) and a recent consensus report on School Screening for Scoliosis (SSS) programs. The objectives of the latter are numerous. The evolving role and aim of SSS and the recommendations for improvement of the procedure are highlighted.

Introduction
Epidemiology
The prevalence of adolescent IS (AIS) is traditionally described to be 2% to 3% in the general population. Almost 10% of those diagnosed with AIS will require some form of treatment, while up to 0.1% are at risk of surgery. Severe AIS is more commonly found in females. However, the published prevalence values of AIS are much more different in the peer review literature, ranging from 0.93% to 12%.
SSS Programs
A recent consensus report on SSS Programs is presented. Its objectives are: the inclusion of the existing information on the issue, the analysis and discussion of the responses to twenty six questions on a relevant to screening questionnaire, the impact of screening and of its discontinuation on frequency of surgical IS treatment, the reasons why these programs must be continued, the evolving aim of SSS and finally recommendations for improvement of the procedure.

Methods
Epidemiology
A study was set up to investigate the above mentioned discrepancy and to examine a possible relation between prevalence of IS & age at menarche (AAM) in the general population, in various geographical latitudes (GL) and their aetiological implications for IS. 20 peer-reviewed published papers reporting AIS prevalence using as a criterion for scoliosis the cut-off point of Cobb angle at 10 degrees and 33 peer-reviewed papers reporting AAM in normal girls from most geographic areas of the northern hemisphere, were retrieved from the literature. The GL of the centres of the studies was documented. The statistical analysis included regression of the IS prevalence and AAM by GL.
SSS Programs
A questionnaire was developed involving questions on primary issues on organization of the methods and criteria used for SSS and on what happens afterwards for children at risk. This questionnaire was processed and discussed during a recent annual SOSORT meeting.

Results
Epidemiology
The regression of prevalence of IS and AAM by GL is statistically significant. Their regression equations have a similar curve pattern. The prevalence of IS differs at different GL. Apart from genetics, the AAM

is also influenced by environmental parameters. Retinal responses to environmental lighting in a way mediate control of pubescence due to diurnal variation of melatonin secretion. Darkness leads to melatonin over-production and light reduces it. Melatonin reduces LH production. Puberty is associated with the appearance of episodic secretion of LH.The amount of sunlight and the quality of light may play a major role in the different initiation of menses in different GL.
SSS Programs
As far as the impact of SSS on frequency of surgical treatment is concerned, it is reported that it reduces the number of surgically treated IS patients and similar reduction is reported where high-standard conservative treatment is available. It is also reported that in places were SSS was discontinued, the referral mechanisms for AIS lead to a suboptimal case-mix in orthopaedics in terms of appropriateness of referral and a good number of patients (32%) are classified as late referrals with regard to brace treatment indications.

Conclusion
Epidemiology
AIS is associated with pubertal growth spurt & its progression decelerates after completion of skeletal maturity. Late AAM correlates with delayed skeletal maturity & it implies that there is a potential for progression of a IS curve. The role of light is documented in association with the pathway of melatonin production. Thus it appears that GL which differentiates the sunlight influences melatonin secretion and consequently AAM. The latter relates to the prevalence of IS and this connection is apparent in northern hemisphere
SSS Programs
The SSS programs must continue for a number of reasons. The prevalence of surgery can be significantly diminished where conservative treatment is available at a high standard. It has also been documented that bracing does alter the natural history of idiopathic scoliosis and SSS does reduce the number of surgically treated IS patients, as discussed above. The evolving role and recommendations for improvement of SSS are also discussed.

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Advanced Instructional Course: Spinal Deformity
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3716-740]

Conservative Treatment

Author
Weiss, Hans-Rudolf (Gensingen DE) | Dr. med.
Praxis Dr. med. Weiß - Orthopädie

Abstract
Historically the treatment options for Adolescent Idiopathic Scoliosis (AIS), the most common form of scoliosis are; exercises; braces and surgery. Methods and modules of rehabilitation are described in more detail within this review.

Introduction
Out-patient physiotherapy (PT), In-patient rehabilitation and correct braces used in the rehabilitation of patients with scoliosis should be pattern specific as described to be current Best Practice. Evidence has been gained to support conservative scoliosis management on level Ib / IIa: One short-term RCT exists to support out-patient PT, a prospective controlled study was found to support Scoliosis Inpatient Rehabilitation. One prospective multi-centre study, a long-term prospective controlled study and a meta-analysis have been found to support bracing. No controlled study, neither short, mid nor long-term, was found to reveal any substantial evidence to support surgery as a treatment for this condition.
In the case of scoliosis and pain certain programs of physiotherapy and bracing are applied, a description of which is included within this paper.

Methods
Scoliosis rehabilitation, unlike surgery, aims to improve the signs and symptoms of scoliosis. Not only curve magnitude, but also functional impairment like reduced general mobility and reduced vital capacity can be improved upon by physical methods. Back pain cannot be regarded as a consequence of scoliosis, however there is evidence that this can be improved by a specialised rehabilitation program and specific bracing technology.
Not only an improved physical, but also an improved psychosocial outcome can be achieved by utilising current standards of scoliosis rehabilitation, which have been described as being the current Best Practice.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg274492/cg275465

Advanced Instructional Course: Spinal Deformity
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [4044-896]

The RSC® Brace Not just a brace – but a holistic treatment system

Author
Schildhauer, Stephan (Berlin DE) | Dipl. OTM
Orthopädietechnik Paul Schulze GmbH

Coauthors
Dino Gallo, CPO, Rosenheim

Abstract
The application of the Chêneau principles shows in practice that the scope of interpretation is very varied. The result: under the name of Chêneau, orthoses for scoliosis are produced that are inconsistent with the ideas and biomechanical construction principles of the inventor.

Introduction
The RSC® braces are produced according to a patented method. 1. Measuring; 2. Classification and determination of brace by Dr. Rigo; 3. Production of brace using CAD technology.
Treatment example from practice: reaction to the curve pattern – changes with special brace models.

Results
Results: patient group n=147. Restrictive criteria: sex: female; age: min. 10 years; present clinical signs of puberty: at least S2 or P2 according to the Tanner scale; diagnosis: idiopathic scoliosis; Cobb angle: at least 25 degrees, max. 35 degrees, Risser: 0. With a percentage of 11.56 % male patients, an average main angle of curvature of 36.52° was established in the whole group. The correction of this was 47.39%, whereby 65.99% of the patients had received previous orthotic treatment and 19.05% of the main group had a Cobb angle of > 50°. Over-correction was achieved in 5.44%. The average age was 12.97 years with 25.85% of the patients being between 15 and 16 years old. There were 42 patients in the group with a Cobb angle of > 50°. Here the mean value of the main curvature was established at 30.21%; the average age was 12.07 years. A correction of 60.26% of the main curvature was achieved; there was over-correction in 11.90%. The group between 15 and 16 years old made up 23.81%. There were 25 patients according to SOSORT RC criteria with an average Cobb angle of main curvature of 26.67%. With 12% who had over-correction, a correction value of 61.09% for the main curvature was established. The average age of the patients was 12.32 years.

Conclusion
A comprehensive standardized treatment is guaranteed with the RSC® brace.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg274492/cg2222204

Advanced Instructional Course: Spinal Deformity
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3995-862]

A Specific Scoliosis Classification Correlating With Brace Treatment: Description and Reliability

Author
Wood, Grant I. (San Mateo US) | MSc, CPO
Hanger Orthopedic Group - Northern California

Abstract
The purpose of the study: to show the intra- and inter observer reliability of a curve classification system correlating with scoliosis brace treatment

Introduction
Background: Various curve classifications have been used mainly correlating with surgical treatment but not with brace principles and design.

Methods
a new classification was developed in order to define specific design principles of correction with a brace. The classification includes clinical as well as radiological criteria. The radiological system differentiates five basic types called: imbalanced thoracic (or three curves pattern), true double (or four curve pattern), balanced thoracic and false double (non 3 non 4), single lumbar and single thoracolumbar. The main criteria are the curve pattern according to SRS terminology, the balance/imbalance at the transitional point and the L4-5 counter-tilting. To test the intra-and inter-observer reliability of the classification three observers (1 MD, 1 PT and 1 CPO) have measured (and one of them, the MD, re-measured) 51 AP radiographs including all the types.

Results
the intra-observer Kappa value was 0.87 (acceptance >0.70). The inter-observer Kappa values fluctuated from 0.61 to 0.71 with an average of 0.71 (acceptance > 0.70).

Conclusion
a specific scoliosis classification which correlates with brace treatment has been proposed with an acceptable intra-and inter-observer reliability.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg274492/cg1858928

Advanced Instructional Course: Spinal Deformity
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3717-799]

Indication for Operation in Idiopathic Scoliosis

Author
Bullmann, Viola (Münster DE) | PD Dr.
Universitätsklinikum Münster - Klinik und Poliklinik für Allgemeine Orthopädie und Tumororthopädie

Abstract
Indication for operative treatment of idiopathic scoliosis in adolescent is a Cobbangle of more than 45°, a progression under nonoperatve therapy in adolescent or juvenile scoliosis, or a Cobbangle over 50° to 60° in mature adolescent.

Introduction
The indication for operation of course is not based only on the Cobb measurement alone. Very important is the age and maturity of the child. The cosmetic appearance, as regards decompensation or thoracic prominence and presence of thoracic lordosis and of course the existence of back pain are important tools for consideration for indication in surgical scoliosis correction.

Methods
Preoperative evaluation includes besides medical history and physical examination long film cassette radiographs in two planes and supine bending films. In rigid scoliosis additional traction films are helpfully. Pulmonary function testing is performed in severe thoracic scoliosis. In atypical curves there is an indication for magnetic resonance imaging in order to exclude intraspinal malformation.
For preoperative planing the Lenke classification is helpfully to decide which curve has to be fused and what levels need to be fused.

Results
Aim of scoliosis surgery in adolescent patients is correction and stabilization of the deformity. Correction of deformity is performed by derotation, translation, compression and distraction. Depending on the curve type decision making is for anterior or posterior correction. In anterior scoliosis surgery the correction principle is segmental derotation and compression after a complete resection of the intervertebral discs. In posterior surgery a real segmental derotation is only possible in flexible curves. The correction principle in posterior surgery is a combination of translation, en bloc derotation, compression and distraction. Modern pedicle screw systems for posterior instrumentation and dual rod systems for anterior correction permit a primary stabilty of instrumentaion and could save distal mobile segments.

Conclusion
In conclusion the aim of scoliosis surgery is a pysiological three dimensional correction of the deformity resulting in a good clinical and radiological outcome. Overall the fusion length should be as short as possible, complication rate has to be minimal and patients satisfaction should be maximal.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg274492/cg275624

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3264-None]

Bilateral Upper Limb Loss Case Study: A Team Approach to ADL Independence and Targeted Muscle Reinnervation (TMR)

Session Chair
Swanson, Shawn (Redondo Beach US) | OTR/L
Advanced Arm Dynamics

Abstract
This presentation will document a case study of a bilateral upper limb loss individual in the early stages of his rehabilitation process. The individual lost his arms in an electrical accident in October 2008. His levels of amputation are right transhumeral and left shoulder disarticulation. This individual also received Targeted Muscle Reinnervation (TMR) surgery on his left side in March of 2009. Occupational therapy intervention for ADL independence, socket design/prosthetic componentry, and the subsequent prosthetic training will be discussed as well as the important nature of the team. There will be an in depth look at the various adaptive equipment and home modifications the patient is utilizing for increased independence with daily tasks for self care and around his home.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg43214

Advanced Instructional Course: Bilateral Upper Limb Loss Case Study: A Team Approach to ADL Independence and Targeted Muscle Reinnervation (TMR)
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3483-726]

Bilateral Upper Limb Loss Case Study: A Team Approach to ADL Independence and Targeted Muscle Reinnervation (TMR)

Author
Swanson, Shawn (Redondo Beach US) | OTR/L
Advanced Arm Dynamics

Author
Prigge, Patrick (Waterloo, IA US) | CP
Advanced Arm Dynamics

Author
Conyers, Dan (Redondo Beach US)
Advanced Arm Dynamics - None

Coauthors
Pat Prigge, CP, Brooke OSteen, OTR/L

Abstract
This presentation will document a case study of a bilateral upper limb loss individual in the early stages of his rehabilitation process. This level of amputee poses a challenge to the rehabilitation team. Their needs are extreme and it demands creativity. To compound this fact, this patient received the Targeted Muscle Reinnervation procedure.

Introduction
The individual lost his arms in an electrical accident in October 2008. His initial presentation was of a bilateral Transhumeral without any bony tissue in his left side. In March of 2009 he received a revision of the left side to a true shoulder disarticulation and the right side was cosmetically revised but remained a Transhumeral in length. This individual also received Targeted Muscle Reinnervation (TMR) surgery on his left side.

Methods
A team was created including 3 prosthetists, a technician and 2 occupational therapists to get his arms fit in an expedited fitting process. OT intervention for ADL independence, socket design/prosth. componentry were discussed by the team and the best solution was to fit his right Transhumeral with a body powered as well as a myoelectric prosthesis. The training that ensued focused on prosthetic controls training, repetitive grasp and release/positioning drills with blocks and pegs to instil confidence through practice and bimanual functional training. It was necessary to solve issues of independence with and without prosthetic devices as well as independence with don/doff of prostheses. The goal for this individual was to use adaptive equipment and home modifications for increased independence with daily tasks for self care and to be able to function around his home. As his TMR surgery healed we fit his shoulder side with a myoelectric prosthesis and added additional sites for use with his reinnervated site

Results

This individual's personality contributed significantly to many of his achievements. He has an incredible outlook on his future and is an amazing role model for his family. He fluently expresses how home modifications, specially adapted equipment, prosthetics, and therapy have helped him reclaim independence in basic, but very personal self-care tasks.

The process took nearly a year to get to where he felt comfortable alone at home and is now learning driving with a driving instructor and doing quite well. He is able to do all ADL's independently as well as instrumental activities of daily living.

He operates his right Transhumeral prosthesis with a single electrode and a linear transducer and on his left he has four electrodes to control the elbow wrist and hand. These options would not be possible if it weren't for the new surgical technique and the new developments from global manufacturers. Thanks to the team and the technology, this individual is doing well.

Conclusion

This individual will continue to face many challenges over the course of his life. A personalized and comprehensive team approach, creative adaptations, and an extremely motivated upper limb loss individual have led to many meaningful successes. As new technologies come available, he will benefit from having a surgical platform to give him more function.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg43214/cg45866

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3690-None]

Community Based Rehabilitation (CBR) and Prosthetics/Orthotics Service Provision

Session Chair
Khasnabis, Chapal (Geneva CH)
World Health Organization

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236926

Basic Instructional Course: Community Based Rehabilitation (CBR) and Prosthetics/Orthotics Service Provision
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3694-929]

Challenges of Offering Prosthetics and Orthotics Services in Developing Countries - a Philippines Case Study

Author
Bundoc, Josephine (Manila PH)
Physicians for Peace

Introduction
Challenged by this seemingly insurmountable barrier, the University of the Philippines – Philippine General Hospital (UP-PGH) Department of Rehabilitation Medicine and Orthopedics
initiated the Walking Free Project with the Physicians for Peace (PFP) and the Mahaveer Foundation. Starting with a situationer in 2005-2006 via a series of amputee screening and
prosthesis service missions in 13 key areas of the 7,100 islands, the stakeholders (amputees, caregivers, P & O technicians, physicians) stated that the high cost is a result rather than the cause. The survey revealed that : 1). increasing public awareness , 2). enabling accessibility, 3). providing appropriate P&O education and 4). ensuring availability of local materials will bring the cost down to an affordable level even to the indigent disabled Filipino.

Methods
Henceforth, from 2007 to the present, steps have been taken by the Walking Free Project proponents to address the aforementioned needs in the form of solutions, innovations and/or adaptations – which for now, has provided services to approximately 1,500 amputees
It is believed that the measure of success for provision of prosthetic and orthotic services is sustainability and the resultant empowerment of its recipients – a challenge that we hope to surmount once the 1st formal P & O Course is implemented , the Philippine Health Insurance Company commits to reimbursement and the inclusive education/employment is expanded.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236926/cg238410

Basic Instructional Course: Community Based Rehabilitation (CBR) and Prosthetics/Orthotics Service Provision
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3692-767]

Community-Based Rehabilitation (CBR) and Prosthetics/Orthotics Services Working Together - a Case Study from Nepal

Author
Sen, Ajay (Kathmandu NP)
Handicap International - Nepal

Introduction

People with disabilities require access to quality physical rehabilitation services to improve their functional capacities and autonomy in order to actively participate in all aspects of life.
Handicap International (HI) has been implementing a project to extend the reach of quality physical rehabilitation in Nepal since 2005. This includes access to prosthetics, orthotics, physiotherapy, corrective surgery through its local partners across the country. Beside prosthetic/orthotic services at the centres, the local partners also provide CBR services using community disability workers (CDWs).outreach mobile camps, participation of local community based organisations and disabled peoples' organisations. To ensure optimum benefit of Prosthetics/Orthotics devices, CDWs provide follow up services with home visits and counselling of people with disabilities, their families, and communities.

Results

Due to combination of prosthetics/orthotics services and CBR, many people with disabilities living in remote areas could access prosthetics/orthotics services. The permanent presence of CDWs in the community and their service has proven to have tremendous impact and helps to balance the technical and social aspects of rehabilitation management. CDWs are very effective in providing information and follow-up on the use and benefit of devices, early identification, intervention, making timely referrals to the centres, adapting mobility devices, as well as making appropriate home adaptations for proper use of devices. As a consequence of this approach, the use of devices is increased; hence the impact of disability is reduced. This encouraging experience has improved the quality of life and social inclusion of people with disabilities, by improving their ability to access education, employment opportunities, health services, and participate in social activities.
To achieve holistic inclusion of people with disabilities, the work of institutions from where usually prosthetics/orthotics services are provided need to develop strong links with CBR activities.

Conclusion

Both prosthetics/orthotics and CBR services are mandatory in order to achieve holistic development of people with disabilities, their families, and society. Simply providing a good quality orthosis or prosthesis does not achieve this ultimate goal. In order to enable full participation and inclusion in society, specialised services like prosthetics/orthotics and CBR need to work together. Nepal experience shows that CBR can reinforce the outcome of physical rehabilitation with community based social, economic and cultural interventions.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236926/cg238000

Basic Instructional Course: Community Based Rehabilitation (CBR) and Prosthetics/Orthotics Service Provision
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3693-759]

Using CBR Workers to Follow Up (Field) P&O Services

Author
Ghosh, Ritu (Bangalore IN) | Impact of wheelchair service provision for wheelchair users livi
Mobility India - Training

Abstract
Training of Community Based Rehabilitation (CBR) staff is a strong requirement when looking at the competencies needed to follow up with home beneficiaries of Prosthetics and Orthotics (P&O) devices so that they can eventually integrate themselves into the community. The International Society of Prosthetics and Orthotics (ISPO) is actively collecting information on good practices to ensure that these trainings are easier to access and to disseminate on a broader scale in developing countries.

Introduction
Since September 2008, ISPO has been operating USAID funded project called “Facilitating Rehabilitation of People with Physical Disability in Developing Countries through Education and Training of Prosthetic-Orthotics Professionals”.
One of the objectives of this project is to continue ISPO’s partnership in the World Health Organization’s (WHO) global campaign to foster the integration of P&O with CBR and to enhance the provision and accessibility of prosthetic and orthotics services.
It is also a follow up of ISPO’s and WHO’s joint statement on “The Relationship between Prosthetics and Orthotics Services and Community-Based Rehabilitation” in 1999 and revisited in 2003. The statement addressed the need for mutual training of P&O personnel on CBR and accordingly, of CBR training on P&O.

Methods
The ISPO and WHO teams have visited several countries and projects using specific evaluation forms. These forms help to evaluate the development of competencies of CBR staff during the course of working with P&0 beneficiaries. Training notes offered to CBR workers are also collected and a questionnaire has been sent to various projects to collect data.

Results
Most workshops on CBR involved in this collaborative approach have started to develop some kind of strategy in establishing training, technical, and financial policies to ensure that People with Disabilities are able to not only access devices but also repair and maintain them.
More of these practices, particularly training courses, need to be collected by ISPO and WHO and shared across most programs of the same type

Conclusion
The collection of data on CBR staff competencies on P&O have showed that training CBR workers with specific modules and competencies on P&0 technologies is a need when looking at the impact it can have on the quality of the follow up for the users of P&O devices. Hence, best practices need to be shared.Receiving a quality orthotics or prosthesis and being able to access proper follow up by CBR worker who can ensure proper maintenance facilitate inclusion, participation and equal rights. This gives children the opportunity to go to school while allowing adults to generate income. The experience showed us that with these kinds of mutual relationships, and adequate training for both the P&O and CBR staff have helped to dramatically improve the quality of life for people with disabilities.

References

The relationship between prosthetics and orthotics services and CBR: A joint ISPO/WHO statement http://www.who.int/disabilities/technology/en/

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o WHO/ILO/UNESCO CBR Joint Position paper 2004 http://www.who.int/disabilities/publications/cbr/en/index.html

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236926/cg238205

Basic Instructional Course: Community Based Rehabilitation (CBR) and Prosthetics/Orthotics Service Provision
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3710-853]

Multicountry Study on Follow Up System of Prosthetics and Orthotics Services in Developing Countries

Author
Jensen, Steen (Copenhagen DK)
ISPO International

Abstract
Providing quality standard prosthetics and orthotics service in a developing country is a challenge in itself with the huge amount of victims after war or civil unrest resulting from war ordnance (amputations), breakdown of vaccination programs (polio) and lack of midwifes (cerebral palsy).

Introduction
Well fitted and functioning P/O devices replacing deficiencies or facilitating function is a high technical demand, and unfortunately mentorship barely exists and time constraint on the professionals limits systematic follow-up programs.Since the beginning of the 1990'ties ISPO has conducted several conventional field studies to look at the quality, functionality and durability of devices produced and delivered by Cat-II graduates. We have been looking for more simple systems, which can be based on questionnaires or interviews by Community Rehabilitation Workers (CRW) in order to identify people with disability (PWD) in need of assistance, repair or replacement of their device. WHO has developed a quality-of-life system (WHOQOL-BREF), which is based on 4 domains (physical, psychological, social relationship, environment) generated from 26 questions. This has not been tried on P&O users before, but was translated into local language.

Methods
Mixed groups of 25 amputees and 15 orthotic users (> 15 years of age) were exposed to a team of an orthopedic surgeon (JSJ) and a Cat-I prosthetist-orthotist, who conducted a usual clinical follow-up study with interview, and examination of user and device, which was considered as the end result. During the same day the PWD was asked to fill in the questionnaire (with help, if needed), and was also interviewed and examined by a CRW. The survey was conducted in the countries: Tanzania, Namibia, Laos, Nepal, and Cambodia.
We saw 65 users with intact prostheses and 66 users needing repair or replacement of the prostheses, mostly because of wide socket fit or broken down foot. The questionnaires could be used to separate transfemoral from trans-tibial amputees on physical health and also in identification of prostheses needing care, both of which experiencing reduced working capacity and pain. TF prostheses needing care could not be singled out through the interviews.

Results
We also saw 21 adults with well functioning orthoses and 13 adults with inappropriate designs or poor craftsmanship. It was not possible through the questionnaires to separate KAFO from AFO on domain level, but there were scattered differences in advantage for AFO. The physical health domain and the questions related to that scored lower in users with AFO's needing care.

Conclusion
In conclusion, the WHO-QOL-BREF system cannot stand alone in identifying PWD's needing care of their orthopedic device, but must be combined with a physical examination.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236926/cg262534

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3944-None]

Introduction to Wheelchair Assessment and Fitting

Session Chair
Constantine, David (Bristol GB)
Motivation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1001813

Basic Instructional Course: Introduction to Wheelchair Assessment and Fitting
Tuesday 2010/05/11 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [4013-917]

Introduction to Wheelchair Assessment and Fitting

Author
Rushman, Chris (Bristol GB)
Motivation Charitable Trust UK

Author
Frost, Sarah (Bristol GB)
Motivation

Coauthors
Chris Rushman / Sarah Frost

Abstract
The workshop will demonstrate an assessment and fitting sequence outlined in two forms, and attendees will practice key techniques in the assessment and fitting process and subsequent adjustment of a range of available products. Attendees will have full access to all materials and documents used in the workshop.

Introduction
Worldmade is an initiative run by Motivation to provide low cost, appropriate wheelchairs and seating through the establishment of Worldmade Wheelchair Services in accordance with the World Health Organizations (WHO) ‘Guidelines on the provision of Manual Wheelchairs in less resourced settings’. A central element of a worldmade service is the assessment and fitting form, which can be used by all stakeholders planning to deliver, or already involved in, wheelchair service provision.

Results
The two assessment and fitting forms use a step-by-step approach to a defined assessment and fitting sequence. The first form guides the practitioner to a safe and comfortable fitting of standard manual wheelchairs. The second form guides the practitioner to a safe and comfortable fitting of supportive seating products to provide stability for function, but only for users with simple postural support needs.

Conclusion
To deal with more complex seating and postural support needs and to achieve full compliance with the WHO Guidelines, further training will be required.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1001813/cg1995326

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3783-935]

Limb Amputations and Prosthetics

Keynote Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Abstract
Partial or full amputations of the upper or lower limbs is always associated with serious damage to patients' physical and mental integrity. Well-executed surgery by the surgeon and mental stability on the part of the patient are the door to successful rehabilitation. Every amputee's social life and career depends on these early decisions, whereas the quality of rehabilitation begins on the operating table. This lecture will focus on several interfaces between the patients' personal ambitions and social environment and the surgeon's qualifications in decisionmaking about stump length and function and, later, about optimal socket shape and fit. The large and increasing number of individuals requiring stump improvement and reconstructive surgery underlines the problem.
Technology in prosthetics is moving foreward at a fast pace posing challenges to every member of the rehab team, especially surgeons. We need surgeons who are educated in P&O.

Introduction
The lecture will highlight how to build a good stump, describe pitfalls and clinical problems and discuss the kind of decision-making necessary to achieve sucessful outcomes

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg409649

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3798-None]

Innovative Technologies for Powered Upper Limb Orthoses

Session Chair
Rupp, Rüdiger (Heidelberg DE) | Dr.-Ing.
Stiftung Orthopädische Universitätsklinik Heidelberg - Zentrum für Paraplegiologie / Forschung

Session Chair
Pylatiuk, Christian (Eggenstein-Leopoldshafen DE) | Dr. med.
Karlsruher Institut für Technologie - Institut für Angewandte Informatik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg441312

Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3799-837]

Interactive Upper Limb Robotic System for Stroke Rehabilitation

Author
Tong, Raymond Kaiyu (Hong-Kong HK) | PhD
The Hong Kong Polytechnic University - Department of Health Technology and Informatics

Coauthors
Tong KY, Hu XL, Song R, Leung WWF

Introduction
Stroke has been one of the major causes for disability. Restoration of motor functions would be greatly improved their quality of life. Post-stroke rehabilitation programs are usually labor-intensive for both the therapist and the patient. Recent technologies have made it possible to use robotic devices as assistance by the therapist, providing safe and intensive rehabilitation with repeated motions to persons after stroke. Active initiation and participation during physical therapeutic training are keys to rehabilitation success. We started a line of research 5 years ago based on this belief and have successfully developed different control strategies for upper-limb training and built prototypes of training devices. Our research has led to the development of a new control algorithm to motivatle with a motor disability to actively interact with the system during a task-related training regimen by using their intention (i.e., use electromyography or EMG signals associated with a subject’s residual muscle activ

Results
More than 50 subjects with chronic stroke attended wrist and elbow training involving assistance by this robotic system, and the results showed that this type of EMG-driven interactive training could enhance the motor relearning process for the recovery of motor functions. Recently we have also developed a hand robot for training hand open, palmar grasp and lateral pinch. We would like to show our development and give a demonstration on our new hand robot in the presentation.

Conclusion
EMG-driven interactive training is an effective training on stroke rehabilitation.

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Image: Tong_837.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg441312/cg441788

Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3800-844]

Training of Functional Movements with the Arm Rehabilitation Robot ARMin

Author
Guidali, Marco (Zürich CH) | MSc
ETH Zürich, Institute of Robotics and Intelligent Systems (IRIS) - Sensory-Motor Systems Lab

Coauthors
Klamroth V., Riener R.

Abstract
Robot-assisted therapy has become a common tool in neurorehabilitation. To enhance the transfer from therapy to daily life a system for the training of functional arm movements was developed and evaluated.

Introduction
Task-orientated repetitive movements can improve motor recovery in patients with neurological lesions, e.g. after stroke. In the last years the application of robotics to assist, enhance and evaluate the rehabilitation therapy has been increased. Many robots focus only on movements in a few degrees of freedom, e.g. planar movements, distal functions, hand function. To maximally involve the patient and enhance the transfer to daily life, functional movements should be exercised.

Methods
The arm rehabilitation ARMin was developed at Balgrist University Hospital in collaboration with ETH Zürich. The latest version was extended to seven degrees of freedom and includes a new forearm module and a hand module to support hand opening and closing. Important activities of daily living (ADL) were identified and mimicked by a virtual world with a state-of-the art game engine. In order to maximize the patient's voluntary effort during the training a path control strategy supports him only as much as needed. The feasibility of the system was tested with several healthy subjects and one patient.

Results
During the experiment all healthy persons and the patient were able to accomplish the demanded tasks. The healthy subjects were instructed to behave passive or active to evaluate the path control strategy, which adapted itself to the needs of the subject and did not hinder faster movements. A stroke patient participated in the experiment and was able to perform functional movements with the assistance of the robot.

Conclusion
First experiments showed that the system is suitable for the training of activities of daily living. The system is currently evaluated in a controlled clinical multicenter trial with the goal to compare robot-assisted therapy to conventional therapy regarding the transfer to daily life.

Image: ARMin3_844.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg441312/cg441979

Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3801-739]

Recent Advances in Upper Limb Functional Electrical Stimulation Technologies

Author
Kenney, Laurence (Salford GB) | Dr.
University of Salford, Brian Blatchford building - Centre for Health, Sport and Rehabilitation Sciences

Coauthors
Howard D

Abstract
This symposium will focus on the use of functional electrical stimulation as a tool to support the delivery of task-specific, voluntary-initiated upper limb therapy after stroke. A brief review of the evidence underpinning this approach will be followed by an overview of the technical challenges in delivering such an approach in clinical practice.

Introduction
The pattern of upper limb recovery after stroke is poor. Of all stroke patients starting rehabilitation with marked impairment of arm function, approximately 50% regain no functional use at six months post stroke [1].
Low intensity physiotherapy for the upper limb appears to be of limited effectiveness. For example, a study showed that motor deficit at 6 months is well predicted by Fugl Meyer score at month 1, suggesting that conventional therapy in months 1-6 has little effect on impairment [2]. However, through studies such as the Excite trial [3] we have a better understanding of the importance of high intensity practice. Further, it is believed that patients benefit most if functionally relevant and challenging tasks are used in their rehabilitation. As patients often need assistance to perform such tasks, there is now considerable effort being put into FES as a tool to support the user in relevant and intensive upper limb task-focused rehabilitation.

Methods
We have investigated two approaches to stimulator controller setup; one based on a neural network classifier [4] and an alternative based on a Finite State Machine controller, that we named the Clinical Set up Tool [5]. This allows clinicians to rapidly setup a sequence of states that describe a given functional task (e.g. picking up and drinking from a cup). The patient is asked to attempt to perform the task while concurrently the motion of the upper limb is monitored from accelerometers on the arm. At appropriate points in the task, the therapist indicates to the system that a state transition (which may or may not be associated with stimulation being turned on or off) has occurred. Following several repetitions of the task, the software computes the value for the motion parameter that best represent each of the transitions between states and these values are uploaded to the stimulator.

Results
We recently reported on the performance of the Clinical Setup Tool [6]. Two subjects, both at least 6 months post stroke and with good proximal control, but limited ability to open the hand, showed an increased ability to perform simple tasks when using FES to open the hand. The parameters governing the state transitions in both cases were obtained via the Clinical Setup Tool

Conclusion

The promising results from our recent work on the Clinical Setup Tool are being built on in our current project, developing an Advanced FES Rehabilitation Tool. Further details on this will be presented at the Symposium.

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Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3802-754]

Development, Assessment and Clinical Applications of a Hybrid System for Upper Limb Rehabilitation in Tetraplegics

Author
Cliquet Jr., Alberto (SãoPaulo BR) | PhD
Faculty of Medical Sciences, Universidade de Campinas-UNICAMP, Universidade de SãoPaulo-USP - Dept. Electrical Engineering & Dept.of Orthopedics & Traumatology

Introduction

This work presents the application and functional evaluation of a hybrid system towards upper limb rehabilitation for tetraplegics. The system is comprised of an elbow dynamic orthosis (1), neuromuscular electrical stimulation and an instrumented glove for feedback (2)(3).

Methods

Clinical Assessment enhances the devices performance in relation to reach and grasping. A further application leads to an assited therapy, through repetitive movements of the patients upper limbs, that can actually yield elbow flexion-extension (range from 20 to 120 degrees) muscle activity improvements due to neuroplasticity.
The overall assessment included motion analysis, with an image capture technique, sensors for force, angle monitoring and electromiography.
Twenty spinal cord injured subjects were part of the first trials and the hybrid system, combined with scapular and shoulder movements, did effectively help them (figure). The use of the system improves reaching range (20%), grasping as well as bringing an object towards the body and as such, it becomes an alternative therapy for spinal cord injured individuals.

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Image: Cliquet_None.jpg (see online)

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Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3804-760]

Design Evolution and Evaluation of a Mobile Arm Support for People with Muscular Weakness

Author
Plettenburg, Dick (Delft NL) | Dr. Ir.
Delft University of Technology - BioMechanical Engineering

Coauthors
Imelda J.M. de Groot

Abstract
For people with muscular diseases, a spring balanced arm support was developed. Based on home visits, design criteria were set up for essential activities of daily living. Three generations of prototypes were created, thefirst to demonstrate the principle of single point support, the second to perform clinical testing, and the third as a product. Over a hundred units are produced so far. Clinical evaluation based on IPPA and Dquest showed that the device is considered as very useful.

Introduction
Assistive devices for people with muscular disorders can be categorized as robotic arms, powered orthoses, and passive orthoses. Since the first two are very expensive, and the third usually suffer from friction and balancing errors, a new spring-balanced arm support was developed. This study focuses on the design evolution of the design from need identification to product.

Methods
To complement the questionnaires found in literature, it was decided to set up design criteria based on home visits to identify essential activities of daily living. As a target group, Spinal Muscular Atrophy patients were selected, characterized by a good hand function but weak shoulder girdle muscles and normal co-ordination. The design method was based on biomechanical analysis of upper arm support force systems. An iterative design process was employed with physical prototypes at the end of each phase so as to generate user feedback. In the intermediate phases, informal and semi-structured feedback was obtained from all users. The final design was evaluated clinically using the IPPA and D-Quest methods.

Results
The home visits revealed that the ability to do tasks of personal hygiene, independence and unnoticeable appearance are most important. In addition, the importance of a fixed arm rest was reported in order to maintain trunk balance.
Biomechanical analysis demonstrated the possibility of single point support. This notion was used in the subsequent concept generation process. An important consequence is that the support mechanism does not need to be placed alongside the users' upper arm. This way a mechanism around the shoulder was avoided. A first physical model was made based on a spring balanced pantograph concept, to demonstrate the principle of single point support. Users appreciated the design, both its function and its aesthetics.
A second design iteration was performed to add adjustability to different arm weight, optimize kinematics to reduce overall linkage size, and improve the interface. This model was assessed by 16 patients. Their feedback was encouraging, and a third iteration was performed to reduce friction and improve the design and manufacturability.

The resulting design is currently a product which is distributed through rehabilitation centers in the Netherlands. Over a hundred units are produced so far. Clinical evaluation amongst 7 users based on IPPA and D-Quest showed that the device is considered as very useful and that service can still be improved.

Conclusion

The need for a new type of arm support was identified with improved mechanical performance relative to current designs. A spring-balanced pantograph mechanism was proposed with a single connection to the arm of the user, slightly distal from the elbow. The spring settings are adjustable to accommodate different users, clothing, and objects. Three generations of physical models were created, the first to demonstrate the single point support principle, the second for patient testing, and the third as the initial product series. Over a hundred units were manufactured so far. Clinical evaluation based on IPPA and D-Quest showed that the device is considered as very useful.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg441312/cg444073

Symposium: Innovative Technologies for Powered Upper Limb Orthoses
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3803-None]

Powered Elbow Orthosis for Orthopaedic Rehabilitation

Author
Vanderniepen , Ines (Brüssel BE) | MSc
Vrije Universiteit Brussel, Faculty of Applied Sciences - Department of Mechanical Engineering

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg441312/cg442552

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3870-None]

Amputation of the Lower Extremity and Healing of the Residual Limb

Session Chair
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg754557

Symposium: Amputation of the Lower Extremity and Healing of the Residual Limb
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3871-773]

Transtibial Amputations

Author
Bowker, John H. (Miami, FL US) | MD
Miller School of Medicine, University of Miami - Department of Orthopaedics

Coauthors
Professor John H. Bowker

Abstract
Transtibial amputation (TTA) is the most proximal level at which near-normal function can be restored prosthetically due to retention of the knee joint. Basic principles of surgical technique are described as well as variations in technique related to etiology and the extent of tissue trauma or disease.

Introduction
This instructional course lecture covers the indications and contraindications for TTA and useful variations in surgical technique which respect sound surgical principles under a variety of circumstances. Emphasis is placed on preservation of tibial length, fashioning a stable soft tissue envelope with myodesis, and preventing knee joint contracture and perioperative deconditioning.

Conclusion
Transtibial amputation, despite being the most common major ablation in the lower limb, often has a suboptimal outcome. The principles and techniques outlined in this talk may prove useful to the surgeon in achieving the desired functional outcome for the patient.

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Chapter 38 Transtibial Amputation:Surgical Management
pp 481-501

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg754557/cg755182

Symposium: Amputation of the Lower Extremity and Healing of the Residual Limb
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3872-831]

Knee Disarticulation and Through-knee Amputations

Author
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Abstract
Knee disarticulation and through-knee amputations are classic levels of amputations, but relatively little used compared to transtibial and transfemoral amputations. But runners with knee disarticulations are winning the Gold Medals in the category of transfemoral amputees, which proves its superior performance.

Introduction
Only whenever it is not possible to save the knee joint by means of an ultra-short transtibial amputation, knee disarticulation and through-knee amputations are indicated. The femur and the thigh muscles are fully preserved. The stump permits full terminal weight bearing with a long muscle lever. These features improve proprioception and circulation. They also prevent
osteoporosis caused by a lack of mechanical axial strain.
The operative technique with a stump with full weight bearing and without any extra length. are demonstrated and discussed. They include postoperative management, complications and prosthetic fitting.
The total contact soft-socket technique developed by Pierre Botta and four-bar linkage knees designed for knee amputation levels provide excellent functional and cosmetic results.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg754557/cg755391

Symposium: Amputation of the Lower Extremity and Healing of the Residual Limb
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3873-875]

Transfemoral Amputation: the Surgeon’s Point of View

Author
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Introduction
A transfemoral amputation only is justified if it is not, by no means possible to amputate at a through-knee level with a stump end with full load bearing and with fully preserved thigh muscles. Transfemoral stumps tend to abduction and flexion contractures because of muscle dysbalances. An ultra-short transfemoral stump at the trochanteric level must not be removed for prosthetic reasons. It is very useful to keep balance in sitting position. Various techniques of myoplasty and myopexy are demonstrated. They must avoid muscle tissue strangulations particularly in dysvascular patients. The future of the stump is highly dependent on the socket size and shape and the prosthetic alignment. No comments can be made about osseointegration due to the natural lack of long term results for 20 years and more.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg754557/cg755600

Symposium: Amputation of the Lower Extremity and Healing of the Residual Limb
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3874-None]

Measures to Improve Healing of the Residuum

Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg754557/cg755809

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3656-None]

Upper Extremity Prosthetics - Functional Components 1

Session Chair
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Session Chair
Bertels, Thomas (Duderstadt DE) | Dipl.-Ing. (FH)
Otto Bock HealthCare GmbH - R&D

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905

Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3566-663]

Development of a Multifunctional Myoelectric Hand

Author
Heo, Yoon (Incheon KR) | Master of Engineering
Korea Orthopedics & Rehabilitation Engineering Center - R&D 3 Team

Coauthors
Hong BK, Kim JK, Park SH, Mum MS

Abstract
This paper presents a myoelectric hand controlled by two EMG sensors. The developed prosthetic hand can grasp many type of object with the 5-independent fingers, possible to play a game or express intension with the five different hand gestures

Introduction
As IT technology and welfare aid for the disable people is getting improved, the needs of the multi-function prosthesis is also getting increased. Especially, for the upper limb amputees who are free to move, it is possible to participate in normal activity if they have proper prosthetic hand. For the prosthetic hand, the research topic is getting changed from the 3-finger to 5-finger type myoelectric hand which is similar to human hand and easy to grasp many type of object. However, until now, the research about prosthetic hand has only focused on grasp facilities, but nobody has focused on interpersonal facility of the human hand. In daily life, hand gesture is another useful way to represent human intension. In particular, the gaming gestures such as Rock, Scissors and Paper, and the intension expression like Pointing and OK are representative hand gestures. In this paper, we present a 5-finger type myoelectric hand which has multi-grasp function and express 5-type of hand gesture.

Methods
To develop a light, minimized myoelectrc hand, a DC geared motor and 4-bar linkage mechanism were applied in each finger. In each active joint of finger, the worm gear mechanism was applied for the simple implementation of the self-locking system without additional breaker. For understanding amputee's intension, two surface EMG signals which is processed as MAV(Mean Absolute Value) to minimize external noise were compared with the pre-determined myelectric signal of the amputee. For the management of the two EMG sensors and 5 independent motors, a micro-processor based controller which is small enough to be built in the prosthesis was developed. Lastly, a simple manipulation algorithm that an amputee can easily handle was developed for the grasp control and the hand gesture switching.

Results
It was presented a 5 finger type Myoelectric hand which can grasp many type of object, express user intension and play a simple game with the 5 different gestures. 4-grasp types such as Hook grip, Cylindrical grip, Spherical grip and Tip grip are possible to satisfy the basic function of the hand. In addition, two special functions with the proposed 5 gestures were applied to elevate the quality of life. The one can play the game of rock-scissors-paper which is very frequently used as a game or a decision method. The other is OK and Pointing gesture to express user intension and indicate something in the distance. For the convenient control of the amputee, only two surface EMG sensors were applied for the mentioned all the function. A simple control algorithm with a sequential combination of the two sensor signal was developed. For example, a sequential action, flexion just after co-contraction means Scissors, and two consecutive

co-contractions is for OK gesture. The weight of the developed myoelectric hand was about 380g without battery and controller, and 7.2V 1100mA Li-ion battery was applied.

Conclusion

The developed prosthetic hand which is composed of five independent DC geared motors. However, the worm gear mechanism which was applied for the implementation of a self-locking system caused low efficiency for the actuator. So the grasp torque was not enough for the real implementation. In the future study, we will upgrade the grasp torque and add other grasp functions such as precision and lateral grip for more natural grasp like human hand.

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Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3105-303]

Assessment of Functionality of Prosthetic Hands using the Southampton Hand Assessment Procedure

Author
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Coauthors
Bush G and Hill W.

Abstract
The Southampton Hand Assessment Procedure (SHAP) was used to measure the relative performance of a range of commercial prosthetic hands. As the test aims to measure the functional capability of the subject, a single subject was used for repeated measures and to remove the inter-subject variability.

Introduction
SHAP measures the function of a hand using a form-board and self-timed tasks. It uses methods that are repeatable and easily measured. It is the in Function domain within the WHO-ICF model [1].
The tasks are divided into 2 sections; abstract objects of 2 weights, to encourage the use of the 6 standard grips, and 12 simulated Activities of Daily Living[2]. The score is based on the difference in time to a normal group. The grasps are given weightings depending on their relative use in daily activities[3]. The result is a score with a maximum of 100, (normal above 97). Its repeatability and validity have been tested and it has been used to study of different conditions [4,5,6].
This study focuses on the performance of the current generation of myoelectric hands. To remove variability between subjects a single user was chosen, performing multiple tests with different hands and different control schemes. The relative scores emphasise the differences between devices and control schemes.

Methods
The tests were performed twice daily. The author was fitted with a self-suspending socket over his (non-dominant) arm. Otto Bock, Motion Control, RSL Steeper and Touch Bionics hands were tested.
Three Otto Bock hands were used: SensorHand speed, DMC Hand and Transcarpel, (former two 7 3/4”).
The SensorHand Speed was set to maximum speed and three different control formats were tried:
1/ Twin electrode proportional control - force control and slip detection.
2/ Single electrode Voluntary opening Involuntary closing - force, no slip detection.
3/ Two electrode proportional.
There were 2 weeks of 2 runs a day. Sessions 1 to 12 were discarded to remove learning effects.
The data was analysed: The daily order through paired t-tests of the first and second run each day. Learning effects, though the t-tests between epochs, 3 to 12 were compared to 13 to 22. The individual scores were also Normalised against the overall score (ie divide the individual grip score by the overall).

Results
Hands of similar design have similar overall scores but with different individual grip scores. The limited gape of a conventional prosthesis limits the functional capabilities more than the speed of prehension or the availability of wrist flexion. For example; the measures showed that although the Motion Control could

have passive wrist flexion, it did not change the function of the hand, as measured with the SHAP score alone, as it is easier to raise the elbow than it is to flex the wrist.
The Steeper hand was slower in motion and only used a simple On/Off. The slower speed meant that it was easier to control than the very quick Otto Bock, hence the score was very similar with relatively better scores in the Spherical, Lateral and Power Grips.
Otto Bock While the TC hand was the smallest (hence a score of 84) its relative score for all grasps, especially the spherical, was larger. This was in part due to the control format. The SensorHand speed relies on the force sensors to apply lighter forces on the target. Its minimum grip is still large. So combined with a fast prehension speed, it makes the hand hard to control in precision based tasks, forcing the user to re-apply grip onto some objects before a creating a stable grip.
Touch Bionics Although the hand had a weaker grip than the other prosthesis the range provided by the fully curling fingers mean that it can grasp more objects in a natural and enclosing grip such that greater prehension force is not required.

Conclusion

The SHAP was designed to give simple assessment of the functional capabilities of the hand and as such can highlight where improvements can be made in the design and application of the devices.
With the exception of the Touch Bionics hand all of the other hands were of a similar design; single degree of freedom with the fingers set in a precision grip, but it is not the precision grip that achieves the highest score. Additionally, despite the fact that the test employs a timed element the fastest hand did not score much higher than other hands with similar geometry.
The iLimb hand used two controllers: The first drove all fingers with the EMG command, the second allowed selection of a two point grip for precision based grasps. In this latter form the Tips category scored much higher, 73+/-4, and more consistently compared with 55+/-10. This shows the importance of the control format of the hand.

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Image: Fugure1_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905/cg38119

Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3046-244]

Usability Analysis of the Multi Degree of Freedom Prosthetic Hand System “Michelangelo” - A First Case Study

Author
Kalmar, Janos (Vienna AT)
Otto Bock Healthcare Products GmbH - R&D

Coauthors
van Vliet JW

Abstract
A case study shows that the Michelangelo hand system clearly brings advantages. In comparison to a hand system with a current state of technology, the user can successfully master a significant amount of additional tasks of daily living.

Introduction
Most of the currently available prosthetic hand systems are limited to one degree of freedom. This merely enables the user to open and close the hand with a simple pliers-movement. Separate components are available which allow a pro- and supination as well as a wrist flexion and extension.
Michelangelo offers both, an integrated passive pro- and supination plus a passive, lockable wrist flexion and extension. An integrated powered thumb offers the user additional hand/finger-positions: the pinch grip, the lateral grip, the open-hand flat and the open-hand natural position. The integration of four degrees of freedom into a prosthetic hand results in an improved quality of life on an every day basis when gripping, holding and fixing objects.

Methods
Two male probands (29 and 34 years old) were tested and supplied with an Otto Bock sensor hand speed and a new Michelangelo hand. Both probands – who are amputated transradial in the upper third – were asked to do common activities of daily living. A team consisting of 48 international specialists observed and evaluated the test. After finishing the test the probands filled out a survey.

Results
The team was divided into four groups (G1-G4). Each group made two independent tests with both probands as follows:
Test1 (simple actions):
• Holding a credit card
• Picking up a pen from a table
• Holding a plate
• Sweeping a broom
Test2 (complex actions)
• Preparing a sandwich
• Preparing a pancake
The first cycle was carried out by the probands with the sensor hand speed. The second cycle was done with the Michelangelo hand.
The team evaluated:

• posture (spine, shoulders, compensating motions, balance)
• hand movement (accuracy, way of movement)
• required time
• handling
The tests showed significant benefits when using the Michelangelo hand. The probands especially judged the far more natural gripping patterns as positive, in comparison to the current prosthesis.

Conclusion
The test showed that Michelangelo clearly offers advantages to the user. The functional advancements in connection with the normal acting gripping patters undoubtfully demonstrate a big gain for the broad user field. The customer requirements of users of all kinds of cultures clearly point out that it is important not to stand out with the prosthesis in every day life. The mentioned advantages of Michelangelo become very transparent if all degrees of freedom are operated myo-electrical. Then there is no need for the user to reposition joints of the prosthesis with the sound hand. The end goal is to enable intuitive and simultaneous control of all joints.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905/cg35533

Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3287-462]

Mechanical Design of a Multifunction Hand Prosthesis System - The UNB Hand

Author
Clawson, Adam (Fredericton CA) | Mr
University of New Brunswick - Institute of Biomedical Engineering

Coauthors
Segil J, Jones B, Losier Y, Kyberd PJ, Weir R

Abstract
In order to create a hand which can perform the 6 basic grip forms it was determined that 3-axis of motion are required. The index finger and thumb are individually actuated. The other fingers are linked via a differential mechanism so they can conformally grasp the detailed shape of the object.

Introduction
It is now possible to make an anthropomorphic prosthesis 5 independent articulated fingers, (the iLimb hand), but its current limitation is the control of the grip shape. This project aims to construct an anthropomorphic hand, with a controller design that will allow for more sophisticated solutions.
A prosthetic hand is a compromise between number of actuators and flexibility. The natural hand has 6 basic grasps. Conventional prostheses manage 2 and the iLimb hand 5. The Belgrade [1] and Sven [2] hands link 2 fingers through flexible drives for passively adaptive hands. The Southampton Hand splits the index finger from the others [3]. Both forms allow the fingers to adjust to an uneven surface, but the latter creates 3 and 2 jaw chucks.
While previous prostheses have relied on a single microprocessor control the hand, a distributed system will allow different parts of the control problem to be tackled locally and supervision can be left to a master node, [4].

Methods
The UNB hand aims to create a solution to maximise the capabilities of the hand while tackling production costs. This paper describes development of the first prototypes.
A study of previous methods to achieve suitable grasps was made. This included existing multi-degree of freedom hand designs. Consideration to the compromise between the number of motions used and the functional capabilities of a resulting hand was made. Additionally, the limitations posed by using two or three articulations on the finger were observed, plus the knowledge gained from experience of other multi-degree of freedom hands was incorporated into the overall design specification.
An important aspect of grasping is that if the fingers are driven from a single motor then there needs to be some compliance within the drive train to allow the fingers to all contact the object and spread the grasp load more evenly. A compliant mechanism was placed on the proximal joint of the fingers to provide this feature.

Results
The index finger and the thumb are driven independently and are actuated at the meta-carpal phalangeal (MCP) joint and carpometacarpal (CMC) joints. The other fingers are actuated by a single drive. The mechanism, located at the MCP joints of these fingers, balances the torque between the fingers while

allowing for semi-independent movement of each finger, and so a compliant grasp. All digits have a kinematic linkage system within the proximal phalange which creates an extra degree of motion about the proximal interphalangeal (PIP) joint. Additional compliant elements in the joints allow for compliance in the flexion/extension and abduction/adduction directions. The mechanical drive system of the UNB Hand produces the six functional grasps; spherical, tripod, power, lateral, tip and extension, while being able to conformally adjust to the majority of objects.
The mechanical design uses off the shelf components in order to minimise production costs. The drives use coreless brushed DC motors and associated 4-stage planetary gearheads. The distal gearing and differential systems are modified parts designed to withstand maximum loading conditions. The majority of the purchased components are also modified to fit within the hand envelope.
Testing of the hand system will take place with users who attend the Institute of Biomedical Engineering's limb centre and the hand will be assessed using functional assessment tools [5], and motion analysis of the arm in use [6].

Conclusion
A multi-axis adaptive hand prosthesis has been produced that can form all six basic hand grasps. The mechanism is both passively and actively adaptive to the shape of the target object and can be fitted as a trans-carpel hand. The mechanism includes the local microprocessor controller.

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Image: UNB Hand_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905/cg43584

Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2981-179]

A Collaborative Team Approach to the i-LIMB Hand and ProDigits: What are the Future Implications for Greater Partnerships with Each Other?"

Author
Atkins, Diane (Hilliard US) | OTR/L
Touch Bionics - Clinical Services

Abstract
The interaction and partnership of the team approach with the therapist, prosthetist and manufacturer, will be reinforced in this presentation. Since the i-LIMB Hand was developed, team members have worked together to explore its unique features and a solid workingpartnership has been the result.

Introduction
With the increasing sophistication and technological advances in upper limb prosthetic technology, it is becoming critically important for the prosthetist, therapist, engineer and patient to work closely together to achieve optimal outcomes. How can this be achieved in a time efficient, goal oriented and collaborative manner? What bridges can be built between the clinical team and patient to enhance communication and achieve the highest level of independence and patient satisfaction?

Methods
Several patient cases will be highlighted in order to demonstrate the partnership of the prosthetist, therapist, engineer and patient that has enabled optimal outcomes unique to the features of the i-LIMB multi-articulating hand. The i-LIMB Therapy Training Protocol will be featured in order to orient the prosthetist and therapist so that they may explore new and different ways to approach functional independence. Input from the individual with limb loss will also be closely examined. Prosthetists, therapists, and Touch Bionic's engineers will partner with patients to help them achieve their functional, vocational and avocational goals.

Results
The experience and insights from patients, therapists, prosthetists and other members of the clinical team have challenged the manufacturer to pursue and create additional advantages for i-LIMB users. These ideas and innovations have resulted in unique engineering developments, new prosthetic designs and the i-LIMB Hand Therapy Training Protocol.

Conclusion
Current technologies and opportunities for the prosthetist, therapist, engineer and patient hold great promise to future design, development and collaboration in upper limb prosthetic rehabilitation. Open exchange will be encouraged in order to listen, learn and share each other's pursuit of excellence in this exciting, emerging and fast changing field.

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Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2982-180]

Early Partial Hand Patient Outcomes Utilizing ProDigits Myoelectrically Controlled Prosthetic Digits

Author
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Coauthors
Passero, T, Atkins, DJ

Abstract
Creation of detailed patient evaluations, test socket design, signal site testing, dynamic and final fittings, covering options and pre and post occupational therapy training to provide powered prostheses to individuals with partial hand loss will be provided.

Introduction
The treatment of individuals with through-hand amputation has been limited previously to either passive or body-powered options. To date, 30+ early stage patients have been fitted with ProDigits technology, varying between three and five replacement fingers, with both unilateral and bilateral involvement. These individuals were provided with the modular componentry of the i-LIMB Hand to increase their dexterity and function. Knowledge from those early fittings is shared. Information addressing the ways in which ProDigits technology is applied to standardize techniques is given, including future plans for the adoption of 3D scanning for socket design, myoelectric site location and aesthetic coverings.

Methods
Evaluations and trial fittings of two patients (from Spain and China) include preliminary discussions on appropriate prosthetic suspension, socket design, myo site location and viability, FSRs or electrodes for myoelectric signal input, thumb mounting, thumb rotation, battery location, and programmed control strategies. Initial discussions involved standard evaluation methods employed by the prosthetic and orthotic profession. Decisions were then made for the subjects to participate in step-by-step procedures including advanced patient evaluation, test socket development, signal sites, input strategies, dynamic testing, initial fitting, final fitting, familiarization, covering development and occupational therapy. The patients participated in these processes in condensed weeklong intervals at the manufacturer’s Center of Excellence in Livingston, Scotland. Comparisons of varying techniques employed by both Touch Bionics and partnering prosthetists were incorporated.

Results
Utilization of external powered prosthetic digits (ProDigits) provided two individuals with partial hand amputations new ways of achieving prosthetic success in their activities of daily living. Initial prosthetic work addressed critical elements including independent donning and doffing of the prosthesis, which was achieved using traditional rigid and flexible interface designs. Various suspension methods using intrinsic bony/muscle landmarks of the remnant hand as well as extended flexible interface designs utilizing extrinsic residual limb surfaces were incorporated. Consideration was given to unrestricted wrist motion when possible. Functional goals were achieved with the ProDigits and were substantiated by conducting Occupational Therapy Training Protocols, developed specifically for advanced training of multi-articulating

digit technology. Aesthetic goals were partially achieved by the human like behavior of the ProDigit system but patients were not fit with aesthetic coverings, as that development continues.

Conclusion

Addressing the multiple deficits of an individual with partial hand absence requires special attention when fitting a prosthetic system. Advances in prosthetic technology including the introduction of external powered (ProDigit technology) partial hand solutions have the potential to enhance the quality of life of these individuals. Future needs will require incorporation of advanced training from an Occupational Therapist to fully utilize the multiple grip patterns available with ProDigits along with how to address incorporation of this technology into the whole person.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905/cg35035

Session: Upper Extremity Prosthetics - Functional Components 1
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2934-132]

Physiological Advantages of a Prosthesis with Wrist Joint Flexion

Author
Bertels, Thomas (Duderstadt DE) | Dipl.-Ing. (FH)
Otto Bock HealthCare GmbH - R&D

Coauthors
Schmalz T, Ludwigs E

Abstract
During active use, patients attempt to overcome limitations in range of motion with non-physiological compensating movements. This study of forearm patients shows that changes in the flexion angle of a prosthetic wrist joint significantly reduce compensating movements of the arm and torso.

Introduction
An arm prosthesis is designed to approach the natural model as closely as possible in terms of appearance and function. Compensating for lost body mass is another important physiological aspect. This allows typical problems such as back pain, etc. to be significantly reduced. [1] Therefore, using the prosthesis is important to ensure that posture is as sound as possible over the long term. A prosthesis socket reduces the patient’s freedom of movement. [2] Limitations are also imposed by the prosthesis components themselves so that compensating movements are required. These movements are not always physiological and also cause the prosthesis wearer to tire quickly. This reduces acceptance of the prosthesis system.
Based on biomechanical parameters, this study objectifies whether a myoelectric arm prosthesis system can facilitate more physiological movement patterns and therefore improve a patient’s quality of life through the integration of a wrist joint with adjustable flexion.

Methods
The study was conducted on 3 patients with a amputation of the forearm and 3 test subjects with a deformity of the forearm. All patients used a prosthesis socket enclosing the epicondyle. A myoelectric system with the Transcarpal Hand (Otto Bock) was used. A mechanical wrist joint system, the MyoWrist Transcarpal (Otto Bock), was integrated into this system. This wrist joint permits flexible wrist flexion settings up to 40° flexion and extension and corresponds to the natural range of function of the human hand. [3]
Measurements were taken in a motion analysis laboratory using an optoelectronic camera system (VICON 460, VICONPEAK, UK) to record the movement kinematics. Five typical movement patterns that occur during everyday use were selected for this purpose. These movement patterns require pronounced arm movement. The movement patterns were initially carried out on the sound side. Subsequently, the tests were repeated on the prosthesis side with various wrist joint flexion settings.

Results
The shoulder angle in the sagittal and frontal planes, the humerus rotation, and the flexion angle of the elbow were selected to examine the compensating movements of the arm. The measurements of the sound side were used for comparison. As expected, measurable compensating movements were required on the prosthesis side. As the flexion angle of the artificial wrist joint was increased, some of the movement amplitudes elevated by compensation were drastically reduced. A significant reduction of the maximum angles was observed in 14 of 20 angle gradients that were examined. In 4 other cases, the differences compared to the sound side were negligible. Only in 2 angle gradients did a prosthetic hand without flexion

exhibit a more physiological range of motion. The subjective assessment of the patients is reflected in the results. It was also shown that pronounced torso rotation and shoulder movement in the frontal plane without wrist joint flexion can also be reduced for certain movement patterns as the flexion angle of the wrist joint increases.

Conclusion

The results show that adjustable wrist joint flexion results in measurable changes to compensating movements. In many cases, a wrist joint with flexion results in a more physiological movement pattern of the arm. Certain movement patterns, such as drinking, were made possible only with wrist flexion. The rotation of the wrist joint also plays an important role. It was individually adjusted. Reducing compensating movements also reduces strain on the joints. In addition, movements become more natural and thus less conspicuous.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg218905/cg34765

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3765-None]

From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies

Session Chair
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Abstract
A variety of models exist for clinical assessment of student orthopaedic technologists and prosthetists/ orthotists. When included in courses, the final clinical examination can be either be based on specific patient presentations or can be a multi-station examination. Graduates of these programmes must then continue their professional development and often attend short courses to develop specific competencies about special techniques or patient conditions.
This symposium will present different models of final clinical examination in depth for prosthetics and/or orthotics including:
• examination of students presenting single patient cases
• examination of student competencies using a 6 station simulation model
• examination of student competencies using a multi-station simulation model
• examination of student competencies using the orthopaedic assessment model
Further to this, it is generally accepted that graduates need early career support following graduation.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg395861

Symposium: From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3766-822]

A Global View of Different Models of Competence Assessment and Development

Author
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Coauthors
Sexton S

Abstract
An introduction to the symposium.

Introduction
A variety of models exist for clinical assessment of student orthopaedic technologists and prosthetists/ orthotists. When included in courses, the final clinical examination can be either be based on specific patient presentations or can be a multi-station examination. Graduates of these programmes must then continue their professional development and often attend short courses to develop specific competencies about special techniques or patient conditions.

Methods
Contrasting approaches to developing and assessing the competencies of student prosthetist orthotist are apparent when comparing educational offerings across the world. Those people responsible for course delivery are passionate about their subject area and about their particular approach to teaching, learning and assessment. As chair of the ISPO education committee, I have often been asked about which styles of assessment are the most effective and how professional practice should be developed, but there is no one “best” mode of delivery, but different approaches to suit different situations. This symposium has been created to address these issues and each presentation will illustrate a different aspect of competence assessment or development.

Results
The speakers for the symposium are leading prosthetist/orthotist clinicians and educators representing a range of views from different countries (and 3 continents!) including Cambodia, Scotland, America and the Czech Republic and from the point of view of the ISPO about assessing and developing professional practice for orthopaedic technologists and prosthetists/orthotists. Despite differences in style of assessment, all of the approaches measure standards of competence against the ISPO professional profiles for orthopaedic technologists (ISPO Category II) and prosthetists/orthotists (ISPO Category I).

Conclusion
This symposium will present different models of final clinical examination in depth for prosthetics and/or orthotics including:
• examination of students presenting single patient cases
• examination of student competencies using a 6 station simulation model
• examination of student competencies using a multi-station simulation model
• examination of student competencies using the orthopaedic assessment model

Further to this, it is generally accepted that graduates need early career support following graduation. Continuing professional development of graduates is needed to maintain general competency and develop specialist competencies and this is supported by employers. Over their lifetime as professionals, graduates can continue to attend specialist courses to develop their skills and knowledge and to learn from reflective practice.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg395861/cg396317

Symposium: From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3767-826]

Examination of Students Presenting Single Patient Cases

Author
Kheng, Sisary (Phnom Penh KH) | BSc, MSc
Cambodia Trust - Cambodian School of Prosthetics and Orthotics (CSPO)

Introduction
In order to achieve this main goal, CSPO follows the joined guidelines of ISPO/WHO for training prosthetist/orthotists in developing country (2001). CSPO carries out single cases presentation in the final examination. Students are required to pass all modules (50% pass mark) in order to be eligible for the final examination. Students who obtained the marks below 60% are considered to be at risk and they can be recommended to delay their final exam.

Methods
Exam format:
Students are given two patients to prescribe and to fit to the final fitting stage. The two patients require one long and one short device (either a KAFO and Transtibial prosthesis or a Trasfemoral prosthesis with an AFO). The students are designated to the type of the device and patients by lucky draw once week prior to the date of the examination. The clinical supervisors screened the patients prior to selection of patients for the final exams. Students
are not allowed to see their patients until the day of the exam. The two patients are available for the students to make assessment and casting from the first day but some may decide to concentrate on a single case on the first day and another patient on the next day. Students have 10 days for their clinical assessment, casting, rectification, fabrication, fitting, adjustment,
and final fitting for the two projects. For the period of the exam, CSPO arranges various observers (experienced clinical prosthetist/orthotists from other agencies) to

Results
Grading guidelines for case presentation:
The oral presentation is split into five parts, each part is weighted differently. Parts which address core skills or significantly impact patient safety are mandatory pass. All areas combine to 100%, the pass level is set at 50%. The five parts are; Patient presentation (30%-mandatory pass), Practical quality (15%), Fitting and assessment (40%-mandatory pass), Instruction to patient (5%), and Questions and answers (10%).
Score and consistent objective assessment:
Excellent (90-100%): The student displays skills and knowledge of a high professional standard.
Very good (75-89%): Skills-strong, could almost be left unsupervised. Knowledge-strong understanding of the concepts and can apply problem solving.
Good (65-74%): Skills-done well and done confidently. Knowledge-understanding with no weakness.
Fair (55-64%): Skills-a little rough, needs a little more attention to detail. Knowledge-some weaknesses, but the student demonstrates enough understanding to be able to find more information.
Pass (50-54%): Skills-the student has done just enough to be called a pass. Knowledge-has obvious weakness.
Below pass (40-49%): Skills-poor. Knowledge-large holes in knowledge.
Poor (30-39%): Done poorly with little understanding of theory.

Not done/No idea (0-29%): Either not done or the student has no understanding/knowledge of concept.
Examination protocol:
Students present the long device first and then the short device. The examination for each case is an hour l

Conclusion

The final clinical examination with the use of single cases presentation model helps the examiners to objectively assess the students on their clinical reasoning ability and critically analyze their assessment, treatment plans, prescription development, fitting critique, and other major core skills in providing optimal prosthetics and orthotics devices. This model is considered to be an effective examination model in summative assessment as various areas can be evaluated.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg395861/cg396500

Symposium: From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3768-828]

Examination of Student Competencies Using a 6 Station Simulation Model

Author
Figgins, Elaine (Glasgow G4 0LS UK) | BSc Honours Prosthetics and Orthotics
University of Strathclyde - National Centre for Prosthetics and Orthotics,

Abstract
At the National Centre for Prosthetics and Orthotics within the University of Strathclyde, Glasgow, Scotland the undergraduate programme is four years full time. The students have clinical exposure within the department followed by two clinical placement exposures, one in Prosthetics and one in Orthotics.

Introduction
At the end of each clinical placement the students return to the National Centre for a clinical examination in either prosthetics or orthotics. These occur at the end of the third year and at the mid-point of the final fourth year. These examinations take place on successive days.There are 12 different examiners for each examination day. So a total of 24 examiners are required.

Methods
Each examination consists of six, twenty-five minute viva voce stations visited by the students in rotation. Before the student enters the station a five minute multiple choice true/false paper is completed at a table outside the examination station. A bell signals the timing of the movement of students between stations.
In each station there are two examiners, most often a prosthetist/orthotist and another member of the clinical team. These examiners are chosen as a mix of the National Centre staff and from externals. Each examiner has an assessment sheet for each student. The assessment sheets guide the examiners in objective questioning of the student and have space for the examiners to enter their assessment of the students' response to the various questions and tasks of the station. A five point (A-E) assessment scale is used as follows:
A for an excellent performance
B for a good performance
C for a performance which is acceptable
D for an unsatisfactory performance
E for a very poor performan

Results
The student may fail two out of the six stations but three stations or over is deemed a fail. This examination process is rigorous and was model as a modified OSCE examination originally set up in the late 1980s by Prof. George Murdoch the eminent orthopaedic surgeon and professor from Dundee University on behalf of the National Centre for Prosthetics and Orthotics at Strathclyde University.

Conclusion
The final 6 station student competencies based examination appears to set out clear objectives and has been surveyed and scrutinised as a good final test of clinical competency assessment. The department surveyed both students and graduates to get feedback on what was felt a very stressful examination process. The feedback concluded unanimously that they felt the exam both fair and thorough and

requested it remain as a good assessment of clinical practice at the end of the clinical placement experiences.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg395861/cg396683

Symposium: From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3770-823]

Examination of Student Competencies Using the Orthopaedic Assessment Model

Author
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Abstract
A comprehensive review of developments in Orthopaedic Structured Clinical Examination in the last year is presented. The relevance of applying modified OSCE techniques to the assessment of prosthetist/orthotist clinical skills will be discussed.

Introduction
The Objective Structured Clinical Examination (OSCE) is an approach that has been used for 3 decades in medical schools across the world. It was devised as a summative assessment of students who would “show how”. The method has been modified and partially adopted in prosthetics and orthotics examination for many years. This presentation will describe the evidence about the most recent developments and use of OSCE in other professions and will reconsider whether other uses of OSCE could be more strongly adopted for prosthetics and orthotics competence assessment.

Methods
A literature search was conducted of all OSCE related Journal articles via the NHS Scotland E-library for Health, which includes the databases Medline, Cinahl, Embase and Psycinfo. The search was undertaken for publications in 2009 to determine the recent evidence on the topic. 240 results were retrieved and their titles were screened for relevance and full text articles sourced and appraised.

Results
The student experience of OSCE is that every student experiences the same examination about clinical competencies by attending a series of consecutive exam stations with simulated clinical situations they must answer questions about and/or perform a particular clinical task. Their competence is assessed by examiners at each station. The examiner experience of OSCE is that they have controlled explanations or questions for students and that they repeat their focussed examination of each student in a similar way to avoid variability in the examination. Current thinking is that each station should be short and concise because the good student can readily give detailed answers about a particular area of practice, but the weak students will soon tell what they know if their knowledge is limited.
Caution should be exercised when trying to compare OSCE results from different courses because the OSCE is not the only assessment of student competence. There are systematic variations between the teaching and learning experience of students on different courses and this must be taken into account.
Differences in the OSCE examination station set up include one long case versus some intermediate cases versus multiple short cases include. Variations also exist in marking and assessment methods. Examples of the different OSCE approaches will be described.

Conclusion
Although thorough, the OSCE examination relies on a strong team of examiners, recruiting examiners from the field may not be possible in countries with limited resources and expertise. However, the OSCE can be

modified to and delivered in such circumstances. OSCE can be modified to reflect individual programme situations and is a useful summative feedback tool, but should be used in association with other methods of formative assessment.

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Symposium: From Student to Professional Prosthetist/Orthotist - Examining and Developing Professional Competencies
Tuesday 2010/05/11 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3771-757]

Maintaining and Developing Employee Competencies

Author
Rosicky, Jiri (Frydek Mistek CZ)
ING corporation, spol. s.r.o

Abstract
Graduates of P&O study programmes must continue their professional development. Continuing professional development seems to be an effective way how to maintain general competency and develop specialist competencies.

Introduction
An employee competence is a standardized requirement to properly perform a specific job. It represents a combination of adequate knowledge, skills and behavior. It is generally accepted that it is necessary to maintain and develop employee competencies during the professional carrier. There are various reasons to do that - a rapid technological progress in P&O field, legislative requirements, a competitive position on P&O market, employee aspirations etc.
Graduates need an early career support following their graduation. Continuing professional development (CPD) of graduates seems to be very effective way how to maintain a general competency and develop specialist competencies. CPD is a long-term process that enables the graduates to become professionals in P&O field.

Methods
It is a core responsibility of employers to support CPD of graduates and other employees. The role of employers consists in establishing the framework for CPD – to define the company/institution needs, to state goals, to plan activities and to evaluate a contribution of CPD both for a company/institution and an employee. Employers should widely discuss, motivate and encourage employees to CPD.
Employees are responsible to their employers and to themselves for lifetime learning to maintain their professional competence and continue to develop in all aspects of their work.
CPD can be realized by a number of activities both internal and external ones. Internal activities within the workplace could be quit informal – there is wide range of activities that provide many of the most important learning opportunities. External off-the-job activities are more formal and comprise wider range of topics related to P&O profession.

Results
There is a wide range of CPD activities – e.g. short courses, conferences, congresses, seminars, workshops, mentoring and teaching activities, participation in product development, research studies, clinical trials etc. These activities could be organized by universities or other educational institutions (BUFA etc.), ISPO, INTERBOR, BIV, national professional P&O associations (AAOP, AOPA, BAPO, etc.), manufacturers (Ossur Academy, Otto Bock Academy, etc.), companies or commercial institutions.
The professional development of employees should not be focused just on clinical and technical competencies but should include the wider range of knowledge and skills – e.g. interpersonal skills (communication, time management etc.), legal and financial issues, learning of foreign languages, computer skills (general, specialized – CAD/CAM, other digital technologies), environmental protection, health and safety, other special fields (biomechanics, design, management etc.).

It is recommended to work out a plan of CPD activities that should be realistic (time and money resources). The activities should be monitored and documented to evaluate the benefits and to review progress (range of knowledge and skills, improvement in productivity, competitiveness and profitability of P&O business, etc.).

Conclusion

Graduates can use a CPD framework for maintaining and developing their competencies to improve their skills and knowledge and to learn from reflective practice.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3688-None]

Rehabilitation - Amputation Lower Extremity

Session Chair
Gailey, Robert (Miami US) | PhD, PT
University of Miami Miller School of Medicine - Department of Physical Therapy

Session Chair
Carroll, Kevin (Oklahoma City, OK 73118 US) | MS, CP, FAAOP
Hanger P&O - Prosthetics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236004

Session: Rehabilitation - Amputation Lower Extremity
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [2913-111]

Effectiveness of an Evidence Based Amputee Rehabilitation Program

Author
Gailey, Robert (Miami US) | PhD, PT
University of Miami Miller School of Medicine - Department of Physical Therapy

Coauthors
Roach KE,Raya M,Gaunaurd IA

Abstract
This randomized control trial was designed to determine whether an evidence-based amputee rehabilitation program could improve the functional mobility of transtibial amputees. The 6-minute walk test and Amputee Mobility Predictor detected significant improvements over 8 weeks.

Introduction
Individuals who receive prosthesis are typically discharged from rehabilitation when they can walk 150 feet. Most do not progress beyond this level of function after discharge. The purpose of this project was to determine whether an evidence-based amputee rehabilitation program could improve the functional mobility of transtibial amputees who had already completed standard rehabilitation and prosthetic training. We hypothesized that the functional mobility of subjects receiving the exercise intervention would improve while the wait list control subjects would remain unchanged.

Methods
This study was a randomized clinical trial. Measurements were be made at baseline and at the end of the eight-week intervention by an individual blinded to group assignment. Outcome measures were the 6-Minute Walk Test2 and the Amputee Mobility Predictor1 with prosthesis (AMPPro) and without prosthesis (AMPnoPro). Higher AMP scores indicate better mobility. Subjects were randomly assigned to intervention or wait list control. The intervention had five components 1) cardiopulmonary endurance, 2) core strengthening and power, 3) balance and coordination, 4) weight bearing and stance control, and 5) prosthetic gait training.3,4 Subjects received the intervention 3 days a week for 8 weeks. A two group repeated measures analysis of variance was used to compare the change in AMPPro, AMPnoPro and 6 Minute Walk scores of the intervention and control groups.

Results
Sixteen transtibial amputees completed the study. Mean age was 63.25 years, mean time since amputation was 8.1 years, 81.2% were male and 75% lost their limb because of PVD or DM. Subjects in the intervention and wait list control groups did not differ in their demographic characteristics and baseline measures. The AMPPro scores of the intervention group improved from 36.4 to 41.7, a 13% improvement in 8 weeks, while the control group scores were virtually unchanged 35.3 to 35.6 (p=.004). Similarly, the AMPnoPro scores of the intervention group improved from a mean of 23.2 to 27.1, while the control group scores moved from 24.7 to 25.0 (p=.04). The 6 Minute Walk test of the intervention group improved from a mean of 313.6 meters to 387.7 meters, a 19% improvement in 8 weeks, while the control group went from 262.6 meters to 268.8 meters (p=.04). In addition, when comparing the mean values for prosthetic

functional classification levels, participants improved one functional level and therefore would qualify for higher functioning prosthetic components.

Conclusion

Even though the subjects enrolled in this study were many years post amputation, those who received 8 weeks of strengthening, endurance and balance exercises combined with gait training demonstrated significant improvement in mobility as measured by the AMP and by the 6 Minute Walk test. These findings suggest that individuals with limb loss may benefit from additional comprehensive rehabilitation after they have recovered from surgery and the conditions that lead to amputation. Because the wait list control subjects did not improve indicates that simply walking with the prosthesis is not sufficient to restore functional mobility. Comprehensive rehabilitation is required to maximize functional mobility in individuals who have undergone amputation. In addition, in some countries, the functional improvements by the subjects would qualify them prosthetic components that are identified as higher functioning by reimbursement agents.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236004/cg34059

Session: Rehabilitation - Amputation Lower Extremity
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [2919-117]

Guidelines for Physical Fitness Levels Required for Older Hip Disarticulation (HD) Patients to Achieve Successful Prosthetic Walking in a Community

Author
Chin, Takaaki (Kobe JP) | Guidelines for physical fitness levels required for older hip di
Hyogo Rehabilitation Center - Rehabilitation Science, Kobe University Graduate School of Medicine

Coauthors
Maeda Y, Azuma Y, Iguchi T, Sawamura S

Abstract
Older HD amputees in good physical condition and a low prevalence of co-morbidities were able to successfully walk with prosthesis in a community setting. It is suggested a physical fitness of around 60%VO2max is necessary for older HD amputees to successfully walk.

Introduction
In general, the underlying diseases leading to HD are malignancy, severe infections and/or ischemia. Most of older HD amputees have various coexisting conditions in all parts of their bodies, which add to the physiological deterioration brought about by age. Therefore, they experience difficulties recovering from their deconditioned state, and maintaining the physical fitness required to walk with a prosthesis., which then become major factors impeding their success in prosthetic walking. Indeed, many researchers have reported that a level of physical fitness sufficient to meet the energy demands of prosthetic walking is required for practical success (1,2,3).There have been no reports evaluating the physical fitness and thus a deficiency on clinical information available for use in the rehabilitation of older HD amputees. The aim of this research was to investigate the physical fitness required for older HD amputees to achieve successful walking with prosthesis in a community setting.

Methods
Seven HD amputees were included in this study. All were hospitalized at this center for prosthetic fitting , and had never been fitted with prostheses before. The inclusion criteria was: (1) older than 60 years of age, (2) capable of prosthetic walking for at least five minutes at a constant pace on discharge, (3) absence of neurological, coronary, pulmonary and mental disorders that impede ambulation, (4) well-controlled medical conditions. The age of the patients was 67.7±3.9 years. The cause of amputation was malignancy in six cases and postoperative infection following joint replacement in one case. Energy consumption was measured during walking with a prosthesis at each individual's comfortable walking speed by means of a portable telemetric system. An incremental exercise test was performed to evaluate physical fitness before prosthetic rehabilitation. The maximum oxygen uptake during exercise as a proportion of predicted maximum oxygen uptake (%VO2max) was used as an indicator.

Results
The comfortable walking speed (CWS) for the patients was 30.5 ± 9.6 m/min. The oxygen cost value (per unit distance, ml/kg/m) for the pateints at each CWS was 0.639 ± 0.165, and the oxygen consumption rate value (per unit time, ml/kg/min) at each CWS was 18.3 ± 2.4. The %VO2max value for the patients was 57.2 ± 11.1. The result of metabolic measurements for each patient is shown in Table . The result of

metabolic measurements for each patient is shown in Table. Subject 1 and 4 abandoned prosthetic walking. All the other patients continued prosthetic walking upon return to their communities after discharge. The %VO2max value for the five who continued to use their prostheses after discharge ranged from 55.8 to 72. On the other hand, patients who abandoned the prosthesis had lower %VO2max values of 43.3 and 44.2.Among the seven patients, the correlation coefficient for the relationship between %VO2max value and oxygen cost was #0.176, indicating no significant correlation between the two. The correlation coefficient for the relationship between %VO2max value and oxygen consumption rate was 0.406, indicating no significant correlation between the two.

Conclusion

Many authors have reported that adequate physical fitness is required for elderly amputees to meet the energy consumption demands necessary for prosthetic walking. Although we have previously reported that % VO2max value of 50~60 is a valid guideline for the physical fitness required for elderly trans-femoral amputees to walk independently (4,5), no previous research has gone as far as stating guidelines for the level of physical fitness required for older HD patients to achieve successful prosthetic walking in a community setting. In this study, the %VO2max value for the five who continued to use their prostheses after discharge ranged from 55.8 to 72. On the other hand, patients who abandoned the prosthesis had lower %VO2max values of 43.3 and 44.2. Our preliminary studies suggest that physical fitness of around 60%VO2max might be the level required for older HD patients to successfully walk with a prosthesis in a community setting.

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Image: Table The results of metabolic measurements for each subject_None.doc (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236004/cg34200

Session: Rehabilitation - Amputation Lower Extremity
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3446-621]

Gait Training during Prosthetic Fitting Process-The Need of a Propriate Gait to Utilize the Prosthetic Components

Author
Möller, Saffran (SE) | Clinical Specialist
Össur - Össur Nordic

Coauthors
Moller SF,

Abstract
Ten transfemoral amputees were fitted with MPK, additional to the prosthetists fitting procedures they also offered prosthetic gait training. The intention was to help the user to take advantage of their prosthetic component. They all developed a better gait and 9 of ten also developed stair decent.

Introduction
Prosthetic fitting is complicated and complex procedures were multiple variables must be considered. Microprocessor knee(MPK) systems are designed to simplify the fitting and adjustment process while accommodating to a variety of conditions during throughout the daily activities. The ability of MPK system to adapt to the amputees life has been a significant benefit to both the prosthetist and amputee not only during the fitting process but during everyday life. Resistive gait training with transfemoral amputees has been demonstrated to improve the spatial variables related to level walking.(Yeager 2002). The ability walk with a MPK requires reestablishing the normal movement throughout the lower limb permitting the user to load the prosthetic limb enabling them to take advantage their prosthetic components. This presentation will discuss the integration of formal prosthetic gait training by the physiotherapist during prosthetic fitting process.

Methods
Eight transfemoral amputee, one knee disarticulation amputee and a bilateral transfemoral amputee received prosthetic gait training. They were between the ages of 25 and 56 years old. They all wanted to be more active. Observations were made during new prosthetic fitting in the work shop in Scandinavia. The amputees were asked to walk in self selected speed with his/hers original prostheses. Step length, step width, knee and hip movement, arm swing and stair decent were observed. The prosthetist then changed to Rheo knee. All of them were then educated in gait training after the fitting were done according to a dedicated scheme. They were given exercises to find their “balance-line” and to experience the yielding function. They also tried stair decent and ramps to find “know how” and sitting down. Then the users again were asked to walk in self selected speed and the same observations were made. Step length, step width, knee and hip movement, arm swing and stair decent.

Results
At the first observation all of the users took a longer step with the prosthetic leg, all of them as well walked with a greater base of support due to step width deviations. 2 of them also had walting problem and 9 had some hip deviations and one had grate hip deviations. All of the persons had arm swing deviations and none of them was able to walk stair decent step by step. All of the users were satisfied with the fitting and gait training and wanted to continue the specific gait training. All of the users developed a better gait.

They reduced the differences in step length and reduced the walting habits. All of the users except one increased their hip movement and arm swing. Two had very difficult to take advantage of the prosthetic. Nine of the persons who participated were able to go stair decent with step over step. Eight is still walking on RheoKnee, two users has rejected the use of Rheo Knee.

Conclusion

This presentation will indicate the need of gait training during prosthetic fitting to develop enough knowledge to be able to maximize their use of the prosthesis. The prosthetist very often has the key role because they meet all the amputated who will have a prosthetic device. They can indicate the need of gait training if the physiotherapist isn't present. This should not exchange traditional Physiotherapy rather complements it.

All the persons who participated during this new prosthetic fitting all felt a lack of support with their "ongoing" rehabilitation, "life long gait training". They all miss a therapist who have the knowledge of the component and can give them the opportunity to experience their new advice, lifelong. Again and again, not only during the first fitting. Further studies are necessary.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236004/cg44031

Session: Rehabilitation - Amputation Lower Extremity
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3434-609]

Prosthetic Prescription in Clinical Practice: a Pilot Study in the Netherlands

Author
van der Linde, Harmen (Nijmegen NL) | PhD
University Hospital Nijmegen, the Netherlands - Rehabilitation Department

Coauthors
Paping MA, Rommers GM

Abstract
In a pilot study the usability of a prescription protocol for lower limb amputees was tested in clinical practice. Central feature was the match of aimed mobility level and specific prosthetic components. A match was realized in 80%.The protocol seems suitable for use in clinical practice.

Introduction
In the proces of supplying a lower limb prosthesis in the Netherlands the Medical Doctor in Physical and Rehabilitation Medicine (MD in P&RM) and the prosthetist play an important role. Indication and explanation of choices made for specific prosthetic components is becoming more important, not only for clinical professionals but also for insurance companies and suppliers. There is demand for more transparancy in the prosthetic prescription. In a guideline process in the Netherlands a general model for the total process of supplying a medical aid was developed. This model describes the process from patient wishes and intended use of the prosthesis to choice for components and evaluation of the end result.
It is presumed that the level of mobility is the starting point in the prescription process and refining the prescription is done by looking at specific demands based on activities and participation aspects.
Aim of project was to develop a format for the prescription of a prosthsis.

Methods
In a pilot study the usability of a prescription protocol for lower limb amputees was tested in 3 clinical practices. The format was filled in by the MD in P&RM adding patient characteristics according to the ICF standards, describing medical diagnosis, body functions and structures and activity and participation level. The actual prescription and the choice for the prosthetic components was realized in the traditional way without using the protocol.
After 3 months the match between level of activity and prosthetic components was evaluated using the protocol. Level of mobility was predictedusing the K-level mobility scale. In the evaluation mobility with the prosthesis was assessed using the Dutch SIGAM mobility scale. With the evaluation the match between intended patient functioning expressed as the mobility level and prosthesis characteristics was judged.

Results
In the 3 different clinical practices a total of 66 patients was seen with transtibial, knee disarticulation or transfemoral amputations. Mean age was 54.9 years. In 45 patients it was a first prescription of the prosthesis, in 21 patients a follow up supply. In the evaluation 3 patients were lost.
The match between patient mobility score and prosthetic components was realized in 80% of the cases. Mismatch resulting in a prosthesis with a higher mobility rating was found in 12% of the cases.

An end situation was not achieved in 66% of the first supplies mainly caused by co morbidity and stump problems. Further evaluation will be available at presentation.

Conclusion

The protocol is suitabele for use in clinical pratice. It gives transparancy in the prescription process in general and in individual cases. Suppliers, insurance companies and MD in P&RM already agreed on using this in 2010. Further development and evaluation of the protocol will take place.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg236004/cg44019

Session: Rehabilitation - Amputation Lower Extremity
Tuesday 2010/05/11 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3108-306]

Improving Outcomes for Bilateral Transfemoral Amputees: A Graduated Approach to Prosthetic Success

Author
Carroll, Kevin (Oklahoma City, OK 73118 US) | MS, CP, FAAOP
Hanger P&O - Prosthetics

Coauthors
Carroll K, Richardson R

Abstract
This multi-media presentation will focus on how Prosthetists can use the graduated approach to prosthetic management of bilateral transfemoral amputees. 1, 2
This approach includes four phases:
1. Building confidence
2. Walking on short legs (shorties)
3. Graduated increase in

Introduction
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Methods
This multi-media presentation will focus on how Prosthetists can use the graduated approach to prosthetic management of bilateral transfemoral amputees. 1, 2
This approach includes four phases:
1. Building confidence
2. Walking on short legs (shorties)
3. Graduated increase in height
4. Walking on full length prosthetic legs

Results
Over the past few years, there has been a significant increase in the number of high-functioning bilateral transfemoral users. Some of the factors that have contributed to this increase are advances in technology and higher expectations from the prostheses users themselves. The increasing number of bilateral transfemoral amputees is due to the on-going conflicts around the world. Advances in body armor and modern medicine have saved many lives that would have been lost in earlier conflicts. People who loose multiple limbs due to trauma or illness have greatly benefited from the lifesaving procedures pioneered on the battlefield.

Additionally, in recent years, improved diagnostic procedures have led to early detection of such diseases as Meningococcal Meningitis, Escherichia coli and other serious illnesses. This early detection has led to lifesaving interventions, which unfortunately may involve the amputation of multiple limbs. Many of these patients are now able to become successful prostheses users.
All of these issues combined mean that O&P clinicians must have a greater understanding of how to manage this patient population. As soldiers eventually return to their homes, they will need the services of their local O&P clinicians. And as medicine continues to improve and disease survival rates increase, these patients will need local prosthetic care.

Conclusion
This multi-media presentation will focus on how Prosthetists can use the graduated approach to prosthetic management of bilateral transfemoral amputees. 1, 2
This approach includes four phases:
1. Building confidence
2. Walking on short legs (shorties)
3. Graduated increase in height
4. Walking on full length prosthetic legs

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3784-None]

The Education of Prosthetists/Orthotists and Orthopaedic Shoe Technicians from the Perspective of ISPO

Keynote Author
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Abstract
Professional education for prosthetists/orthotists and orthopaedic shoe technicians continues to be defined and developed. Prosthetists, orthotists and orthopaedic shoe technicians all need to gain knowledge, skills and understanding of their disciplines through academic study aligned with practical clinical and technical experiences. There are a number of challenges in delivering quality managed educational programmes for these professions in a tough economic climate, especially in providing sufficient content in the fields of engineering and health to ensure that competent, safe practitioners emerge as graduates. This presentation will explore global trends in professional education from the perspective of the International Society for Prosthetics and Orthotics and consider the way that these professions might continue to develop.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg410952

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3672-None]

Upper Limb Orthotics

Session Chair
Ott, Wolfgang (Bad Häring AT) | Dr.
Rehabilitationszentrum Bad Häring - Abteilung für Amputierte

Session Chair
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg227677

Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3357-532]

The Effect of Neoprene Shoulder Supports on Joint Reposition Sense in Men with Unstable Shoulders

Author
Hassan Beygi, Babak (Tehran IR)
University of social welfare and rehabilitation - Orthotics and Prosthetics

Coauthors
Mousavi M, Giti M, Nodehi A, Rahgozar M

Abstract
In this study we examined the effect of neoprene shoulder supports on passive joint reposition sense in subjects with stable and unstable shoulders.

Introduction
The shoulder joint has most mobility in body and therefore dynamic control of the muscles about this joint is necessary for stability.Instability is one of the common conditions of the shoulder that is related to deficit in proprioception.The sensory receptors for proprioception, which are found in skin, joints, and etc provide information to the central nervous system about tissue deformation. Joint position sense, plays important role in the maintenance of dynamic shoulder stability which deteriorate after instability.
The efficacy of neoprene bracing for ankle & knee joints has been reviewed by many studies.Some remembered the positive effect of these orthoses on the neuromuscular function. Just few studies have been done concerning the effect of neoprene orthoses on shoulder joint position sense. If the use of shoulder brace help to increase joint reposition sense via the stimulation of the skin nerve receptors ,the improved proprioception may help prevent recurrent instability.

Methods
38 men participated in this cross over study in 2 subject groups: 18 patients with the history of more than 1 time unilateral traumatic anterior shoulder instability as experimental and 20 men with stable shoulders as control group.Each subject’s ability to perceive joint position sense was tested by passively reproducing 3 target angles(15° from full external rotation,30° external rotation, and 30° internal rotation) with and without shoulder neoprene support.Repositioning at each preset angle was repeated 3 times and the average of the absolute value of the 3 error was used for statistical analysis.Angles were recorded with Biodex isokinetic dynamometer.At the same time we set up an analogue goniometer aligned with the center of rotation of Biodex. A Laser pointer installed on the Biodex shoulder attachment reflected the angles on the analogue goniometer with the precision of .2°.Measured variables were passive external rotation range of motion and absolute error mean in each angle.

Results
While wearing the shoulder support, the group with unstable shoulders demonstrated significant improvement in the accuracy of passive repositioning at 30° external rotation and 15° from full external rotation (p=0.001) in comparison with the stable group which only had significant improvement in 15° from full external rotation (p=0.006). Orthosis decreased the maximum range of external rotation for both groups. There was not any significant difference between unstable and contralateral shoulder of patients

in joint reposition sense. The comparison of 2 measurement systems showed significant accurate data recording with analogue goniometer.

Conclusion

Our findings suggest that shoulder passive joint reposition sense in both groups of stable and unstable shoulders can be improved at close to maximal external rotation by wearing a shoulder orthosis. This improvement might be attributed to the increased cutaneous input received at the shoulder joint with orthosis.

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Image: Proprioception_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg227677/cg43930

Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3330-505]

Model for Measuring Shoulder Orthosis Kinematics

Author
Begon, Mickael (Montreal CA) | Ph.D.
University of Montreal - Kinesiology

Coauthors
Doyon M, Cotton R, Allard P

Abstract
Modeling an impaired shoulder is complicated by the used of an orthosis. The purpose of this study is to develop a kinematic model of the upper arm. The model is based on reducing error from soft tissue motion by adding extra skin markers and using functional axes of rotation and optimization.

Introduction
Rotator cuff have a reported annual incidence rate of 19.9 per 10,000 full time equivalent employee and a median cost of about 7 000 USD per claim and 97 work day lost [Silverstein1998]. Rotator cuff tears and, in some extend, anterior shoulder dislocations requires surgery followed by immobilization. Postoperatively, the arm is usually kept abducted with the use of a pillow or a splint to decrease tension in the supraspinatus tendon and protect healing tissues. The desired shoulder-trunk angles are not always attained with present orthoses and not maintained in daily-life activities [Sullivan1997]. Biomechanical models are difficult are not easy to apply because markers to describe shoulder-trunk kinematics are occluded by the orthosis. The purpose of this study is to develop a kinematic model of the upper arm and trunk. This model is then tested in able-bodied subjects to measure changes in shoulder angles and the displacement of the orthosis during in three daily-life activities.

Methods
Twenty healthy subjects participated in this study. A shoulder abduction orthosis was put in place by an orthotist. After the positioning, four to six reflective markers are put over anatomical landmarks of the pelvis, trunk, shoulders, arms and forearms in order to determine each segmental position and orientation Monnet, Begon et al. (2009). Marker locations were adjusted for each subject to avoid joint and large soft tissue areas and to be tacked by an eight cameras Vicon system (60 Hz) at any time. Firstly, the subject performed a series of six movements to determine the physiological location of the center of rotation of the scapula/trunk interphase, glenohumeral joint, and elbow using the algorithms described by Monnet, Begon et al. (2009). Five additional markers were put on the orthosis to determine its linear and angular displacements. Participants were instructed to performed simulate writing, putting on a shoe, changing from standing to supine to standing position.

Results
The right side of the enclosed figure represents the marker position on the body to estimate upper arm and glenohumeral joint motion with respect to the trunk. The left side of the figure illustrates the corresponding three-dimensional kinematic model of the pelvis, trunk, arm and forearm. The elbow flexion/extension axis is also indicated.

Conclusion

The developed kinematic model of the upper arm and trunk is based on reducing error from soft tissue motion and applying optimization techniques. To minimize the skin movement artefact segment position and orientation are calculated using five markers. Then joint centres are determined by performing a set of wide range of motion arm displacements as well as circumduction to better define the joint axes since the abduction/adduction have to be accurate. The model combines optimisation techniques to estimate the joint kinematics since conventional models do not present the accuracy to account for small (5° to 10°) movement, especially in abduction/adduction range. Using the same set of motion for the elbow its flexion-extension axis is estimated and little systematic error is introduced in the frontal plane of the upper-arm.

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Image: IPSO_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg227677/cg43903

Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2875-75]

Upright MRI of the Shoulder Demonstrates Labrum Dynamics

Author
Michael, Joern W.-P. (Köln DE) | PD Dr. med.
Universitätsklinikum Köln - Klinik und Poliklinik für Orthopädie und Unfallchirurgie

Coauthors
Springorum HP, Eysel P, König DP

Abstract
To examine glenoid labrum dynamics, the shoulders of 15 healthy subjects were imaged in standing position at different degrees of external rotation wearing the Omo Immobil Rotation orthosis and by using the UprightTM MRI. The functional length of the anterior labrum was measured.

Introduction
The widely accepted treatment regime for primary traumatic anterior shoulder luxations consists of reposition and subsequent conservative treatment in cases where concurrent structural damage is absent. During conservative treatment, the shoulder is normally immobilized in internal rotation, based on the assumption that the laxity of the anterior capsule may be reduced in this position due to some expected shrinking of the joint capsule. It is hypothesized that external shoulder rotation leads to a functional elongation of the anterior ligament-labrum-complex allowing for a stable reposition of this part to properly support the humeral head in the glenoid cavity (Itoi et al.). Since this has not been tested under normal functional conditions, it is the aim of the present study to analyze, with the aid of the UprightTM-MRI, the dynamics of the anterior labrum at external shoulder rotations of different degrees in healthy subjects.

Methods
The study was conducted on 15 subjects (13 men, 2 women, mean age 27.8 years, ranging 22-44 years) having no previous history of any shoulder complaints. The study was approved by the local ethics committee, and all subjects gave their informed consent. Upon clinical examination, none of the subjects showed any shoulder pathologies, especially no impairment in rotation and no instabilities. The range of motion assessed by the neutral-0-method was normal in all planes. A shoulder orthesis suitable for MRI („Omo Immobil Rotation“, Otto Bock HealthCare, Germany) was administered to the subjects, including especially designed wedges that allowed a standardized and reproducible positioning of the shoulder at 15° and 30° external rotation. Both shoulder joints were examined in standing position with the UprightTM-MRI. The functional length of the labrum was measured with a computer-aided ruler at the different positions.

Results
The maximum length at neutral position was 7.5mm, the minimum was 5.7mm among all shoulders (n=30) of all subjects. There were no side differences between the right and the left shoulder at identical degrees of rotation. Functional labrum length increased the more the shoulder was rotated. At neutral position, the labrum measured 6.6mm in length; at 30° external rotation, labrum length was almost doubled (11.9mm). The labrum length for each position was significantly different from the data of the other positions. It appears, as if an almost linear relationship exists between the degree of rotation and the functional length of the anterior labrum, at least within the evaluated range of motion.

Conclusion

Imaging techniques for the diagnosis of shoulder pathologies include x-ray, ultrasound, computerized tomography, and MRI, sometimes, if deemed necessary, with additional arthrography. The introduction of UprightTM-MRI allows high resolution imaging in sitting or standing position, which also may be more comfortable for the patient. The present study clearly demonstrated that the anterior labrum functionally elongates with increasing degrees of external rotation, which can simply be explained by the tension the anterior capsule is producing to the labrum. A similar rationale stands behind the clinical practice of surgical shortening of the anterior capsule in the treatment of Bankart lesions. It can be concluded that, with the use of UprightTM-MRI, the dynamic behaviour of the labrum can be well imaged under functional conditions. Furthermore, the present set of data clearly supports the concept of immobilization in external rotation after anterior shoulder luxation.

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Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2876-76]

Evaluation of a Shoulder Orthosis (Omo Neurexa) in the Rehabilitation of the Severely and Flaccid Arm after Stroke: a Prospective Study

Author
Werner, Cordula (Berlin DE) | Dr.
Charité Universitätsmedizin Berlin, Medical Park Berlin - Neurologische Rehabilitation

Coauthors
Bardeleben A, Rembitzki I, Hesse S

Abstract
Shoulder subluxation and -pain after stroke is a limiting factor to promote motor control in the hemiparetic arm. The shoulder orthosis OmoNeurexa (ON) supported the arm while activities of daily live and improved the gait pattern in patients with hemiparesis.

Introduction
Within this study we evaluated clinical and gait analysis data on the ON, a new shoulder orthosis to prevent - and to treat a painful shoulder after stroke.

Methods
26 patients with arm hemiparesis after stroke and subluxation of the shoulder joint and/or shoulder pain were provided for 4 weeks with a shoulder brace of soft material connected to a forearm cuff to promote elbow extension and supination.
Dependent variables: semi-quantitative gait analysis, shoulder pain, questionnaire

Results
23 patients used the ON continously for 4 weeks and 3 put the orthosis off within 3 days (too tight, no effect anticipated, fear of flexor spasticity). The comfort was good, transpiration minimal, and 15 patients reported a beneficial effect of the orthosis on their activities, e.g. they felt more secure during transfer tasks and mobility. Eleven patients reported a relevant pain reduction. The gait analysis of 10 patients revealed a more dynamic gait pattern reflected by a significant reduction of the relative double stance phase. Furthermore the paretic quadriceps muscle was facilitated during the initial stance phase in selected patients. The therapists reported that they could intensify their functional therapy approach in seven subjects. The shoulder subluxation decreased, spasticity of the initially plegic patients only slightly increased, and the shoulder range of motion did not change.

Conclusion
The ON is an interesting and promising component in the prevention and treatment of painful shoulder after stroke, controlled trials are justified.

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Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3450-625]

Aids for Injured Hands

Author
Ott, Wolfgang (Bad Häring AT) | Dr.
Rehabilitationszentrum Bad Häring - Abteilung für Amputierte

Coauthors
Walochnik N, Gschwentner M
Schaumberger K

Abstract
We´ll show some aids for injured hands, which makes life for disabled of the hands easier and more comfortable.

Introduction
In our rehabilitation-center of the Austrian Worker´s Compansation Board we have a lot of patients with injuries of the hands. most of the patients can be rehabilitaed by physiotherapists and ergotherapists, but some of them have a lot of defects on their fingers or on their hands and have to be treated with aids to make their life easier and more comfortable. We produce such aids either in our center or with orthopedic-companies we work with. There we´ll show some of our products and you can see how patients will work with it.

Methods
We produce these parts at the end of our training-programm with the physios, let the patients work with the ergotherapie and there qwe can see, what the patients need for their daily life.

Results
We worked out between 2002 and 2009 for 24 patients with 28 injured and deformed hands - also after illnesses - practical aids, which we´ll show with the result of helping them in daily life e.g. household, garden, hobbies...

Conclusion
Aids for injured and deformed hands will go after a special examination through the physio- and occupationel therapie and then the orthopedic technicians in our house or from the companies we work with produce the aids we need.

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Session: Upper Limb Orthotics
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3299-474]

Acceptance and Outcomes of the Dynamic Elastomeric Fabric Wrist Hand Orthosis in the Pediatric Population

Author
James, Wynne (20 Ledin Drive, Avon MA US) | CPO, FAAOP
Boston Brace - education

Coauthors
Annette Corriea, OT; Martin Mathews,CO Kali Marquardt, Rayne Dingman, OT

Abstract
Dynamic Movement Orthosis (DMO) has been used in a team oriented cp clinic. A retrospective chart review was conducted to complete a quality audit and to document trends in DMO WHO use, including wearer profile, treatment plan, follow up schedule, and outcomes.

Introduction
Dynamic Movement Orthosis (DMO) is a type of Dynamic Elastomeric Fabric Orthoses (DEFO). They are custom made to measurement orthoses fabricated from computer generated patterns of Lycra® material. This skin tight fitting material appears to provides strong proprioceptive feedback. Sections of Lycra® reinforcements provide corrective forces to the body segment based on reinforcement tension, direction of pull, and types of material. In the case of soft tissue contractures, the device provides a constant stretch toward functional position. Although DMO's can be custom made for both upper and lower extremities as well as the trunk, this paper will concentrate on the use of the DMO Wrist Hand Orthosis (WHO) in a pediatric clinic.
The DMO has been provided in this clinic for the last two years; however a formal Quality Assurance (QA) program and review has not been implemented for the device. In addition, there is a lack of research on indications for use, appropriate follow up protoco

Methods
A retrospective chart review was conducted on the use DMO WHO's in a pediatric cerebral palsy team oriented clinic. Patients were evaluated from January 2008 to July 2009 were included in the study. A chart review was completed to assess wearer profile, treatment plan, follow up schedule, patient/parent satisfaction, and outcomes. Surveys were sent to parents/caregivers inquiring about changes in ADL's, ease of don and dof, carry over effect, and patient acceptance. In addition, surveys of the therapist, both community and hospital based, addressing these same issues are reported.

Results
Preliminary results from a chart audit show high parent and patient satisfaction . Donning the orthosis can be difficult when fingers are incorporated, although most report this to be a non issue after a two week break in period. Patients closely followed with occupational therapy and the orthotist review report the most use of the device. Parents report hand function and thumb position improved. Functional goals identified in order of importance during the initial evaluation were met; however, visually, some secondary goals seem to be achieved more so. Further review will help us evaluate and set goals as we understand the limitations and what function is attainable.

Conclusion

The use of Dynamic Elastomeric Fabric Orthoses (DEFO) is effective when utilized in a team environment. This retrospective review shows how a multi-disciplinary approach to complex patient care, results in the successful implementation of a new intervention. The DMO has proven to be an accepted and useful orthosis in the management of upper extremity function and position.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3658-None]

Upper Extremity Prosthetics - Socket

Session Chair
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Session Chair
Jönsson, Stewe (Göteborg SE)
Sahlgrenska University Hospital - Dept. of Prosthetics and Orthotics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220107

Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3407-582]

Osseointegration on Upper Limb Amputee - Prosthetic Treatment and Outcome

Author
Jönsson, Stewe (Göteborg SE)
Sahlgrenska University Hospital - Dept. of Prosthetics and Orthotics

Coauthors
Caine_Winterberger K, Brånemark R

Abstract
The aim of this presentation is to illustrate the prosthetic procedure, prosthetic constructions and outcomes for all actual levels on upper limb.

Introduction
Treatment with osseointegrated amputation prostheses has been performed in Sweden since 1990, due to the Brånemark method. The treatment comprises two surgery sessions followed by prosthetic fitting and rehabilitation. The technique is used for both upper and lower limb amputation prostheses.
Around 35 upper limb cases have been treated on different amputation levels, provided with various prosthetic types. A majority of the upper limb treated patients have had previous problems with prosthetic socket suspension, mainly related to skin/tissue problems or short stump length.

Methods
All osseointegrated patients follow a strict prosthetic and rehabilitation protocol/procedure, related to amputation level. Prosthetic constructions and components have been developed and the patients can be provided with different types of prosthetics, as cosmetic, myoelectric, multifunctional, body-powered and hybrids.
The patients are followed up by use of function-tests and questionnaires.

Results
Results in September 2009 shows that 34 upper limb cases have been treated since 1990. Representing 7 thumbs, 1 partial hand, 10 trans radial and 16 trans humeral levels. Four of those patients are not prosthetic user today because of various reasons.
Follow up of the prosthetic user shows that overall function has improved in 92% and quality of life in 88% compared to the situation pre osseointegration. None of those patients have indicated an impaired situation and the prosthetic use is more frequent.

Conclusion
Without any stump volume depending socket will the direct bone anchored prosthesis last for very long time. There is no need of harnessing in aim of suspension and the patients achieve full freedom of movement in the proximal joint. The prosthetic situation is improved because of the stable fixation and freedom of motion. Without socket is also a higher degree of comfort achieved, together with improved functionality.
It’s obvious that osseointegration is a very important platform for implementing and optimizing of new prosthetic technology, due to the stable fixation.

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Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3622-681]

Limitations of Socket Support in Upper Limb Prostheses

Author
Daly, Wayne (Mountlake Terrace, US) | CPO, LPO, FAAOP
OrthoCare Innovations, LLC - None

Coauthors
Dr. Teri Chou, PhD
Dr. David Boone, PhD
Dr. Liming Voo, PhD

Abstract
This study measured the effect of position and load on
pressures at the socket/skin interface of three transradial, three transhumeral and three shoulder amputees (n=9). These pressure measurements provide a clinically useful picture of force magnitude
and distribution in the socket.

Introduction
The pressures at the contact interface between the skin
of the residual limb and the internal surface of the socket are vital indicators for proper fit, comfort, and load bearing capability of the prosthetic limb. Since socket fit is an important characteristic for
patient satisfaction (Dillingham et al., 2001), studies have evaluated socket fit by measuring pressures in lower limb prosthetic sockets (Portnoy et al., 2007). However, after an extensive literature review,
no similar study was found to have reported upper extremity socket pressures. The biomechanical conditions of skin-socket contact differ
greatly between upper and lower residual limbs and a study of this population was necessary to determine the forces in conventional prosthetic sockets to improve future designs. This study measured the pressure magnitude and its distribution at the upper limb-socket
interface for various arm positions with different applied weights.

Methods
A Human Subjects Institutional Review Board approved
protocol was followed to register and test human subjects with transradial (n=3), transhumeral (n=3), and shoulder disarticulation (n=3) prostheses. The mean age was 58 with a range of ± 13 years. A Tekscan Versatek 2-port cuff system was used for pressure
measurement. The resistive pressure sensors were applied between the residual limb and socket. The 3D coordinates of the individual sensors were digitized using a Microscribe G2X™ coordinate measuring
device. Study variables included shoulder and elbow angles and masses of 0, 1kg and 2kg, supported at the wrist portion of the prosthetic arm. The test protocol was developed with the use of a design of experiments statistical tool for randomized test orders. For
each of the 70 to 72 test configurations, the subjects indicated their level of discomfort using a Visual Analog Scale (VAS) while interface pressures were recorded.

Results
Preliminary results indicated that the pressure magnitude and pattern of distribution changes significantly with arm position and holding weight. Peak pressures were measured most commonly at the

bony protrusions but also at other locations (Figure 1). The pressure magnitude showed a correlation to the subject reported comfort levels and was influenced by anatomic features such as the type of tissue underneath the skin as well as arm position and loading.
The wearer's report of socket comfort decreased when measured socket forces increased and data analysis is ongoing to determine the correlation between measured pressure and reported comfort. It was found that the interface pressure increased not only with joint flexion
in the socket but also with the load applied at the terminal device and the arm position in space.
Each of these factors will influence the comfort of the prosthesis and will need to be considered in refining fitting techniques to optimize prosthetic comfort and function for the wearer. The availability of
more powerful prostheses with more degrees of freedom will demand a better understanding of the socket interface to keep pace with the increased function of these prostheses.

Conclusion

The methodologies used in this study successfully
measured pressure magnitude and distribution patterns at the limbsocket interface of the upper limb prosthesis using hundreds of pressure sensors when tested on human transradial, transhumeral,
and shoulder amputees. Preliminary results indicate a complex but clinically relevant relationship between interface pressure, anatomic features of the residual limb, arm position, weight supported at the
prosthetic wrist, and discomfort levels. This information will be useful in refining prosthetic socket design for higher function prosthetic devices to provide improved capability and comfort for the wearer.

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Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3469-644]

Utilization of Magnetic Resonance Imaging, Segmentation and Finite Element Analysis (FEA) to Automate and Optimize Fabrication of Prosthetic Sockets

Author
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Coauthors
Shayne Kondor, Brad Mate, Ellenor Brown, Samer Tawfik, Michael Terk

Abstract
MRI scans of lower extremity RLs were segmented into their component tissue parts, optimized for finite element analysis, rectified and then utilized for prosthetic socket fabrication. Prostheses were tested in successive iterations to optimize the models and test our tissue property assumptions.

Introduction
The prosthetic socket/human interface is the keystone of any prosthesis yet socket fabrication remains a subjective skill utilizing either hand casting or topographic scanning of the residual limb (RL). Hand casting skill is dependent on the experience of the practitioner. Topographic scanning offers an objective measure of the external surface of the RL however underlying tissues are ignored.
Magnetic resonance imaging (MRI) provides clinicians with objective information about RL tissues. These scans can be segmented into tissue component parts. Properties can be assigned to theses tissues which can then be optimized for finite element analysis. This model can be rectified digitally as the modifications are performed while viewing underlying anatomy. Furthermore, a virtual socket can be donned onto the RL model yielding pressures about the residual limb. Iterative sockets were made using the method and then pressure results were measured and compared to the virtual model/socket.

Methods
Up to 6 subjects, 3 with transtibial amputations, 3 with transfemoral amputations, will be in this study. After consent was obtained, a plaster shell over a gel liner was created to eliminate deformation of the RL while lying in the MRI scanner. An MRI protocol was developed to optimize the scans for segmentation. Tissues (muscles, tendons, bones, fat and skin) were segmented and optimized for FEA analysis. The model was rectified according to underlying tissues' properties. An actual socket was fabricated via computer aided manufacture and a virtual socket was generated using FEA. Iterative sockets were fit upon the subjects until the socket fitting was comfortable. Next subjects walked in an instrumented gait lab in order to generate objective data to compare to that from the FEA.

Results
MRIs have been utilized to generate information about prosthetic sockets [1]. Results have shown that utilization of an MRI scan of a RL which has had the anatomy segmented offers clinicians the ability to rectify prosthetic positive models while observing the underlying tissues. To the knowledge of the authors, this level of detail surpasses anything practitioners have ever had available. It furthermore allows for rectifications to be applied with precision rather than estimation of both location and depth.

Finite element analysis of these models provides the ability to predict the pressures on a residual limb prior to ever fabricating a prosthetic socket. Results from subjects with lower extremity amputations who were fitted with prostheses according to these methods will be presented including MRI scanning protocols, socket rectification protocols, socket predictive pressures as well as socket pressures and gait parameters identified through instrumented gait analysis.

Conclusion

While the cost of MRI scans are high, they provide an unsurpassed level of detail and information which is essential in order to be able to create a viable model for residual limb modeling and socket design. Combining the MRI generated models with finite element analysis affords the practitioner the ability to predict the effects of socket modifications on the residual limb prior to actual fabrication. The aim of this research project has been to develop the workflows and protocols for utilizing MRIs and FEA as a means for fabricating optimized prosthetic sockets.

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Image: Sagittal View TT1 MRI 09_None.PNG (see online)

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Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3336-511]

Socket-Less Prosthetic System: Upper Extremity Applications

Author
Salam, Youssef (Beirut LB) | MSME, CP
Orthocare International - Prosthetics

Abstract
We introduce a new Prosthetic system that utilizes modified silicone liners acting as soft sockets, thus eliminating the traditional use of hard sockets in prosthetics. It mimics, to a certain extent, the benefits of Osseointegration techniques but does not require surgery.

Introduction
Hard prosthetic sockets have been mostly used to contain the residual limb and to provide a strong base for weight bearing, chassis for prosthetic parts, and for power transmission. These hard shells are known to cause some degree of discomfort to the wearers and some limitations to the ROM. Thus, the Osseointegration technique was developed to solve this problem by eliminating the hard socket completely; it utilized a metallic implant to attach prosthetic parts directly to it. However, the Osseointegration system is limited by requiring high surgical skills and restricting its application in the field of prosthetics. We introduce a new system that combines the benefits of the residual limb containment and the distal receptacle concept. The socket-less system utilizes a silicone liner to contain the residual limb and to provide a chassis for parts attachment. The successful application of this new technique to upper extremity cases is presented here.

Methods
The components used for the simple introductory application of this system are: Locking silicone liner, Teflon connecting rod, Elbow unit/wrist unit, Passive hand, and glove. The silicone liner is rolled over the residual limb then the Teflon rod is cut to the desired length and inserted into the distal umbrella of the liner. Afterwards, the wrist unit is attached to the other end of the connecting rod, and the terminal device is connected in the traditional manner. The same procedure is done for trans-humeral prosthesis but the Teflon connecting rod is connected to the elbow unit distally, then the regular assembly procedure is followed. The application of this system to mechanical upper limb prosthesis will include a housing retainer attached directly to the connecting rod, and a simple figure of 9 harness. For the myo-electrical type prosthesis, the electrodes can be attached to the inside of the liner and the lead wires go through a small hole to the outside of the liner.

Results
The first socket-less cosmetic trans-radial prosthesis has been in use for six months with good success. The wearing time of this prosthesis on average was better than that with a hard socket. A seven-month old child did not mind wearing this prosthesis for over two-hour periods. It proved that the patient was more tolerant to such prosthesis than the hard socket one. In another case, a trans-humeral patient was more comfortable with this type of prosthesis. The range of motion was also improved since there was no hard socket brim to limit the flexion. The prosthesis felt more like an extension of the residual limb. After a short period of time, the sweating inside the silicone decreased thus increasing the level of comfort. The parents of the young child reported easier donning and doffing of the socket-less prosthesis. There was no need for any donning aid as the suspension was more than sufficient. In the trans-humeral case, the patient reported lesser problems with hot/cold temperatures. This patient did not have to wear any socks under or

over the prosthesis. She was also very happy that there were no sharp edges showing through the clothes. It was also noted that the fabrication and fitting time for the socket-less prosthesis is lesser than that with hard sockets. There was no need for casting, cast rectification, socket fitting, etc... The modification of current prosthetic components was necessary, but that required just a little more fabrication time.

Conclusion

The application of the socket-less prosthesis can be suitable to many upper limb amputees and some lower limb amputees. The successful result of the first two cases of using this socket-less system has been encouraging. If silicone liners design can be modified and produced specifically for this type of socket-less prosthesis then the application for upper and lower limbs will be wider. In addition, we noted the following advantages in the Socket-less System:

1. Increased range of motion because there is no hard socket brim
2. Increased comfort
3. Better proprioception
4. Easier donning and doffing
5. Better accommodation to volumetric changes
6. Less effect of heat/cold on residual limb
7. Lighter weight
8. More conspicuous, no hard edges showing through clothes
9. Less fabrication time
10. Cheaper replacement and maintenance

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Image: Socketless Prosthetic System_None.jpg (see online)

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Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3066-264]

Individual Fitting Solutions with HTV Silicone Sockets in Upper Extremity Prosthetics

Author
Andres, Erik (Duderstadt DE)
Otto Bock HealthCare GmbH - Competence Center

Coauthors
Förster H

Abstract
This presentation describes the advantages of silicone sockets for upper limb prostheses in terms of comfort and adhesion. The application options and practical fitting benefits of this innovative concept are illustrated using real-life examples.

Introduction
The design of the prosthetic socket has been a demanding orthopaedic technology challenge ever since prosthetic devices for arm amputees were first developed. As the connection between the human body and the upper limb prosthesis, it has to exhibit a variety of characteristics and fulfil different functions.
Ideally, the socket of an upper limb prosthesis should allow the wearer to use the device over the course of the entire (working) day. In particular, the secure fit of a prosthetic socket is decisive for the more or less active use of the prosthesis.
Absolutely secure adhesion of the socket is essential for myoelectric prostheses, since any shift of tissue inside the socket can unintentionally activate the prosthetic control. The socket also has to make it as simple as possible to put the prosthesis on and take it off.
The use of materials that do not trigger allergies or cause other types of skin irritation is an important factor to assure the acceptance of the prosthesis.

Methods
High-temperature cross-linking silicones were used for the socket material.
These silicones created through polyaddition do not contain softeners and are inherently stable.
The FDA has even certified the material as suitable for implants.
HT cross-linking silicones are stable at temperatures of up to 200°C. Thanks to their high level of temperature stability, their hygienic characteristics are unique.
These materials were used in prosthetic fittings for transradial and transhumeral amputees.
Fittings for shoulder joint and shoulder girdle disarticulation patients were also realised.
The socket was connected to the prosthesis using setting nuts developed especially for this purpose, coated and with a larger contact surface, which were vulcanised in place.
All of the patients were fitted with myoelectric prostheses.
The prostheses for transradial amputees were equipped with an electric hand and an electric rotator for the hand.
Transhumeral fittings were realised with the DynamicArm®.

Results
With the help of individually fabricated silicone sockets, the fitting quality and therefore the acceptance of prostheses in general can be improved tremendously.
In particular, patients suffering from allergic reactions to traditional socket materials such as acrylic resins achieve a significant improvement in fitting quality and therefore quality of life thanks to silicone sockets.
Since the patient can effectively clean the socket using soap and water, the hygienic characteristics are also outstanding.
The especially high adhesion of the material to the skin is ideal for myoelectric prostheses in particular. Shifts of the prosthetic socket that generate electrode signals are minimised.
In the past, very large sockets had to be fabricated for prosthetic fittings following amputation or disarticulation in the shoulder region in order to assure a relatively secure fit of the prosthesis on the body. Thanks to the high adhesion of silicone, sockets for this type of fitting can be made much smaller which of course improves quality of life and acceptance significantly.
The use of these sockets on severely scarred residual limbs has also proven to be ideal (see photo documentation). A durable layer of silicone gel can be applied to the socket surface facing the skin, which has a tremendously positive effect on the development of scar tissue thanks to a massage function in the moist conditions inside a socket.

Conclusion
With these socket systems, the period of use for the prosthesis is increased significantly. They are clearly indicated for patients with short residual limbs who cannot be fitted with a silicone liner.
A large part of the weight, e.g. in upper arm prostheses, is supported by the harness. Thanks to its tremendous adhesion, this socket system can minimise the high tensile load of an upper arm harness.
This minimises the negative consequences of unilateral strain on the shoulder girdle caused by the harness.
Due to the high level of static friction of the silicone material, a donning assist has to be used when putting on the prostheses. This is common practice with conventional sockets.
In conclusion, it can be said that this socket system enhances the level of wearer comfort and improves the secure hold of the prosthesis, thereby facilitating the longer-term and more active use of upper limb prostheses.

Image: Bild zu Abstract Andres_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220107/cg36865

Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2984-182]

Age of First Prosthetic Fitting and Later Functional Outcome in Children and Young Adults with Unilateral Congenital Below Elbow Deficiency

Author
van der Sluis, Corry (Groningen NL) | Dr
University Medical Center Groningen - Center for Rehabilitation

Coauthors
Huizing K, Maathuis CGB, Hadders-Algra M, Reinders-Messelink HA

Abstract
Age at first fitting in children with an unilateral congenital transversal below-elbow deficiency was not associated with satisfaction with the prosthesis, functional use or motor skills. Early prosthetic fitting seems to have a limited impact on prosthesis use during later stages of life.

Introduction
Prosthetic rejection rates in children and young adults with a unilateral congenital transversal below-elbow deficiency (UCBED) are considerable. In the present study we focus on the effect of age at initial prosthesis fitting. Previously, it has been suggested that fitting at a young age is associated with higher prosthetic skills as the child grows older1. The recommended age at first fitting ranges from two months to 25 months. After this age, fitting seems to be related to higher rejection rates.
The aim of the present study is to evaluate whether prosthetic fitting before the age of one year is associated with better outcomes in children with unilateral congenital below-elbow deficiency compared to children fitted after the age of one. Outcomes are expressed in satisfaction with the prosthesis, functional use and the quality of motor skills. In addition, differences in functioning between prosthetic users and non-users will be evaluated.

Methods
Children and young adults with UCBED aged between 6 and 25 years were recruited during a 15 month period. The children or the parents filled out a questionnaire on age at prosthetic fitting, prosthesis use, reasons for rejection and length of time the prosthesis had been worn. Two standardized questionnaires, the Child Amputee Prosthetics Project-Prosthesis Satisfactory Inventory (CAPP-PSI) 2 and the Prosthetic Upper Extremity Functional Index (PUFI) 3, were used to evaluate satisfaction with the prosthesis and to assess arm/hand functioning and functional use, respectively. The ‘Prosthetic Activities Score (PAS) 4 was used to correct for the confounding effect of low scores on ease of performance and usefulness for activities during which the prosthesis was not used. Finally, the quality of motor behaviour was evaluated exploratively.Ten tasks representing general activities of daily living were selected and video-taped. Prosthesis users were tested with and without their prostheses.

Results
Twenty children and adolescents (8 boys, 12 girls) participated in the study, 5 prosthetic users and 15 non-users. Prosthetic devices had been used for 1.5 to 17 years (median 6.5 years). Prosthetic fitting before the age of one year was related to relatively long usage of a prosthesis: 11 of the 13 individuals who were fitted prior to one year of age had used a prosthesis for more than 5 years, whereas of the 6 individuals

fitted after the age of one only one person had used the prosthesis for more than 5 years. Age at first fitting was not associated with satisfaction with the prosthesis, functional use of the prosthesis or motor skills. Discrepancies between ease of performance with prosthesis and usefulness of the prosthesis as well as between capacity and performance of activities were found. The prosthesis was found to be very useful for specific activities. There was no significant difference between users and non-users in the quality of motor behavior. The video assessments showed impaired movement adaptation to some of the tasks in 6 subjects. The difficulties in movement adaptation were observed in particular during non-daily routine tasks, such as cutting circles or peeling a banana. Two out of the 6 persons with impaired movement adaptation were prosthetic users, both performing worse with than without the prosthesis.

Conclusion

Fitting with a prosthesis prior to one year of age seems to have limited impact on prosthetic use during later stages of life. The limited effect may indicate that the disadvantages of prosthesis use in early life, such as interference with sensory exploration using the affected limb, outweigh the advantages associated with early fitting, such as an increased repertoire of motor strategies. A reassuring finding was that both prosthetic users and non-users function very well and use their residual limb actively in bimanual activities. Persons with UCBED use the prosthesis for specific activities rather than for general activities in daily life. Our data suggest that one of the factors that determine whether a person with UCBED will profit from a prosthesis is neuromotor condition – a suggestion which deserves exploration in future studies.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220107/cg35037

Session: Upper Extremity Prosthetics - Socket
Tuesday 2010/05/11 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2883-81]

Congenital Limb Deficiencies – Epidemiology and Management

Author
Siev-Ner, Ytzhak (Kiryat Ono IL) | Congenital Limb Deficiencies – Epidemiology and Management
Sheba Medical Center - Orthopedic Rehabilitation

Coauthors
Guthman D, Daich A, Kristal A.

Abstract
Congenital Limb Deficiencies (CLD) is a challenge in rehabilitation. Despite the introduction of screening ultra sound in pregnancy, certain populations refuse an abortion even if a severe fetal defect is diagnosed. We present 112 cases followed in our special clinic for CLD.

Introduction
Congenital Limb Deficiencies (CLD) is a challenge in rehabilitation. Despite the introduction of screening ultra sound in pregnancy, certain populations refuse an abortion even if a severe fetal defect is diagnosed. We present 112 cases followed in our special clinic for CLD. In the last decade (1998 – 2008) we received 40 new cases, for an unknown reason 10 (25%) were born in 2004 and 7 (17.5%) in 2002.

Methods
We present 112 cases followed in our special clinic for CLD. In the last decade (1998 – 2008) we received 40 new cases, for an unknown reason 10 (25%) were born in 2004 and 7 (17.5%) in 2002.

Results
11 (9.8%) out of the 112 individuals have a PFFD (Proximal Femoral Focal Deficiency).
Of the remaining 101 individuals: 77 individuals (76.2%) had a single limb deficiency, 3 (2.9%) – 2 limb deficiency, 4 (3.9%) – 3 limb deficiency and 6 (5.9%) – 4 limb deficiency, at different levels.
Site: 39 (38.6%) - left upper limb, 19 (18.8%) – right upper limb, 8 (7.9%) – each lower limb.

Conclusion
The treatment was personally tailored to each individual. For the PFFD patients the treatments included: orthoprostheses with and w/o an arthrodesis of the "hip/knee" joint and partial foot amputations. The amputations were carried out for a better prosthetic fitting, A "Van Ness" operation was also performed. For the other CLD, most of them use prostheses. Most of the upper limb deficiency (ULD) patients use a cosmetic prostheses, some of them a functional one. All the lower limb deficiency (LLD) patients use prostheses or an orthoprostheses and ambulate.
We shall describe the prosthetic solutions as well as the rational for surgery.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220107/cg33666

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3501-None]

Outcome Measures in Upper Limb Prosthetics

Session Chair
Hill, Wendy (Fredericton CA)
Institute of Biomedical Engineering University of New Brunswick

Session Chair
Swanson, Shawn (Redondo Beach US) | OTR/L
Advanced Arm Dynamics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718

Symposium: Outcome Measures in Upper Limb Prosthetics
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3502-None]

Review of Outcome Measures Work from ULPOM

Author
Hill, Wendy (Fredericton CA)
Institute of Biomedical Engineering University of New Brunswick

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718/cg46741

Symposium: Outcome Measures in Upper Limb Prosthetics
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3503-None]

Summary of SSC Findings

Author
Swanson, Shawn (Redondo Beach US) | OTR/L
Advanced Arm Dynamics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718/cg46866

Symposium: Outcome Measures in Upper Limb Prosthetics
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3504-None]

The Occupational Therapist Perspective on Outcome Measures

Author
Norling Hermansson, Liselotte M (Örebro SE) | Dr.
Örebro county council - Dept for Prosthetics and Orthotics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718/cg46911

Symposium: Outcome Measures in Upper Limb Prosthetics
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3505-None]

The Engineer Perspective

Author
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718/cg46934

Symposium: Outcome Measures in Upper Limb Prosthetics
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3506-None]

The Prosthetists Perspective

Author
Miller, Laura (Chicago US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46718/cg46957

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3485-None]

Psychosocial Issues in Amputation and Prosthetic Rehabilitation

Session Chair
Gallagher, Pamela (Dublin 9 IE) | PhD
Dublin City University - School of Nursing

Session Chair
Desmond, Deirdre (Maynooth, Co. Kildare IE) | Dr.
National University of Ireland Maynooth - Department of Psychology

Abstract
Psychological factors predict adjustment to amputation. Understanding of the psychological and social realities of limb loss and prosthetic use can contribute to a holistic rehabilitation and limb-fitting experience and the optimization of ongoing care. This symposium will present current research in the psychology of amputation and prosthesis use and will highlight future directions for research in this domain.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45992

Symposium: Psychosocial Issues in Amputation and Prosthetic Rehabilitation
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3486-741]

Exploring Client Preferences: Children and Young People's Views of Their Prosthesis

Author
Donovan-Hall, Margaret (Southampton UK) | Dr.
University of Southampton - School of Health Sciences, Building 45, Highfield Campus

Coauthors
1) Professor Lucy Yardley, Chartered Health Psychologist. School of Psychology, University of Southampton.
2) Suryana Mohamad, Research Fellow
School of Health and Rehabilitation Sciences, University of Southampton
3) Dr Jeff Lindsay, Consultant in Rehabilitation Medicine
West Midlands Regional Rehabilitation Centre
4) Dr Vera Neumann, Consultant in Rehabilitation Medicine
The Leeds Teaching Hospitals NHS trust
5) Sue Banton, Director of Steps Charity
Professor Lucy Yardley, Suryana

Introduction
Previous work in the field of limb absence has shown that children and adolescents with limb deficiency can be vulnerable to psychological problems. From research with adults, it is suggested that psychological well-being may be affected by the physical appearance of the prosthesis. In order to explore these issues further, a two-stage research programme was completed to explore children and young people's (5 to 18 years) views and experiences of their prosthesis. This presentation reports questionnaire data from the first stage of the research.

Methods
Two questionnaires were developed, one for participants and one for the parents if the participant was unable to complete the questionnaire, consisting of factual, likert and open questions. The questionnaire comprised four sections relating to demographic, clinical, prosthetic use, and perceptions of fit, appearance and choice of the prosthesis. Recruitment was from two large limb fitting centres and four charities with 149 completed questionnaires returned. A combination of descriptive, non-parametric and thematic analysis was used to analyse the data.

Results
Appearance was rated as being quite good or very good by 34.3%, fit was rated as quite or very good by 35.6%, and 36.9% of participants wanted more choice in selecting their prosthesis. Thematic analysis demonstrated that participants related to their prostheses differently, which influenced the features of the prosthesis that were considered most important.

Conclusion
The findings highlight the importance of communicating with children and young people to discover their individual views on prosthetic limbs to fulfil needs, increase satisfaction and aid adjustment.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45992/cg46092

Symposium: Psychosocial Issues in Amputation and Prosthetic Rehabilitation
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3487-706]

Adjustment to Amputation and Body Image

Author
Gallagher, Pamela (Dublin 9 IE) | PhD
Dublin City University - School of Nursing

Coauthors
Pamela Gallagher (Dublin City University), Deirdre Desmond (National University of Ireland Maynooth), Laura Coffey (Dublin City University), Olga Horgan (Deeside Community Hospital, Flintshire, UK), Malcolm MacLachlan M (Trinity College Dublin)

Introduction
A common response to amputation is concern over the changes in one's body image that occur as a result of the limb loss. How people feel about their appearance and body image may play a role in whether and how they use their prosthesis and in their overall adjustment. Despite this, relatively little research has explored body image following lower limb amputation and in particular there is an absence of research identifying amputation-related, physical and psychosocial predictors of body image disturbance. The study set out to address this issue and to investigate psychosocial adjustment and body image disturbance in people with a lower limb amputation.

Methods
One hundred and forty five people aged 18 years or over who had a lower limb amputation and were currently using a prosthesis completed the Trinity Amputation and Prosthesis Experience Scales (TAPES), the Hospital Anxiety and Depression Scales (HADS), the McGill Pain Questionnaire (MPQ) and The Amputation Body Image Scale-Revised (ABIS-R).

Results
Several of the TAPES subscales (aesthetic satisfaction, functional satisfaction, functional restriction, social restriction, general adjustment, social adjustment, and adjustment to limitations), the anxiety and depression subscales of the HADS, and a single item measuring satisfaction with social support were significantly associated with body image disturbance. These variables were entered into the regression equation, and accounted for 55% of the variance in body image disturbance, with social adjustment, anxiety and depression making a unique contribution. Specifically, greater social adjustment, fewer symptoms of anxiety, and less depressive symptomatology were predictive of less disturbance in body image

Conclusion
This research is a first step in identifying the factors which contribute to resilience or disturbance in relation to body image and appearance. Being aware of a person's body image post amputation and being aware of what might impact upon their body image is a potentially important consideration in ongoing post amputation care and its inclusion as part of a comprehensive outcome measurement merits consideration.

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Symposium: Psychosocial Issues in Amputation and Prosthetic Rehabilitation
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3489-771]

Early Self-Management Training May Improve Outcomes in Persons with Limb Loss

Author
Wegener, Stephen (Baltimore US) | Prof.
Johns Hopkins University - Johns Hopkins Medicine and Rehabilitation

Coauthors
Wegener ST, Mackenzie E, Ephraim P, Ehde D, & Williams R

Abstract
A community-based, randomized, contolled clinical trial of the effectiveness of a self-management program specifically designed for persons with major limb loss. Subgroup analyses indicated the impact of the intervention was greater for participants who were < 3 years post amputation.

Introduction
There is a growing interest in programs to manage secondary conditions of depression and pain that are particularly common among persons with limb loss. These secondary conditions can significantly impact function resulting in restrictions in activities and diminished quality of life. Traditionally, interventions to address these secondary conditions have focused on standard medical treatments such as medication or physical rehabilitation therapies. More recently, there has been interest in supplementing these traditional approaches with self-management (SM) programs that are rooted in the principles of cognitive-behavioral theory (CBT). The overall objective of the study was to test the acceptance and effectiveness of a community-based self-management (SM). This paper focuses on the impact of SM for persons who were < 3 years post amputaion. We hypothesized that the SM intervention will be more effective than standard support group activities in improving outcomes.

Methods
A community-based, randomized, contolled clinical trial was conducted. Pre-existing support groups (N=50) were randomized to a treatment arm (participation in a self-management program specifically designed for persons with limb loss) or control arm (participation in the existing support group activities). The Promoting Amputee Life Skills (PALS) self-management intervention consists of nine, 90-minute group sessions delivered by trained volunteer leaders. The primary outcome measures were depression, positive mood, and self-efficacy. Secondary outcome measures were functional status and quality of life. The primary analyses were carried out using an intention to treat method. For each dependent variable, except depressed mood, changes from baseline at immediate post treatment and six month post treatment were analyzed using multivariate linear regression models. For depressed mood, logistic regression was employed and odds ratios are reported.

Results
Overall, 287 intervention and 235 control participants with major limb loss participated in the study. Completion rates at post intervention and six month follow-up assessments were 97% and 91%. Participant mean age was 56, 57% were male, 57% married, 21% nonwhite, 31% working, mean years living with limb loss was 4.5, and 37% were dysvascular, 30% traumatic and 7% cancer related amputations. For the overall sample at six month follow up those in the SM group were 40% less likely to be depressed

(0.6, CI = .03-1.1), had significantly lower functional limitations (P < .05) and higher self-efficacy (P< .05). Participants <3 years post-amputation (n=100) had a more robust response to the intervention. These individuals in the SM group were 60% less likely to be depressed and unlike the entire sample, this subgroup also had higher levels of positive affect (P<.05) and positive cognitions (P<.05). Similar to the larger sample, participants < 3 years post-amputation had lower functional limitations (P<.05), and higher general self-efficacy (P<.05) Comparison of the odds ratios and effect sizes in those < 3 years post-amputation versus the entire sample indicate they are larger for the primary outcomes of depression (odds ratio .4 vs..6), positive affect (effect sizes.32 vs. .13), functional difficulties (.37 vs. .21) as well as for the intermediary variables of general self-efficacy (.40 vs. .23), pain self-efficacy (.34 vs.14) and catastrophisizing (.56 vs. .17).

Conclusion

While this study targeted the entire spectrum of community dwelling amputees, an analysis of a subgroup of participants who were < 3 years post-amputation provides additional evidence that individuals who receive SM interventions in the early period following limb loss may have enhanced benefits. These data reinforces our observations from the literature and confirms our theoretical approach that early intervention may be key in limiting secondary conditions and improving health following impairment.

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Symposium: Psychosocial Issues in Amputation and Prosthetic Rehabilitation
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [4055-882]

Quality of Life of Persons with Lower Limb Amputation During Rehabilitation and at 3 Month Follow-up

Author
Zidarov, Diana (Montreal CA) | Physiotherapist
Montreal Rehabilitation Institute

Abstract
Quality of life of persons with lower limb amputation admitted for inpatient rehabilitation was assessed at admission, discharge and at 3 month follow-up. Results indicated that generic and specific quality of life of persons with lower limb amputation was high and remained relatively stable during inpatient rehabilitation and 3 months after discharge.

Introduction
Lower limb amputation (LLA) is a permanent surgical procedure which has important functional, psychological and social sequelae that can influence the quality of life (QoL) of the person experiencing an amputation. Using a holistic approach, rehabilitation interventions aim to address these sequelae and to impact on the QoL of patients. QoL is increasingly recognized as a valid outcome measure in rehabilitation. Studies addressing health-related QoL among persons with LLA are relatively recent and usually target individuals who are several months or years after amputation. The purpose of this study was to investigate the overall QoL of persons with LLA and examine QoL changes during and after rehabilitation interventions.

Methods
Nineteen persons (14 men, mean age, 53.4 ± 14.6 yr.) with a unilateral LLA admitted for inpatient rehabilitation were assessed with a generic QoL tool, the Subjective Quality of Life Profile (SQLP), and with a specific QoL tool, the Prosthesis Evaluation Questionnaire (PEQ). Assessments were performed at admission (T1), discharge (T2) and 3 months post-discharge (T3).

Results
Subjective QoL was relatively high at T1, T2 and T3 (0.87/2, 1.1/2 and 1.0/2, respectively) except for items related to physical functioning. There was no significant change over time for all but one QoL satisfaction measure (ability to go outside, P =0.024). Prosthesis-related QoL was very favourable with no significant difference found between scores at discharge and follow-up.

Conclusion
This exploratory longitudinal study documented Qol of persons with LLA during and 3 months after a rehabilitation process. Globally, generic and specific QoL of persons with LLA was high and remained relatively stable during inpatient rehabilitation and 3 months after discharge. Furthermore, this research supports the idea that specific QoL measures are especially cogent measures of the performance of rehabilitation care because they incorporate the multiple domains addressed during the rehabilitation process. Most importantly, specific QoL measures integrate patient's own perception of his/her accomplishments during the rehabilitation process.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45992/cg2480096

Symposium: Psychosocial Issues in Amputation and Prosthetic Rehabilitation
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [4129-None]

Qualitative Data on Upper Limb Prosthetics

Author
Biddis, Elaine (DE)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45992/cg3639209

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3685-None]

Convention on the Rights of Persons with Disabilities and Mobility Devices

Session Chair
Khasnabis, Chapal (Geneva CH)
World Health Organization

Session Chair
Heim, Sepp (Öhningen DE)

Abstract
The Convention on the Rights of Persons with Disabilities and its Optional Protocol was adopted on 13 December 2006 and entered into force on May 3, 2008. The Convention further strengthens the United Nations Standard Rules on the Equalization of Opportunities for Persons with Disabilities, adopted in 1993. Both Standard rules (article 3 and 4) and Convention (article 20 and 26) highlighted the importance of assistive/mobility devices. The Convention has further stated that people with disabilities have rights to access mobility devices and States are to facilitate this. However in most part of the world, there is very limited access to mobility devices. A greater impetus need to be given to ensure that Article 20 on Personal Mobility and Article 26 on Habilitation and Rehabilitation get operationalised. Convention is bringing new opportunities and at the same time challenges for the entire rehabilitation profession- Prosthetics/Orthotics and wheelchairs in particular.
The Convention especially articles

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234717

Symposium: Convention on the Rights of Persons with Disabilities and Mobility Devices
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3711-911]

Convention on the Rights of Persons with Disabilities - Article 20 & 26

Author
Constantine, David (Bristol GB)
Motivation

Abstract
The UN Convention on the Rights of Persons with Disabilities signified a watershed for disabled people worldwide. For those with mobility disabilities Articles 20 and 26 have significant relevance as they at last recognise that people require the correct equipment that brings independence and engagement to enable access to society.

Introduction

Sometimes described as the ‘last civil rights movement’ the world has often been a tough place for disabled people to thrive and sometimes survive in.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234717/cg263549

Symposium: Convention on the Rights of Persons with Disabilities and Mobility Devices
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3712-856]

WHOs Role in Promoting Access to Mobility Devices in Support of the Convention on the Rights of Persons with Disabilities (CRPD)

Author
Khasnabis, Chapal (Geneva CH)
World Health Organization

Introduction
In developing countries only 5-15% people with disabilities can access mobility devices. Seeing the need, UN brought a Convention on the Rights of Persons with Disabilities in which it asks States Parties to take effective measures to ensure personal mobility by facilitating access to quality mobility devices at an affordable cost. But due to lack of resources and expertise, many developing countries will fail to honour the demand of the Convention.
To assist the Member States to fulfill its obligations, the World Health Organization has organized a stakeholders meeting on 28-29 October 2009 in Geneva. Representatives from most of the key organizations involved in assisting developing world on this issue took part in the meeting.

Methods
Based on presentations, observations and discussions made during a two-day meeting at the WHO office in Geneva, it is recommended that:
• Global actions need to be undertaken to promote access to mobility devices in developing countries;
• In partnership with the key stakeholders, WHO to develop a joint position paper which highlights the importance of personal mobility and the role of mobility devices and provide the necessary know-how to implement the Convention by October 2010;
• WHO organize a second meeting to review the recommendations and discuss future plans of action in November 2010;
• WHO organize a donor conference to mobilize additional resources for supporting the Member States to develop programme on provision of mobility devices in December 2011;
• Stakeholders work together towards developing a global alliance to promote access to mobility devices in developing countries by 2012.

Results
USAID Leahy War Victims Fund provided necessary financial support for the meeting. WHO will primarily be responsible for implementation of the recommendations in collaboration with the stakeholders who are involved in provision of mobility/assistive devices. Congress will have the update on this initiative.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234717/cg263784

Symposium: Convention on the Rights of Persons with Disabilities and Mobility Devices
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3686-849]

International NGOs Response in Implementation of the Convention

Author
Urseau, Isabelle (Lyon cedex FR)
Handicap International - Rehabilitation Technical Unit

Coauthors
Neuhaus R

Abstract
The aim of Making It Work is to provide a uniform methodology to share and exchange examples of good practices. The added value of MIW is to act as a clearinghouse for information on what works and how this knowledge can be used to advocate for both practitioner and policy change at all levels.

Introduction
The ratification of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) sets a major challenge: how to bridge the huge gap that exists between the standards set by this international convention and the actual standards of existing services, systems and policies, particularly in low or middle income countries.
To promote the implementation of the UNCRPD Handicap International has developed a multi-stakeholder initiative entitled ‘Making it Work’ (MIW).
The idea of MIW is to develop MIW projects that collect and exchange these examples of good practices and then use these experiences to advocate for the replication of practices and development of policies that are in line with the CRPD.
As there is currently no shared mechanism for exchanging these good practices -- and innovative ideas-- among international, regional, national and local partners., MIW is an initiative designed to address these needs.

Methods
The Making It Work initiative is based around four clear objectives:
1. To develop the capacity of stakeholders (at local, national and regional levels) to collect information on key disability issues and good practices that uphold the principles of the CRPD.
2. To develop the capacity of stakeholders to use this information to produce thematic reports and working papers with clear recommendations.
3. To develop the capacity of stakeholders to carry out broad based dissemination and advocacy efforts to disseminate the report and recommendations with the aim of affecting changes in practices in this domain.
4. To facilitate the international exchange of these reports through an interactive website
The idea of MIW is to develop MIW projects that collect and exchange these examples of good practices and then use these experiences to support replication of such practices that are in line with the CRPD.

Results
In all countries of the world, there are innovative projects and good practices that have achieved real impact in addressing the barriers experienced by people with disabilities.
They are currently four projects using the MIW Methodology: Middle East, South-East Europe, Central and South America, West Africa, and additional projects are in development.

MIW is directly applicable to the areas of Article 20 (personal mobility) and Article 26 (Habilitation and Rehabilitation) of the CRPD. There are many areas for possible projects, some of which are below:
Art. 20- MIW projects could be in the area of:
- governments or the private sector providing assistive technologies at affordable costs;
- replication of trainings on mobility skills to persons with disabilities.
Art. 26- MIW projects could be in the area of:
- state run rehabilitation and habilitation services (or using good practices of private entities to provide information to governments on how they can do the same);
- community based rehabilitation;
- successful training of professionals in this domain.

Conclusion

There are many different practices around the world which contribute to the reduction of poverty, social exclusion and discrimination of persons with disabilities.
The central aim for Making it Work is to reduce the gap between standards set by the convention and actual existing practices through processes of information dissemination and exchange, and in doing so, to promote a model for inclusive development.
Long-term vision:
- Guideline as a universal tool - many MIW reports produced and shared on MIW website
- International sharing of good practices and policies – to make CRPD work!
- Standardised tool can work across any disability programme – on any disability issue
The goal is to promote a bottom-up approach to Inclusive Development1, where actors and agencies working at field level (particularly in countries where there are limited resources) have the opportunity to influence National Development Frameworks, in collaboration with policy-makers and civil society groups.

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www.un.org/disabilities
www.makingitwork-crpd.org

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234717/cg235419

Symposium: Convention on the Rights of Persons with Disabilities and Mobility Devices
Tuesday 2010/05/11 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3689-860]

Convention and Prosthetics/Orthotics Services

Author
Harte, Carson (Dromara, Dromore County Town IE)
Cambodia Trust

Introduction
The United Nations Convention on the rights of Disabled People, provides an imperative and a framework for action, and responsibility for our profession and our professional body, ISPO. The convention should, if handled positively, produce new resources and new opportunities to promote the use of affordable, biomechanically sound and cosmetically acceptable, P&O devices. To actualize the aims and the spirit of the convention, ISPO will have to increase their level of international collaboration, further improve research and development strategies and further increase engagement in the training of professionals, in collaboration with other allied health professionals. The ISPO will also further focus on sound data and outcome measurement, and should operate in the future on an evidence base.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg234717/cg236071

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3744-None]

Open Forum 1

Session Chair
Franke, Jens (Dortmund DE)
Bundesinnungsverband für Orthopädie-Technik

Session Chair
Magnusson , Lina (JÖNKÖPING SE)
Jönköping University School of Health Sciences - Department of Rehabilitation, Jönköping University

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [2979-177]

Development of the Prosthetic Casting Simulator for Trans-Femoral Amputation in P&O Education

Author
Oda, Takeshi (JP)
Kobe college of medical welfare - the department of prosthetics and orthotics

Coauthors
Mitsuhiko U
Rie I
Yuta T
Gentaro H

Abstract
A casting for Trans-femoral prostheses is considered to be most difficult work, requiring advanced techniques for a prosthetist. For this reason we developed the Prosthetic Casting Simulator for Trans-femoral amputation which is available in P&O education.

Introduction
In a Japanese P&O schools, there are few opportunities in which one can obtain the cooperation of a amputee on whom the students may freely practice their casting skills.
In order to compensate for this, the students must practice these skills on one another.
As was the case, it became clear that an elaborate imitation stump would be useful in practical prosthetics and orthotics training for P&O students to be able to practice upon.
We created the Prosthetic Casting Simulator for Trans-femoral amputation first. Because the casting technique for T/F requires the most advanced casting techniques as well as the most stressful casting procedure for the volunteer patient to endure. Thus, we felt that this particular type of casting deserved more focus.

Methods
We used the “pudding gel“ as main materials. this is 100% polyurethane resin and has a flesh-like consistency similar with a human body.
The inside of the PCS has been arranged to replicate the anatomy of a human. The femur was reproduced using resin, tendons from rubber tubing and the hip joint has been replicated using a steel boll joint.
The PCS had been trialed by the P&O students in their classrooms
The PCS as an effective tool has been evaluated by both students and teachers. A subjective survey from the students was used to judge the effect of the plaster wrap casting process. And also the result of the casting scored by teachers is compared with 2 groups with/without the training using the PCS.
Using the body tissue hardness scale, the hardness of each part both of the PCS and real stump were also measured and compared.
It was from these evaluations that the effectiveness of the PCS was verified.

Results
In subjective evaluation by a questionnaire with the impression of hardness and position of anatomy, the result that I had 11 landmarks of imitation stump evaluated by five-point full marks, Those which has

the high evaluation of hardness, Greater trochanter(4.08) and Those which has the lowest evaluation of hardness, the buttocks(2.20)
11 landmarks of PCS were evaluated with five point full marks by a questionnaire as a subjective evaluaition. The Great trochanter(4.08) has the highest score of hardness, the buttocks(2.20) has the lowest score.
In an evaluation with a position of anatomy, the femur bone end(4.20) has the highest score and, ASIS(3.24) has the lowest score,
Regarding the results of student's score of the plaster wrap casting with or without using the PCSstudents performed pre-practice both IC and QL. The instructor evaluated the negative model which the student made at the lesson after pre-practice.
In IRC practice, there are no significant differences of score between the groups.
In QL practice, the group which performed pre-practice by the PCS had significqantly higher score in average than the group which did not pre-practice.
The result of hardness measurement of the PCS by the body tissue hardness scale (PEK-1) shows thatASIS and greater trochanter hardness were near a human body.
However, other parts were almost uniform hardness; so, it was able to be reproduced neither the tension of a ligament, nor the softness of adipose tissue.

Conclusion

The obtained from this research has lead us to believe that the PCS is expected to become necessary tool in P&O education, especially in the improvement of casting skills for the Trans-femoral prostheses.
However, before this is to occur, further improvements in the accuracy as well as function of the PCS as an imitation stump must be developed.
The various limitations of the PCS became clear through this research. For this reason, we want to carry on researching and continue to resolve the issue of the PCS relating to its accuracy and function.
The various problems to the PCS which we developed became clear through this research as the next.
/reconsider a multi-layering of structure, using materials, and make the part of soft tissue hardness lower.
/improve the hip joint to reproduce more various conditions.
/make the opposite of PCS and reproduce practical difficulty of casting technique.
/mount sensors to each pressure part on bones and carry out visibility pressure method.

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*research cooprater; Mitsuhiko Uchida, Japan Kobe college of medical welfare

Image: Prosthetic Casting Simulator_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775/cg35032

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [3011-209]

Prosthetist/Orthotist Educational Experience & Professional Development in Pakistan

Author
Magnusson , Lina (JÖNKÖPING SE)
Jönköping University School of Health Sciences - Department of Rehabilitation, Jönköping University

Coauthors
Ramstrand N

Abstract
Pakistan graduates indicated that P&O services for Pakistan can be better provided by modifying program content, upgrading teachers' knowledge, improving access to information and addressing issues of gender equality.

Introduction
The Pakistan Institute of Prosthetics and Orthotics Science (PIPOS) is the only educational institute for prosthetist/orthotists in Pakistan. The PIPOS education programme is an ISPO/WHO category II recognised programme [1] that includes three years of academic studies and one year of clinical internship. Given that the category II inspection [2] of PIPOS has recommended curricula changes to the program and given that there is such a need for prosthetic and orthotics services in Pakistan, it was considered important to explore, on a deeper lever, how the program could be further improved to meet the immediate and future needs of the country. The aim of this study was to explore areas in which the education at the Pakistan Institute of Prosthetic & Orthotic Science (PIPOS) could be improved or supplemented to facilitate clinical practice of graduates. To describe educational opportunities PIPOS graduates have had since their graduation and explore their further educational needs.

Methods
Method. Fifteen graduates from PIPOS participated in semi-structured interviews. Persons interviewed had graduated from the school between 1999–2005. The graduates had an average of 2.5 years experience (range 0.5–6years). A qualitative content analysis manuscripts using the principles described by Graneheim and Lundman [3]was applied to the transcripts. Findings are presented according to the categories that were developed under each of the content areas: prosthetic and orthothic education; entering the workforce and professional development (Figure).

Results
Findings. Respondents indicated a need to upgrade the education at PIPOS. This should include upgrading of resources such as literature and internet access as well as providing staff with the opportunity to further their own education. Females experienced inequality throughout their education but were supported by management. Upon entering the workforce graduates reported that they were supported by senior staff but experienced difficulties in determining appropriate prescriptions. They further indicated that a multidisciplinary approach to patient care is lacking. Graduates knowledge of workshop management was identified as a problem when entering the workforce. Limited awareness of the prosthetics and orthotics profession by both the general community and the medical community was also identified as a problem. If offered the opportunity to continue their studies the respondents would like to specialise.

‘‘Brain drain’’ was noted as a risk associated with post graduate education. Interaction from international collaborators and networking within the country was desired.

Conclusion

Conclusion. The education at PIPOS meets a need in the country. Graduates indicated that P&O services for Pakistan can be better provided by modifying program content, upgrading teachers’ knowledge, improving access to information and addressing issues of gender equality. PIPOS graduates have had limited opportunities for professional development and have a desire for further education.

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Image: content area fig_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775/cg35208

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [3410-585]

The International Program of Prosthetics and Orthotics Education in Thailand

Author
Rakbangboon, Thanyaporn (Bangkok TH) | The International Program of Prosthetics and Orthotics Education
Sirindhorn School of Prosthetics and Orthotics - Rehabilitation, Faculty of Medicine Siriraj Hospital, Mahidol University

Coauthors
Sasithon SUKTHOMYA

Abstract
The P&O International program will open on June, 2010 after the SSPO was accredited by ISPO category 1 education as the first school in Thailand and south East Asia.

Introduction
The purpose of this paper is to firstly review the historical Prosthetics and Orthotics in the past decades in Thailand and briefly introduce the current P&O school (SSPO) especially for the International program which will be opened in 2010.

Methods
Since 1979, The previous 2 Prosthetics and Orthotics schools ran into problem in the area of shortages of bachelor degrees instructors capable of teaching up to university standard. As such, the school closed down in 1998 despite attempts to revive teaching of the matter to meet standard requirement of this profession.

Results
The Sirindhorn School of Prosthetics and Orthotics (SSPO) had officially established in 2002 under the Mahidol University which strives to internationalize its educational mission and advance its teaching and research efforts to meet global standards of excellence. The SSPO also aimed to produce good qualify Prosthetists and Orthotists in Bachelor degree level . In order to utilize their knowledge to produce Prostheses and Orthoses rehabilitate patient or disable people as well as develop Prosthetics and Orthotics in Thailand into the international standard.

Conclusion
SSPO was accredited by the ISPO for probation category 1 education in 2009 and the school has plan to open the International program from June, 2010 aiming for the international students from other developing countries in the region with the wish to help other developing nations who also need qualified professionals.

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www.sspo.ac.th
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Image: Annoucement 2nd page_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775/cg43995

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [3247-428]

Continuing Professional Development in Post-Graduation Practice: Cambodian Prosthetist-Orthotists

Author
Kheng, Sisary (Phnom Penh KH) | BSc, MSc
Cambodia Trust - Cambodian School of Prosthetics and Orthotics (CSPO)

Abstract
Key words: CPD, professional development, continuing education, capacity building, staff training, low income countries, Cambodia

Introduction
CPD plays an important role to ascertain that the clients will receive the best possible services. Cambodia has approximately 70 ISPO Category II Prosthetics and Orthotics professionals, amongst those some are women and people with disabilities. This paper is two folds: to investigate the areas of interest that Cambodian prosthetist/orthotists identify as their required CPD programme; and to find out what have been done as CPD for those clinicians post their graduation. On the job training programme is considered one of the major activities in CPD. In addition to, open learning opportunities, professional continuing education programme and the mentoring of professional practice.

Methods
Questionnaire with 21 items concentrating on CPD was used. Questionnaire was sent to 46 clinicians who are practicing in the field and who had graduated from CSPO between 1996 and 2008. The completed questionnaires were either mailed or emailed back. Local and international human resources have been involved in this CPD programme to assist the Cambodian clinicians in their professional development. On the job training programme is considered one of the major activities in CPD. In addition to, open learning opportunities, professional continuing education programme and the mentoring of professional practice.

Results
More than half of the respondents viewed the challenges in their practice as lack of confidence in dealing with complex cases (59), difficulty to work with other clinicians from the same profession or other profession who are not responsible for their treatment process (41%) and the lack of ability t handle clients who are not compliant to the treatment plans (28%). Almost every respondent considered that their professional strengths were strong clinical/technical skills, interest in continuing professional development, adequate English language ability to further self-studies and commitment to make improvement (79%). Majority of respondents (55) said that the CPD has to be compatible (marching) with their current job in order to elevate their practice and services for persons with disabilities. From the findings of this current study on Cambodian Prosthetist-Orthotists, CPD is crucial for the professional development of the prosthetist-orthotists, particularly, the advancement of their clinical practice in providing the most up to date and most appropriate care to persons with disabilities (end users). On the job training programme is considered one of the major activities in CPD. In addition to, open learning opportunities, professional continuing education programme and the mentoring of professional practice.

Conclusion

Professional development including further studies aims at broadening the professional competency in practicing found techniques, new techniques, and more advance techniques in new developments in the field of prosthetics and orthotics (Simpson, 2002). A suggested beginning in fostering CPD is said to start from education and training of the professionals, inter-professional education is believed to have significant effects on professional practice and health care outcomes (Reeves et al, 2007). Grol and Grimshaw (2003) identify the shortfalls in providing appropriate care which are resulted from inadequate changes of professional behaviours in the provision of comprehensive client care. Thus, CPD might be a suitable approach in addressing this issue among the professionals, specially for Prosthetist-Orthotists.

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Image: CPD in Postgraduation practice_None.doc (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775/cg41559

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [2954-152]

Prosthetics & Orthotics Undergraduate Education Programme for the Sichuan Earthquake Stricken Areas

Author
Leung, Aaron K. L. (Hong Kong HK) | Dr.
The Hong Kong Polytechnic University - Health Technology and Informatics

Coauthors
Wong MS, Mak AFT

Abstract
The Hong Kong Polytechnic University and the Sichuan University, have worked together and launched a 4-year full time Prosthetics & Orthotics undergraduate education programme at the Sichuan University to train prosthetics and orthotics professionals. The programme was started in September 2009.

Introduction
After the 5.12 earthquake in Sichuan, The Hong Kong Polytechnic University and the Sichuan University established the Sichuan Post-disaster Reconstruction Support and Research Centre on 21 June 2008. The aim of the Centre is to provide support services, to contact training programmes, and to undertake research in connection with post-disaster relief and reconstruction.
There is limited number of qualified prosthetics and orthotics teaching staff in Mainland China. The Department of Health Technology and Informatics of The Hong Kong Polytechnic University has offered undergraduate degree programme in prosthetics and orthotics since 1995 and has accumulated valuable experience in this area. In order to support and provide high quality prosthetics and orthotic education and services in Sichuan, the two universities had extensive discussion on development of an undergraduate degree programme in prosthetics and orthotics at the Sichuan University.

Methods
The staff of the Deaprtment of Health Technology and Informatics of The Hong Kong Polytechnic University (PolyU)worked with the staff of the West China Medical School of Sichuan University on the planning of the prosthetics and orthotics undergraduate education programme, especially the syllabus for prosthetics and orthotics theoretical, practical and clinical attachment subjects, and the setting up of the specialized prosthetics and orthotics laboratories. Professional Prosthetics and Orthotics courses include: Upper Limb Prosthetics, Lower Limb Prosthetics, Upper Limb Orthotics, Lower Limb Orthotics, Spinal Orthotics and the associated practical and clinical attachments. Since there is limited qualified prosthetics and orthotics professional teaching staff in Mainland China PolyU staff would be responsible for the teaching of prosthetics and orthotics courses at the Department of Rehabilitation Medicine of Sichuan University.

Results
The proposal has been supported by the Hong Kong Government. A 4-year full time prosthetics and orthotics undergraduate education programme was commenced in September 2009. The programme followed the requirement of the Guidelines for Category I professional training endorsed by the World Health Organization and the International Society for Prosthetics and orthotics (WHO-ISPO, 2005). The annual intake number of students the programme is 20. The Foundation courses were taught by the academic staff of the Sichuan University. The academic staff of The Hong Kong Polytechnic University

is responsible for the teaching of Professional Prosthetics and Orthotics courses. Besides academic staff from PolyU and the Sichuan University, visiting P&O clinical staff from Hong Kong was involved in the teaching of clinical skills. Temporary laboratory was allocated for the interim period. Formal laboratory space has been planned in a new rehabilitation building. Communication with prosthetics and orthotics services centres has been started for arrangement of clinical attachment and placement. Further planning will include local staff development for the continuity of the programme. Communication with the International Society for Prosthetics and Orthotics has also been started.

Conclusion

With the support from the Hong Kong Government Trust Fund in Support of Reconstruction in Sichuan Earthquake Stricken Areas as well as the senior management of the two Universities, the Department of Health Technology and Informatics of The Hong Kong Polytechnic University and the Department of Rehabilitation Medicine of the West China Medical School of Sichuan University has launched a 4-year full time prosthetics and orthotics undergraduate degree programme at the Sichuan University, to train high quality prosthetics and orthotics professionals to serve the earthquake victims and other people requiring prosthetics and orthotics services.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg345775/cg34840

Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [3294-469]

Training Prosthetic Technicians in the Dominican Republic - A Report on Program Evaluation

Author
Phillips, Julia A. Gass (Yorktown, Virginia US) | B.S.N., M.P.H.
Phillips and Company - Walking Free Evaluation Project

Coauthors
Grisetti, GC, EdD, PT, Ngoc-Com, T. Escoffery, PhD, MPH, CHES

Abstract
This program evaluation was designed to assess the effect of a training provided by an NGO. The program goal was to develop knowledge and skills in a group of prosthetic technicians in the Dominican Republic. Data were gathered from trainers and trainees using face to face interviews and surveys

Introduction
According to the WHO, the global need for prosthetic and orthotic services greatly outweighs the number and capability of those currently trained in the field. Affordable and sustainable training programs are vital to addressing this gap.
The Walking Free Program, an initiative of the non-profit organization Physicians for Peace, trains prosthetists and orthotists in developing countries in hopes of closing this gap. In the Dominican Republic, the program was established in 2001 and consists of training missions provided by volunteer experts in the field that last one to two weeks and occur two to four times per year as the personal funds and time of the volunteers allow. The purpose of this project was to evaluate the reactions to the trainings, the learning which occurred during the trainings, and the knowledge transfer from the perspective of the trainees and the trainers.

Methods
A cross sectional survey and interview of the trainees and trainers were used. The entire population of those being trained was surveyed as it was small enough to be feasible. The two principal trainers were interviewed as they were considered the key informants on the program. Through this design, attitudes and opinions were gathered for a descriptive analysis of the success of the Walking Free program.
The researcher developed a program description that included the need, expected effects, activities and resources and the purpose for the evaluation and the methods to be used. Gathering evidence such as interviews with the trainers, surveying trainees and site observation in the Dominican Republic comprised the data collection phase of the evaluation. Interview responses and qualitative comments were evaluated according to Kirkpatricks Four Level Model of Training Evaluation. Conclusions were justified using standards, qualitative and quantitative data analysis and judgment.

Results
Survey data were analyzed for frequencies and means from questions with rated answers using a Likert scale. The differences in confidence ratings in each trainee's skills from pre-training and to post-training were analyzed using two tailed paired t-tests. The survey contained questions asking for qualitative answers which were analyed using cross-case analysis.

Twelve trainees completed the survey, representing 100% of the trainees who have participated in the program
and are still employed in the facility.
The trainees survey showed statistically significant improvements in the set of skills presented for ranking over the time of the training missions at the alpha level of 0.05.
The skills shown to have the greates difference from pre training to post training were: measuring the residual limb (mean difference 2.00), making the cast (mean difference 1.83), and making the socket (mean difference .71).
The trainer interview data were reported by grouped themes according to Kirkpatricks Four Level Model of Training Evaluation. The trainers identifed change as occuring in: receptivity to training/Level One, quality of product created/Level Two and professionalism/Level Three. Barriers to the training identified by both groups centered on challenges presented by language and comunication in Spanish for both oral and writen materials.

Conclusion

The study suggests that the Walking Free Program has been successful in increasing the knowledge and skill level of the prosthetics technicians at two rehabilitation out- patient facilities in the Dominican Republic. The technicians have gained skills and knowledge which help them produce higher quality prosthetic devices with greater efficiency. They are able to better meet the needs of the amputee population that they serve by applying what they have learned during the training missions to their practice. And they are also better able to participate as knowledgeable members of the rehabilitation team in partnership with the physical therapists and physicians. While the technicians skills have improved greatly, the trainers have expressed the need to continue training missions while planning to begin a distance learning program through Don Bosco University in El Salvador, through which the technicians could ultimately become certified by ISPO.

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Session: Open Forum 1
Tuesday 2010/05/11 | 15:00 - 16:30

Congress Lecture [3975-851]

Exploring the Effectiveness of the Mental Health First Aid Course for Prothetists and Orthotists in Australia

Author
Steel, Andrew (Ballarat AU)
Ballart Health Service

Coauthors
Mackenzie R, Bach T, O'Halloran P

Introduction
In any year one in five Australians experiences a mental health problem2. It's been established that a significant number of prosthetics and orthotics patients suffer higher levels of mental health disorders compared to the general population3. This places the prosthetist/ orthotist in a unique position to identify when a patient may be suffering a mental condition. Early identification of mental health disorders has been shown to lead to better patient rehabilitation outcomes4 however prosthetists/ orthotists must have an adequate level of mental health literacy to appropriately identify and manage patient mental health issues. The Mental Health First Aid (MHFA) course has been shown to improve individual's mental health literacy5. The aim of this research was to establish the current level of mental health literacy within the Australian prosthetist/ orthotist population, and to assess the effectiveness of the MHFA course on improving levels of mental health literacy in prosthetic/ orthotic clinicians.

Methods
The study design was emulated previous MHFA research2. Ethical approval was obtained.
SUBJECTS:
19 total, 11 females, 8 males. 6 participants in the study group 29.17, 6.52 (mean, SD) years, 13 in the control group 27.92, 9.05 years.
APPARATUS: The survey instrument was constructed by combining a number of validated questions from previous research2.
PROCEDURES:
Invitations to participate were sent to prosthetic and orthotic facilities in Australia. Both study and control groups completed an initial survey. The study group undertook the MHFA course over a four week period. One month after completion of the MHFA training by the study group, follow up surveys were sent to all participants.
DATA ANALYSIS:
A 1-sample Wilcoxon signed rank test determine the differences within each group from initial to follow up. Coen's effect size was calculated for the mean improvement, and a Mann-Whitney analysis was used to determine if the differences between the initial and follow up survey was significant.

Results
Mental health literacy was established according to its four scales. Ability to correctly identify a mental health disorder 79%, confidence to provide help 56%, ability to provide appropriate help 39% and appropriate attitudes towards mental health issues 58%. Both groups showed an improvement in all four scales over time. Large effects according to Cohen's statistic were observed by the study group after completing the MHFA course for the scales of confidence (1.06), helping behaviour (2.63) and attitudes

(2.75). The improvements observed by the study group from initial survey to follow up across all four scales, were larger when compared to the improvements by the control group. Confidence is the only scale where the control group had a higher percentage of correct responses in the follow up survey compared to the study group. A significant difference was found within the study group for the scales of attitudes (0.018) and helping behaviour (0.018). Significant differences were also recorded by the control group for attitudes (0.001) and helping behaviour (0.001). The difference in the amount of improvement from initial to follow up between the two groups was found to be significant for the scales of confidence (0.008), helping behaviour (0.001) and attitudes (0.001). Recognition was the only scale where there was no level of significant improvement found either within the groups or between the groups.

Conclusion

Compared to previous studies, prosthetists/ orthotists have a higher ability to recognise mental health disorders and slightly higher levels of confidence and helping behaviour2. However these levels of helping behaviour and confidence are judged to be unsatisfactorily low, considering the increasing prevalence of mental health disorders5. This study highlights that Australian prosthetists/ orthotists confidence, knowledge about appropriate help and attitudes needs improvement. The effectiveness of the MHFA course to improved individuals mental health literacy compared to an increase in general mental health awareness, is proved by the large effect sizes in the study group and the significant difference in improvement between groups. This research established that prosthetists/ orthotists mental health literacy closely reflects that of the general public. It also adds to the growing evidence base for the effectiveness of the MHFA course to improve participant’s mental health literacy.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3657-None]

Lower Limb Prosthetics - Hightech Foot

Session Chair
Moser, David (Basingstoke GB) | Dr.
Blatchford - NPD

Session Chair
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg219746

Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3069-267]

Use of Experimental Prosthetic Feet to Improve Understanding of Prosthetic Foot Function for Lower Limb Prosthesis Users

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Coauthors
Klodd E, Meier MR, Fatone S, Edwards ML, Sessoms P, Childress, DS

Abstract
This paper describes our approach of using experimental prosthetic feet to examine effects of prosthetic foot features on gait of prosthesis users. We describe the results of two double-blind studies (n=14 for each study) that examined effective keel length and forefoot flexibility effects.

Introduction
There are many prosthetic feet available, but little scientific knowledge to indicate the best choice for each user. Many studies have measured the gait of persons with lower limb amputations using a series of commercially available prosthetic feet (see review in [1]). However, prosthetic feet used in these studies have numerous design differences, making it difficult to understand the source of measured differences in gait. Also, new designs continue to enter the market, providing a moving target for research. This presentation will describe our approach of using experimental prosthetic feet to systematically alter one mechanical property at a time to examine its effect on gait. While this approach may appear to have a reduced clinical impact in the short term, it may give a better core knowledge and understanding of prosthetic foot properties and their effects on gait, which can be transferred to commercially available prosthetic foot/ankle mechanisms in the future.

Methods
The Shape&Roll Prosthetic Foot (S&R PF) is a low-cost device that was developed for use in resource-limited areas [2]. The S&R PF technology was used as a base for creating experimental prosthetic feet for two studies: a double-blind cross-over study to examine the effects of effective keel length on the gait of 14 unilateral transtibial prosthesis users [3]; and a double-blind randomized cross-over study to examine the effects of forefoot flexibility on the gait of 14 unilateral transtibial prosthesis users [4]. Qualified prosthetists were involved in aligning the prosthetic feet in both studies. A cosmetic foot cover and a sock were used in both studies to blind both the prosthetist and the users to the condition being used. Gait analyses were conducted at the VA Chicago Motion Analysis Research Laboratory. Repeated measures ANOVA tests were conducted to determine effects of forefoot flexibility and effective keel length on gait measurements. The significance level was set at 0.05.

Results
Shortening the effective keel length of the prosthetic foot caused a significant reduction in the maximum external dorsiflexion moment on the prosthetic side ($p<0.001$), and significantly increased the initial loading on the sound limb at normal and fast speeds ($p<0.001$) [3]. Increasing the flexibility in the prosthetic forefoot led to significantly reduced effective foot length ratios ($p<0.001$), significantly increased “ankle”

flexion on the prosthetic side ($p<0.001$), significantly reduced maximum external dorsiflexion moment on the prosthetic side ($p<0.001$), and significantly increased initial loading on the sound limb ($p=0.001$) [4].
Discussion: Prosthetic feet that are very flexible produce similar gait characteristics for their users as prosthetic feet with short effective keel lengths. In both cases, an overly flexible system can lead to a “drop-off” of the prosthetic limb and an increased loading on the sound limb. The higher repetitive impact forces could be detrimental to the health of the sound limb [5-6]. These changes are more pronounced at faster walking speeds, suggesting that keel length and flexibility factors are most important for walking function of active users of prostheses. Further work should address the effects of effective keel length and flexibility on standing balance performance of lower limb prosthesis users. It is likely that standing balance is reduced with overly flexible or short keeled feet, due to a reduction in inherent mechanical stability.

Conclusion
Experimental prosthetic feet can be used to develop and test general theories surrounding the relationship between mechanical characteristics and clinical function, allowing us to build a scientific foundation for prescription. This approach may be more practical given the rate of turnover of prosthetic foot designs in the industry.
In studies performed thus far using this approach, we have determined that prosthetic feet that have short effective keel lengths or overly flexible keels do not allow sufficient forward progression of the ground reaction force, leading to reduced dorsiflexion moments and a “drop-off” effect on the prosthetic side, as well as an increase in initial loading on the sound limb.

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Acknowledgements: Funded by the Department of Education (#H133E030030) and the Department of Veterans Affairs (#A4325R). We also acknowledge Rebecca Stine, MS, for helping with data collection.

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Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3178-365]

Evaluation of Biomechanical Optimization of Prosthetic Ankle-Foot Stiffness Using Intelligent Microprocessor Control

Author
Moser, David (Basingstoke GB) | Dr.
Blatchford - NPD

Coauthors
Zahedi S, Ross J, McCarthy J, Harris G

Abstract
A novel microprocessor controlled ankle-foot system has been developed. Analysis of the system showed that foot function can be enhanced by intelligently adapting and matching foot stiffness to better suit varied walking activities particularly on uneven surfaces.

Introduction
Despite many advances in modern foot design the lack of alignment adaptability at the ankle has shown that prosthetic feet still fail to offer amputees' safe, comfortable and efficient gait on uneven terrains. The relatively recent introduction of feet with "adaptive alignment" features such as the Echelon [1,2] (Endolite) and Proprio (Ossur) offer improved function on uneven terrains. However we hypothesize that further adaptive functionality must be added to allow greater optimization of amputee gait. In this paper we report on the design and evaluation of a further generation of adaptive function which simultaneously combines adaptive alignment with an intelligently adaptive stiffness control. In the experimental work reported herein we sought to determine if greater optimization of ankle-foot function can be achieved by intelligently matching the ankle foot stiffness to walking terrain and activity.

Methods
To test the hypothesis a viscoelastic hydraulic ankle- foot was developed that included a remote control designed to enable user self adjustment and selection of Plantarfexion and Dorsiflexion damping characteristics. The developed system was designed to offer a selection of 64 different ankle stiffness settings. Biomechanical measurements were made using a pylon loadcell to quantify kinetic loading and, a portable gyroscope based gait analysis system was also used to measure limb kinematics and determine temporal spatial gait parameters. 5 amputees (3TF/2TT) completed the experimental protocol which was conducted on a variety of inclined surfaces. Starting from a nominal damping setting to suit level ground the amputees were instructed to walk at a range of speeds on each surface. In subsequent test runs the amputees were instructed to self- select via a remote control a combination of PF/DF damping settings that best suited each walking requirement.

Results
Over inclined terrains distinctive trends and patterns to the damping level selection were identified for each walking condition, as shown in figures 1 and 2. When walking down an incline the user tended to select damping settings that created a feeling of more stability and a "braking" effect. When walking up inclines the opposite was found, setting which provided greater "propulsion" effects were preferred. These self-selected changes to damping settings showed that each amputee could readily perceive changes to the ankle-foot function through the socket interface in manner that allowed greater optimization of foot function

to match the activity being performed. The pylon load cell data showed that the ankle bending moment profile, specifically the timing and magnitude of the PF/DF phases became closer to normative data [1]. The axial load carried through the prosthesis was also significantly greater with the self-selected setting compared to the nominal settings. Part of the reason for this can be explained form the gyroscope gait event detection data which showed that significantly greater time was spent on the prosthetic limb with the self-selected optimized settings. The gyroscope data also indicated greater similarity to the segment motion data between limbs. The temporal gait event data also showed that with the optimized settings the range of speeds that amputees could comfortably walk on inclined surfaces was markedly increased.

Conclusion

The magnitude of the changes in damping settings for each grade of incline lead us to conclude that there is considerable value in the development of an intelligent control system which can adjust the damping stiffness of the ankle to more specifically match the walking surface. Feedback from the amputees further supports this finding as all the amputees reported benefits to socket comfort and ease of walking on the inclined surface. The assistive nature of the adapted control settings was also described by amputees as offering more control and scope in terms of the speed range in which they could easily to walk on the varied inclined surfaces. The temporal gait data was in support of these user perceptions. The nature of the limb loading data with the user optimized control both in duration and magnitude of loading would appear to suggest benefits in terms of reducing the risk of long term damage to the sound limb.

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Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3289-464]

Robust Terrain Detection System for the Foresighted Control of Active Terrain-adaptive Limb Prostheses

Author
Kleiner, Bernhard (Stuttgart DE) | Dipl. Ing.
Fraunhofer Institut für Produktionstechnik und Automatisierung - Orthopädie und Bewegungssysteme

Coauthors
Dr.med. Schneider U

Abstract
Concepts for active limb prostheses cannot manage step-to-step real time adaption to ground. We present a method to overcome this problem with an optical simultaneous terrain detection system which is mounted of the prosthesis and generates the input for the control strategy of the prosthesis.

Introduction
Current energetically passive feet can store and dissipate energy during a gait cycle, but can not provide net power back for adaptive foot control. This inability reduces the capability of the prostheses to fully restore locomotive functions such as walking upstairs or downstairs, up and down slopes. This functionality require a simultaneous reaction of the prosthesis joints to the underground. A work in [2] describes an approach to combine EMG signals from the limb and a finite state machine to adapt the prosthesis foot angle to stair walking. A pre-defined motion will be processed for stair and normal walking. There is only one foot active foot in the market [1]. This foot is adaptable to stairs and to ramps at different angles. It is based on learning methods with input from force reaction of the prosthesis. A delay of two steps is necessary to process the adaption. Our approach describes a predictive method to adapt the prosthesis with information from the terrain.

Methods
The approach is a non tactile detection of the underlying terrain during amputee gait. System requirements were:
- Five meter field of view in walking direction.
- A field of view under the prosthesis.
- Extraction of the geometry and distance to plains, stairs, obstacles, ramps and holes.

Detection method is a combination of a laser scanning device in the sagittal plane and ultrasonic sensors pointing to the ground. Prosthesis motion leads to optic information of the sensors in the vertical plane. An inertial navigation system (IMU) developed by our Fraunhofer IPA team [3] provides position and orientation information of the prosthesis and the sensors. Transformation of the distances in a three dimensional world coordinate system is done. Line and surface extraction algorithms [4] are used to extract geometrical structures from the gathered coordinate points of the terrain followed by best fit methods for modeling the detected obstacles.

Results
The ramp detection performed robustly throughout the experimental session in the laboratory. The sensor set consists of a one dimensional laser sensor and an inertial measurement system which are mounted on the prosthesis tube above the prosthesis ankle joint. The detection was tested on a ramp in front of the

prosthesis which was mounted on an industrial robot to simulate the human motion during a gait (Figure 1). The measurement was done during the simulated stand phase. Noticeable is a maximum error of 1.3 degrees of the measured ramp with the inertial position measurements. Results with a laser scanner and an object set of ramp and stairs with different materials will be maintained until 03/2010.

Conclusion

The concept proved to be a step-to-step applicable method for sagittal plain inclination detection of prosthetic feet. Robot based functional in our lab proved to be useful for repetitive gate cycle features.
The concept can help to hill up and down terrain detection once combined with an active prosthesis foot. Beside this relevant single obstacles like pavements can be detected.
The described sensors are applicable for above- and below knee prostheses and can be integrated in a separated module on the prosthesis. The concept will be extended to three dimensional ground detection. This technology can lead to future stumbling and falling prevention through obstacle detection and foot plate adaption in active feet. Leg orthoses after stroke might be a secondary market.

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Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3386-561]

A Novel Below-knee Prosthesis for Snowboarding

Author
Plettenburg, Dick (Delft NL) | Dr. Ir.
Delft University of Technology - BioMechanical Engineering

Coauthors
Sander Minnoye

Abstract
Snowboarding with a below-knee prosthesis is compromised by the limited rotation capabilities of existing below-knee prostheses. Based on snowboarding range of motion analyses, a novel below-knee prosthesis was designed with the aim to achieve similar range of motions like able-bodied snowboarders.

Introduction
Someone with a below-knee defect is limited in performing ankle motions making snowboarding difficult. Existing prosthetic components do not provide the necessary passive and/or active rotation. Three problems can be identified: 1) the up-right posture of a person with a below-knee defect differs from a sound person [1], making snowboarding more challenging; 2) the rotations at the ankle used in snowboarding are plantarflexion/dorsiflexion, inversion/eversion, and abduction/adduction [1,2]. Below-knee prostheses provide no, or only to a limited amount of such rotations; 3) below-knee prostheses are passive. Voluntary control of the plantarflexion/dorsiflexion would enable the snowboarder to modulate the grip of the snowboard when turning.
Based on the limitations mentioned above, it was decided to design and construct a new below-knee prosthesis for snowboarding that would allow interaction between the snow-boarding person and the board similar to a person with no amputation.

Methods
A literature survey was used to determine the required angles, i.e. foot angles; passive degrees of freedom; and for the option to voluntary control the ankle in order to adapt to different slope angles. A new design was conceived, inspired by the anatomy and functionality of the normal human ankle, and subsequently manufactured and tested. In the laboratory the actual rotation angles achievable were measured and compared to the design criteria. Two video cameras were used to perform field tests. The motions with the new prosthesis were analysed and compared to the motions made with a traditional below-knee prosthesis, and those of an able-bodied snowboarder. The measurements were taken for an able-bodied subject, a subject with a traditional below-knee prosthesis, and the same subject with the new below-knee prosthesis discussed in this article. This subject was a highly experienced professional snowboarder and a candidate for the Olympic Winter Games before her amputation.

Results
From the literature, the required range of angles for the foot were derived.
The human ankle was used as inspiration for the design. The passive rotation of the prosthesis can be related to the plantarflexion and dorsiflexion in the human ankle joint [3]. The active control by using supination/pronation can be related to the rotation of the subtalar joint of the human ankle, where a combination of plantarflexion/dorsiflexion and inversion/eversion resembles the motion necessary for the active control [3].

By using an outward rotation of the knees and hip, the abduction/adduction and inversion/eversion of the newly designed subtalar joint can be controlled. This joint is shaped in such a way that the abduction/adduction and inversion/eversion of the foot is coupled to plantarflexion/dorsiflexion of the foot. Thus a lateral rotation of the upper leg and knee will result in dorsiflexion of the ankle and vice versa a medial rotation of the upper leg and knee will lead to plantarflexion [4].
Figure 5 shows the final prototype. The laboratory tests showed the rotations defined in the design criteria were met. In the field test the new prosthesis achieved similar degrees for ankle dorsiflexion and ankle eversion as those seen for an able-bodied person. The test subject with the below-knee defect was very pleased with the new prosthesis design. It enabled improved control over the board: “snowboarding with the new prosthesis is like it was before the amputation.”

Conclusion

The overall goal of this R&D project was to improve mobility and control when snowboarding with a below-knee prosthesis. With the new design, the orientation of the lower leg with respect to the foot resulted into a standing posture which was symmetrical and natural. Added passive rotation in the ankle joint, shows a clear change in the plantarflexion/dorsiflexion rotation during the turns for the subject with the new prosthesis, which is comparable to the range of motion used by the able-bodied subject. The voluntary rotation of the new subtalar joint enabled additional control of the supination/pronation angle and resulted in a drifting or carving turn. The measurements of the inversion/eversion of the lower leg compared to the foot show an increasing use of this rotation for the subject with the new below knee prosthesis when compared to the subject with the traditional below-knee prosthesis. This demonstrates the use of this new additional joint.

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Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3591-671]

The Contribution of a Flexible Prosthesis to Promoting Health

Author
Kickinger, Wolfgang (St. Andrä AT) | Primarius PhD
Sonderkrankenanstalt Zicksee - Orthopaedic Rehabilitation Center

Coauthors
Günther Tell, Rosemarie Adrian, Markus Sailer

Abstract
Each year we treat some 250 to 300 limb amputated patients and provide them with prostheses. One possibility is to incorporate a flexible rod system (Clever Bone®). We carried out a prospective, double-blind, randomised trial on 28patients who had undergone below-knee amputation.

Introduction
The aim was to compare a flexible rod system (Clever Bone) with the conventional rigid tube system in the prosthetic care of people who have undergone amputation of the leg. Patients with low to moderate levels of activity who had recently had a unilateral below-knee amputation were randomly allocated to one of two groups, each consisting of 14 people, using the different prosth. systems. The same shaft and forefoot were fitted in every case.
On admission, on discharge from the rehab centre, and three months after being fitted with the artificial limb, the patients were examined by a medical specialist and a physiotherapist. Subjective parameters such as personal feeling and everyday activities were recorded using a standardised questionnaire, while objective parameters such as gait, pace length, and floor reaction force were measured by means of dynamic gait analysis. The nursing staff of the rehab centre carefully observed the therapeut Success during the first weeks and kept records

Methods
On admission, patients were divided into two groups: one group being fitted with the flexible (Clever Bone) system, the other with a rigid tube system. Patients were randomised by a throw of the dice in order to ensure the greatest possible objectivity. Patients were informed objectively by the doctor, physioth. or nurse. The study was carried out in three examination blocks: (1) on admission;(2)on discharge from the rehab centre;(3)follow-up three months after being fitted with the prosth. By the positive outcomes we had found in the clinical study, we also evaluated the results of a gait study to demonstrate the efficiency of the Clever Bone® system in the prosth. care of elderly patients after below-knee amputation. Our study, which included ten patients, showed the efficiency of the Clever Bone® system in energy recovery with respect to several parameters (mean walking speed, increase in hip extension and flexion, greater rate of knee extension and flexion, shortening of the phase

Results
Rigid tube
On admission: 14patients. 12patients able to walk up to 50m. 2patients able to walk up to 500m. 8patients in wheelchairs. 9patients using walking frames and two with crutches. Prosth was fitted in 8 cases. Gait in 10 cases extremely unsteady and slow. 4patients with hesitant and steady gait. On discharge: 7patients able to walk up to 50m, 5patients up to 500m. More than 500m in 2 cases. Crutches or a walking stick required in 14 cases. No patients mobile without the use of walking aids. Gait was brisk and even in 4 cases.

10patients were mobile but hesitant. Follow-up examination: 12patients were followed up. 2 dropouts (revision amputation, illness). 83.3% able to walk up to 500m and 8.3% more than 500m. 33% had an unsteady gait. Only 8.4% walking freely, 8.3% did not need any walking aids. Clever Bone
On admission: 14patients. 9 out of the 14patients had no prost. 13 patients between “unable to walk” and able to walk up to only 50m. 1patient up to 500m. 10patients with walking frames, 8 in wheelchairs.
On discharge: After all patients had been fitted with a Clever Bone system, only four still had a maximum walking distance of 50m. In contrast, 10patients could walk up to 500m. All patients had progressed to two crutches or a walking stick. 2patients were able to walk without aids. Gait was brisk and even in 6 cases. Gait still hesitant in 5patients. Follow-up examination: 12patients were followed up. 2 dropouts (revision amputation, death). No patient was still

Conclusion
Results:
in a wheelchair. 1 patient able to walk only up to 50m; all the other patients could walk up to 500m, and 6 of them more than 500m. Gait steady and brisk in all cases. No walking aids required in 8.3% of cases.
Conclusion:
In conclusion it can be said that, even in elderly patients with reduced walking capacity, fitting a prosthesis with flexible components is clearly beneficial in improving mobilisation and, from the rehabilitation centre’s point of view, can be completely justified in economic terms.

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Session: Lower Limb Prosthetics - Hightech Foot
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3355-530]

A New Hydraulic Foot/Ankle

Author
Iversen, Edwin K. (Salt Lake City US)
Motion Control Inc. - Research and Development

Coauthors
Sears HH, Jacobs T, Strazdins PK

Abstract
A new hydraulic foot/ankle system by Motion Control will be presented - the evolution of the design objectives, the development challenges, and the subsequent design trade-offs.
Outcomes and wearer's impressions will also be presented from initial limited release to approximately 40 full-time wearer

Introduction
The major motivation of the new foot/ankle system is the difficulty that nearly all lower limb amputees (K2 and above) have in walking or running on inclines. This new foot/ankle system has targeted improved comfort, stability and efficiency for inclined walking and running, with benefits for and level walking as well. This development project has attempted to develop a system that targets these needs by developing and experimenting with the following systems:
The development has considered the other approaches used in earlier developments: 1) the earlier hydraulic multi-axis system (by Mauch in the 1980s) that modifies the dorsi-flexion stop as a function of incline, 2) present electronic systems with active electric dorsi/plantar flexion, and 3) finally, a simpler system that integrates an independently-controlled hydraulic dorsi/plantar flexion ankle with the energy-storing capabilities of a carbon fiber foot.

Methods
During the evolution of the new hydraulic ankle system, a variety of approaches were considered, including multi-axial hydraulic actuators, mechanical and electronic inclination sensors, as well as electronic controls of hydraulic resistance. The benefits of a simpler lightweight system led to a non-electric hydraulic foot/ankle system utilizing a rotary hydraulic damper. Independently adjusted plantar flexion and dorsi flexion impedance were integrated into the hydraulic valve system. The system also provides adjustment by the prosthetist of heel height adjustment, and graphite toe spring stiffness.

Results
Early results from a limited field trial, further validated by a 40-wearer outcome study, showed very promising results, as well as revealing needed changes in the phase 2 design. Unanimously, in a group including transtibial, trans-femoral, and hip-disarticulation amputees, a significant level of stability is provided, especially on declines. Increased comfort and efficiency were also benefits of the 50-degree ankle range of motion, on both level and uneven ground. The hydraulic motion of the ankle also provided low shock and smooth roll-over transition through the stages of stance phase, from heel strike through toe off.
Two design improvements have also evolved from the field trials:

1) Changing direction while the toe is plantar flexed, can be awkward, because of the extensive ROM, 2) A need was observed to lock the ankle during certain activities such as driving. Both these reported needs resulted in design changes, meeting the needs expressed by wearers.

Conclusion

Despite the negative features noted, the positive reported outcomes of utilizing this new hydraulic foot/ankle system include: greater stability, comfort and efficiency while walking and running on inclines and level ground. In addition users have reported more comfort and natural appearance while standing, sitting and kneeling.

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Image: Motion Foot-Ankle System_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg219746/cg43928

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3553-None]

Biomimetics

Session Chair
Buis, Arjan (Glasgow GB) | Dr.
NCPO University of Strathclyde

Session Chair
Henderson, Emma (Glasgow UK) | Dr.
University of Strathclyde

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58213

Symposium: Biomimetics
Tuesday 2010/05/11 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3642-749]

Biomimetics for Medicine

Author
Vincent, Julian (Bath UK) | Prof.
University of Bath - Dept of Mechanical Engineering

Introduction
Biomimetics (aka bionics, biomimicry, bio-inspiration, bioinspired design, biognosis) is the implementation of design instances and processes derived from biology. It can be direct (Velcro [1], Lotusan [2]), indirect (flight distance derived from optical flow in bees [3]) or abstract (development of BioTRIZ and novel roof insulation [4]). Biomimetics can be traced back to the ancient Chinese who, 3000 years ago, wished to develop artificial silk, a material finally achieved with the invention of nylon [5]. Meanwhile Leonardo da Vinci made useful observations on the flight of birds, George Cayley produced some interesting gliders, and the Wright brothers probably achieved the first controlled powered flight.

Methods
To many observers of the current practise of biomimetics, it all depends on finding – by chance – biological processes which can be turned to some use. But you still need the mindset. Georges de Mestral would not have invented Velcro without having experienced trouble with his wife's zip a few days earlier, and realising that there was a need for a simpler zip-like mechanism. However, such random connections are not reliable, and biomimetics will simply end as an interesting but not very practical adjunct to design which has little impact.
We need a properly crafted "bridge" between biology and engineering. We have been working on this for the last ten years and have produced BioTRIZ. TRIZ is a Russian system for producing inventive solutions to problems. By its nature it transcends boundaries between disciplines, which means that it can be made to apply suitable codified solutions from biology to engineering – without the engineer knowing anything about biology! It does this mainly by insisting o

Results
Other medical developments, apart from prostheses of various sorts (which are basically replacement engineering and do not demand a particularly great leap in inventive power), are endoscopes based on a squid tentacle [6] or the egg-laying tube of a wasp [7]. The former is steerable but needs an insertion force; the latter provides (some of) its motive power and, ideally, will be developed to have zero intertion force. It is steerable, but has no limit on length and can take any path. It is being developed for intracranial use.

Conclusion
"Biomimetics" is becoming increasingly popular as a descriptor, but to some extent this is academic fashion! However, the main early adopters are to be found in sports, medicine and defence, all of which areas can boast several examples of biomimetics.

In sport the quality of the innovation can easily be gauged by how quickly the rules are changed to outlaw it. Defence is currently the biggest beneficiary, mainly due to the American way of funding through DARPA.
There are still some lessons to be learned and implemented. Hierarchy is probably the main one, which allows a structure to be more durable and damage tolerant [8], and allows the designed to partition various ‘material’ properties amongst the different sizes in the hierarchy [9].

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Symposium: Biomimetics
Tuesday 2010/05/11 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3643-None]

Biomimetics in Prosthetics

Author
Buis, Arjan (Glasgow GB) | Dr.
NCPO University of Strathclyde

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Symposium: Biomimetics
Tuesday 2010/05/11 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3644-None]

Biomimetics in Orthotics

Author
Jones, Derek (Glasgow UK) | PhD, M.B.A.
University of Strathclyde

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58213/cg180620

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3659-None]

Upper Extremity Prosthetics - Functional Components 2

Session Chair
Sensinger, Jonathon (None US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Session Chair
Uellendahl, Jack (Scottsdale US) | CPO
Hanger Prosthetics and Orthotics, Inc. - Prosthetics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220478

Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3156-354]

Changes in Prehension, Force Control, and Gaze when Learning to Use a Myoelectric Simulator with a MyoHand VariPlus Speed

Author
Bongers, Raoul (NL) | Dr
University of Groningen - Center of Human Movement Sciences

Coauthors
Bouwsema H, van der Sluis CK

Abstract
Different ways to learn using a myoelectric simulator did not affect training results. Object rigidity affected coordination of reach and grasp in prehension and learning force control required more time than learning to control prehension. This can serve as a basis to set up prosthetic training.

Introduction
The rate of use of prosthetic devices that replace the arm after an amputation is generally low. It is known that training increases the way the amputee is able to handle the prosthesis (Dromerick et al 2008; Lake 1997). However, the way the training should be set up has received scant attention in the scientific literature. We aimed to establish the changes in actions over learning to use a prosthetic device. This helps formulating hypotheses about how to set up a training. We examined the changes in prehension, force control, and gaze when able-bodied participants learned to grasp and fixate objects with a myoelectric simulator with a MyoHand Variplus Speed hand. These tasks were derived from actions for which prostheses are used in daily life (Van Lunteren et al 1983). Because there is only a small number of recently amputated persons, we had able-bodied participants learning to use a prosthetic simulator, to increase the reliability of our tests.

Methods
32 right-handed participants used a right-handed myoelectric simulator—with a MyoHand VariPlus Speed of Otto Bock, with proportional speed and grip force control—mimicking the working and performance of a real prosthesis (Bouwsema et al 2008). Participants were assigned to one of four groups: Group 1 grasped objects directly with the simulator, Group 2 handed over the objects from the sound hand to the simulator (indirect grasping), Group 3 fixated an objects, such as a ruler, and Group 4 performed all the three tasks mixed. In a two weeks period each participant trained on 5 days. On each day the tasks were trained 60 times. We conducted the Southampton Hand Assessment Procedure (SHAP, Light et al 2002) as a pretest and posttest. An opto-electric camera system measured arm and hand position. The objects used were deformable allowing to determine the exerted force. A head-mounted eye tracker measured gaze position. We also recorded the EMG signal controlling the prosthetic hand.

Results
Until now we analyzed 16 participants (4 in each group), and for these participants the SHAP, the kinematics of the hand, and the force control were studied.
The analyses on the SHAP showed that performance in the posttest was faster than performance in the pretest, moreover, abstract tasks were performed faster than daily life tasks. Importantly, no differences were found in the SHAP among the four training groups.

The hand aperture pattern in the grasping tasks had a plateau, which is stereotypic for prosthetic use (Wing & Fraser 1983). Over learning the performance became faster which was mainly due to a shortening of the plateau. This change in duration was largest in the first days. The duration of the plateau and the duration of hand opening and hand closing was shorter when the objects to pick up were more rigid. The indirect grasping was performed faster than the direct grasping but the tasks also differed dependent on the rigidness of the object, that is, the decrease in grasping time with more rigid objects was larger in the direct grasping task than in the indirect grasping task.
The analyses on the force control showed that objects were less deformed over learning. Interestingly, the degree of learning of force control seemed to be rather constant over the experiment. Moreover, the force was adapted to the rigidness of the object to be picked up.

Conclusion

The training with the simulators improved functional performance, as is reflected in the improved SHAP score in the posttest. Moreover, the type of training did not matter given that the groups did not differ.
The increase in grasping time, in particular the plateau time, when picking up less rigid objects indicate that more deformable objects require more coordination of the reach and the grasp. This is in agreement with the smaller forces that are produced to grasp those easy deformable objects.
The shortening of the plateau time over learning makes that more experienced grasping with prostheses resembles able-bodied grasping more. Interestingly, the learning of the grasp kinematics took place in the early stages of the training whereas force control still changed at the end of the experiment. This might indicate that with prostheses position tasks are easier than force tasks and, thus, that the latter deserve more attention in prosthetic training.

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Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3045-243]

Biomechanical Evaluation of a Free-swinging Shoulder Prosthesis for Shoulder Amputees while Walking and Standing

Author
Bertels, Thomas (Duderstadt DE) | Dipl.-Ing. (FH)
Otto Bock HealthCare GmbH - R&D

Coauthors
Schmalz T, Ludwigs E

Abstract
This study shows that wearing an arm prosthesis due to a unilateral shoulder amputation has positive physiological effects while walking and standing. The varising moments on the knee joint are reduced by an arm prosthesis that harmonises the gait pattern and optimises body alignment.

Introduction
For a shoulder amputation patient, restoring appearance is extremely important. Only wearing a prosthesis makes overall appearance inconspicuous and therefore more acceptable to the patient. The function of such a prosthesis is often limited since controlling the components is very difficult under the circumstances. In many cases, patients make do with a lightweight passive fitting. At this level of amputation, the unilateral loss of body mass can cause pronounced difficulties such as back problems, etc. Compensating for the loss of mass usually leads to clinical improvement [1].
An electrically driven elbow joint in combination with a passive, free-swinging, lockable shoulder joint creates new possibilities for the patient. The prosthesis is easy to control so that active use is improved. Based on biomechanical parameters, this study objectifies whether such a prosthesis system makes walking and standing more physiological and therefore improves the patients quality of life.

Methods
The study was conducted with 6 unilateral shoulder amputation patients. A Rental DynamicArm® (Otto Bock) and the MovoShoulder Swing shoulder joint (Otto Bock) served as the prosthesis system. The shoulder joint is free-swinging in the sagittal plane. The Rental DynamicArm® is equivalent to the DynamicArm®. This arm can be individually adjusted to various arm lengths.
The loads on the major joints of the patients' lower extremities were measured in the sagittal and frontal planes using L.A.S.A.R. Posture (Otto Bock). The deviation of the load line to C7 was also recorded in the frontal plane. Gait analysis measurements were taken in three situations: without the prosthesis and with the prosthesis (with and without locking the shoulder joint) at a freely selected walking speed in a gait laboratory. The kinematic parameters were recorded using an optoelectronic system (VICON 460, VICONPEAK, UK) and the ground reaction forces were measured with two force plates (KISTLER, SUI).

Results
There were no significant differences between the investigated situations regarding the load on the joints of the lower extremities while standing. With respect to C7, the load line shifted 26 mm towards the contralateral side without the prosthesis. This distance was reduced by half when the test prosthesis was worn.

With respect to the external moments, significant differences were found in the moment acting on the knee joint in the frontal plane. Without the prosthesis, this value was non-physiological and significantly elevated on the prosthesis side at 0.64 Nm/kg (maximum value in sound individuals: 0.50 … 0.60 Nm/kg [1]). The values on the contralateral side were in the normal range. When a prosthesis with a locked shoulder joint was worn, the maximum values on the prosthesis side were reduced (0.58 Nm/kg). The moments of both sides approached each other. A further approach towards normal values was measurable with a free-swinging shoulder joint (0.53 Nm/kg).
The kinematic analysis of the torso and arms documents compensating movements. Without the prosthesis, patients walk with the ipsilateral shoulder in forward rotation. The rotation of the shoulder is compensated when the prosthesis is worn.
A free-swinging shoulder joint allows a certain extent of uncontrolled pendulum movement of the arm while walking. This is consistent with the subjective assessment of patients, some of whom found this movement bothersome.

Conclusion

The results of the static study show that using a prosthesis provides enough compensating mass to significantly reduce the misalignment of the body. While walking, the most important effect of using the prosthesis is the reduction of varus moment on the ipsilateral knee joint. The values without the arm prosthesis are so high that there is an increased risk of developing gonarthrosis over the long term. When using the prosthesis, the moments of both sides approach the physiological norms. Compensating movements also approach the comparative physiological values. The parameters that were measured show that gait becomes more harmonious and physiological overall when the arm prosthesis is worn.
This used prosthesis system has a higher mass compared to cosmetic prostheses, which optimises posture and makes the load on the locomotor system while walking more physiological. The patient’s movement pattern also becomes more harmonious and therefore less conspicuous.

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Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3095-293]

Twenty Year Follow-up of a Bilateral Shoulder Disarticulation (BSD) Amputee

Author
Uellendahl, Jack (Scottsdale US) | CPO
Hanger Prosthetics and Orthotics, Inc. - Prosthetics

Coauthors
Heckathorne, CW

Abstract
This presentation will outline the original prosthetic design rationale and describe subsequent changes to the bilateral shoulder disarticulation prostheses developed for this user. Video will be used to demonstrate the high level of function achieved by this highly motivated and innovative user.

Introduction
Management of high-level bilateral amputees poses a significant challenge for the treating parties. Selection of the most appropriate prosthetic components and controls requires knowledge of the many options available and the ability to predict which systems will most benefit the user. Given the many options available, the authors feel it is valuable to retrospectively evaluate what has led to successful fittings as a guide for contemporary practice.

Methods
This presentation will review the prosthetic management of a BSD amputee (KF) who sustained a high voltage electrical injury in May 1989. Later that same year he was brought to the Rehabilitation Institute of Chicago for comprehensive rehabilitation. The fitting philosophy employed by the authors at the time called for a hybrid approach using predominantly body-powered components on the dominant side and electrically powered devices on the non-dominant side. Fitting of KF proceeded in accordance with these principles.

Results
Over the years, KF has been reevaluated and refit several times and changes to the prosthetic systems have occurred as technology has improved and needs were identified through use. KF has achieved a remarkable level of independence in ADL’s, donning/doffing, driving, and much more.

Conclusion
Experience gained from this fitting and other high level bilateral fittings has demonstrated that a hybrid approach combining body-powered and electric prostheses has merit. Body–powered prostheses offer proprioceptive feedback through the cable and harness and are therefore favored for fine manipulation by users of hybrid prostheses similar to those described. Electrically powered prostheses offer higher grip strength and greater live-lift capabilities and are favored for activities that require those features. The most important variable in fitting the high-level bilateral arm amputee is the user. Persons with the ability to problem solve and with the determination to master the use of their prostheses can achieve a remarkable level of independence.

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Image: ISPO_2010_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220478/cg37992

Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3139-337]

A Weight Compensating Shoulder Joint to Assist the Short Transhumeral Amputee

Author
Williams III, T. Walley (Holliston, Massachusetts US)
Liberating Technologies, Inc - Product Development

Coauthors
Williams, TW, III

Abstract
A weight compensating mechanism has been developed that permits a short transhumeral amputee to use a powered prosthesis to work with the arm extended in front. Compensation is minimal at full shoulder extension and maximal at 90°of flexion. Abduction can be either free or compensated.

Introduction
Two short transhumeral amputees were fitted in 2005 with powered elbows and terminal devices. Neither fitting was a success because the subjects could not bring their arms to a useful flexion angle.
There are many amputees with this problem. Therefore, a development project was undertaken. The resulting mechanism and how to fit it are presented here.

Methods
The project first identified the design requirements. 1. The device is an orthosis joining a transhumeral socket to an x-frame socket. 2. There are two joints, one for flexion-extension and one for abduction-adduction. 3. The joint axes must pass through the same point—the center of the glenohumeral ball. 4. The joints must lie flat against the upper arm and upper back. 5. The compensation mechanism may be placed below the short transhumeral socket. 6. No anti-rotation wings are required on the socket. 7. Compensation must be maximal with the arm flexed out in front and little or none for free swing at full extension. The ideal compensation is proportional to the sine of the flexion angle. 8. Weight must be minimized. 9. The abduction-adduction joint may also be compensated. The joints must withstand an instantaneous overload of 68 Nm. Development followed the standard engineering approach with many prototypes of individual components followed by testing several complete assemblies.

Results
A first prototype was presented at the University of New Brunswick conference {Ref 1} in 2008 where numerous deficiencies were discovered. A completely redesigned mechanism was then shown at the September 2009 AOAP conference in Seattle WA, USA. A limitation was discovered with the gas strut that was used as a spring: it varies 20% from constant force. The clinical apparatus for the first amputee will incorporate a choice of a long strut with an improved force constant or a short strut with less optimal compensation for cases where there is less room on the prosthesis. Several levels of compensation are available by choosing one of three spring constants for the strut. The maximum compensation is 5.4 Nm. This compensates a prosthesis with a one-kilo elbow at 300 mm and a half-kilo hand at 600 mm. The first user will be shown on video

Conclusion

It is now possible to fit a short transhumeral amputee with a prosthesis that transfers to an x-frame socket both the weight of the prosthesis and the loads experienced when working out in front. The prosthesis only works well when the flexion and abduction axes cross at the center of the glenohumeral joint. A technique has been developed that permits the prosthetist to mark on the patient the optimal locations for the flexion and abduction joints and for transferring this information to the check socket.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220478/cg38735

Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3282-457]

Activity-Specific Upper Limb Prosthetic Options

Author
Spill, Ryan (Redondo Beach US) | CP
- Certified Prosthetist

Coauthors
Spill, R

Abstract
This presentation will highlight several patient stories including their custom made activity- specific prostheses. A few examples include trans-humeral mountain biking prosthesis, trans-radial baseball/golf prosthesis and wrist-disarticulation lacrosse prosthesis.

Introduction
Working with a young, active patient population with upper limb loss, the boundaries are continuously pushed to help create the right activity specific prosthesis to fit patients' energetic lifestyles.

Methods
This presentation is based on patient experiences with terminal devices in comparison to activity specific prostheses.

Results
Even with all of the incredible technological advancements in upper limb prosthetics, some activities require custom made prostheses, or activity-specific prostheses, to ensure optimal function.

Conclusion
Current terminal device designs offer several options, but some activities are limited by what's available. By listening and understanding the patient's lifestyle, the customized options are endless.

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Session: Upper Extremity Prosthetics - Functional Components 2
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3007-205]

Cycloid Drives for Use in Motorized Prostheses

Author
Sensinger, Jonathon (None US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Abstract
Cycloid drives provide high efficiency and strength in a compact package. This study compared performance characteristics of cycloid drives and harmonic drives. Both drives have benefits and disadvantages. Cycloid drives should be considered for incorporation into the design of future prostheses.

Introduction
Commercial motorized prostheses use electric DC motors to generate force and movement. These motors require large gear ratios to convert the fast, weak movement of the motor to the slower, stronger movements required by humans. Some existing prostheses use a harmonic drive gear because it provides a large gear ratio, moderate efficiency, and it is more durable than many other gears.
A different type of gear, called a cycloid drive, may be a more appropriate gear to use in prostheses (Figure 1). Cycloid drives have an offset input shaft. The wobbling motion of this shaft causes the cycloid disk to rotate slowly with respect to rollers. This rotation is captured by an output disk. Cycloid drives are quieter and more efficient than harmonic drives, and still provide a durable package and high gear ratio.
This study matched models of cycloid drives against existing harmonic drives and evaluated their characteristics over a range of sizes suitable for use in prostheses.

Methods
Six harmonic drives [1] were selected with outer diameters ranging from 21-70 mm and maximum gear ratios ranging from 100:1 to 160:1. Cycloid drives were modeled using theory and equations provided elsewhere [2, 3]. Cycloid drives models were constrained to have the same outer diameter and be capable of producing the same maximum torque as their harmonic drive counterpart. Gear ratio was then maximized until stress limits had been reached, using a 2:1 safety factor. Drive characteristics were calculated from the resulting geometry. These characteristics included the thickness of the drive, the maximum efficiency, the input inertia, and the amount of backlash. Inertia may be thought of as the sluggishness of the gear during acceleration. Backlash is the amount the gear can wiggle when the motor is fixed.

Results
Four out of the six cycloid drives could produce the same maximum gear ratio as their paired harmonic drive. The largest and the smallest cycloid drives could only provide 70-80% of the maximum harmonic drive gear ratio. Cycloid drives had substantially thinner thickness than harmonic drives for smaller diameter gears (21-41 mm), and equal thickness for larger diameters (50-70mm). Maximum cycloid efficiency ranged between 90-98%, and was constant even for small forces such as seen in positioning the prosthesis. This efficiency was substantially greater than harmonic drive efficiency, which ranged from 67-79%, and became much worse for small forces. Cycloid drives had two orders of magnitude less inertia than harmonic drives, making them much less sluggish during accelerations. Harmonic Drives are unique in that they have no backlash (wiggle) when the motor is stopped. In contrast, cycloid drives had a small

amount of backlash, ranging from 0.4# to 1.4#. These results are shown in Table 1. Beneficial differences are emboldened.

Conclusion

Cycloid drives have many of the same characteristics as harmonic drives, but they are quieter, more efficient, and less sluggish during acceleration. Cycloid drives may be more easily designed than harmonic drives, and are thus easier to customize for small-market products such as prostheses. They should be considered for use in the design of future upper and lower limb motorized prostheses, especially in elbow, wrist, knee, and ankle units.

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Image: Cycloid table_None.PNG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220478/cg35201

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3687-None]

Rehabilitation - Amputation Upper Extremity

Session Chair
Stark, Gerald (Chattanooga TN US) | CPO/L, FAAOP
The Fillauer Companies Inc. - Product Development and Education

Session Chair
Banzhaf, Andre (Tübingen DE)
Brillinger OT - Armtechnik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg235548

Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3207-393]

Defining Success after Upper Limb Loss: Prosthesis Use, Activities and Participation, and Self Image

Author
Ni Mhurchadha, Sinead (Dublin IE) | Ms.
Dublin City University - School of Nursing

Coauthors
Gallagher P, Wegener S, MacLachlan M.

Abstract
A Delphi study with Rehabilitation professionals (RP's) and individuals with upper limb loss (ULL) was conducted to reach group consensus on what constitutes successful outcomes in three key areas, 'prosthesis use', 'activities and participation', and 'self image'.

Introduction
There is wide variation in the literature concerning the definition of 'successful prosthesis use', with several studies assessing greater hours of prosthesis use as indicative of greater success (1, 2) and many studies assessing differing factors between 'prosthesis users' and 'prosthesis rejecters' (3, 4). A lot of research is concerned with assessing predictors of prosthesis rejection or 'use' without taking into consideration an individuals own definition of 'successful prosthesis use' and other potentially important factors to them such as 'activities and participation' and 'self image'. The aim of this research is to reach consensus on the definitions of successful outcomes in three key areas, 'prosthesis use', 'activities and participation' and 'self image' following ULL, through the use of a Delphi study. This involves a series of sequential questionnaires interspersed by controlled feedback that seek to gain the most reliable consensus of opinion of a group of experts (5).

Methods
A three-round Delphi study was conducted in order to reach consensus. Items for the Delphi study were developed from the literature on ULL and from prior qualitative studies with RP's and individuals with ULL. The Delphi allows participants to give their opinions and to see how it aligns with others, and to change it, if desired, after reconsideration of the groups' response (6). 53 participants that were recruited internationally completed all rounds of the Delphi; 38 RP's, 13 individuals with ULL and 2 people with ULL who were also RP's. Participants were asked to rate the statements concerning the definition of a successful outcome on a 1-5 Likert scale of agreement. Consensus (agreement amongst panel members) was defined prior to starting the study. Consensus on an item was reached when it had a standard deviation of less than 1 (indicating a small variation in responses from participants). If the item also had a mean rating of 4 or above, it was accepted as a successful outcome.

Results
Consensus was reached on 25 of 28 statements concerned with defining successful outcomes. Of these, 11 statements had a mean rating of 4 or above and were accepted as successful outcomes. 14 statements were rejected as successful outcomes for having a mean score below 4. The results suggest that successful outcomes of prosthesis use include when a person 'wears a prosthesis for specific activities', 'wears a prosthesis as often as they wish' and 'uses the prosthesis as intended'. In relation to 'activities and

participation' accepted statements included that a successful outcome is a person's ability to perform their own personal care and activities of daily living without help from other people. With regard to 'self-image', participants felt that a successful outcome included people not feeling self-conscious when in public with a prosthesis. An analysis of rejected statements and the associated reasons given for ratings facilitated a greater understanding of what was not considered a successful outcome. In particular patients should expect some degree of reduction in function, and that if patients do not feel confident to show residual limb in public, that neither of these outcomes necessarily suggest an unsuccessful outcome following upper limb loss.

Conclusion

The results of the present study challenge the notion that successful prosthesis use can be solely measured quantitatively through hours of use and that instead an individuals goals for their prosthesis need to be also taken into consideration both in an applied setting and in research studies aiming to identify the predictors of 'successful prosthesis use'. This study also provided an insight into what RP's and individuals with ULL deem important regarding 'activities and participation' and 'self image'. The results should be used as a means for structuring group discussion or future research relating to determinants of 'successful prosthesis use' and other successful outcomes following upper limb loss.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3091-289]

Clinical Guidelines for Bilateral Upper Extremity Management

Author
Stark, Gerald (Chattanooga TN US) | CPO/L, FAAOP
The Fillauer Companies Inc. - Product Development and Education

Coauthors
Jeremy Farley, CPO/L

Abstract
The bilateral upper extremity patient presents with a number of fitting challenges that may be intimidating. Various factors that must be addressed with respect to evaluation, component selection, fitting timeline, interface design, and harnessing as well as overall funcitonal optimization.

Introduction
The bilateral upper extremity patient presents with a number of fitting challenges that may be intimidating for the prosthetist. Within the team environment the evaluation should consider ROM, limb length, work source strength, flexibility, and load sensitivity, cognitive ability, family support, vocation, avocation, and self-image. Additionally “gadget tolerance”, lower limb prehension capability, and emotional resilience must also be considered. After an overall plan has been developed the componentry will be chosen using both body and external power options to optimize function. Terminal devices that provide alternative grip options are also recommended along with hybrid designs that incorporate external control or alternately for bilateral transhumeral designs. Harnessing alternatives will also be presented for external, body, or hybrid control options as well as concepts that may help optimize use such as double-ring harness, excursion amplifier, or 4 function wrist.

Methods
Clinical guidelines for fitting the bilateral patient were developed by Jack Uellendahl, CPO and Craig Heckathorne, MSc at the Rehabilitation Institute of Chicago and Northwestern University respectively. They were a result of over 40 bilateral fittings over al 12 year period. The success of these fitting guidelines were corroborated with an additional 11 clinical fittings by the author. The guidelines are pertinent clinically for a number of reasons. These include smaller numbers of bilateral amputees, more active usage, multiple grip pattern demands, greater donning need, independence requirements, independent control needs, and custom harnessing. The goals need to remain for full independence, avocation/vocational needs, optimized function, minimal mental loading, donning ease, maximum control, ROM capability, and satisfactory appearance.

Results
The evaluation must begin within the 30-90 "Golden Period" if not immediately where the adapatdation of the patient to various control mechanisms is at its maximum. The fitting process proceeds best when done in the rehab team including PT, OT, Nurse, and Physician. The team needs to discuss with the patient the priority of the vocational and avocational goals as well as individual goals. After the long and short term goals are discussed the post-operative prosthesis can be created. The post-operative prosthesis much first address wound healing and any volume fluctuation present. The prototype arm begins with terminal device activation in an endoskeletal form with simplified control demands. The short term goals are addressed within the first 6 months and include many of the ADLs necessary for usage. Long term goals extend 1 year

and more. The patient will require constant adjustment and the system will evolve over time. Dominance of the arms must be establish to introduce the control method. Typically the non-dominant arm utilizes external power whereas the body power is used on the dominant arm. The movements must be prioritized based on functional goals. Control isolation should also be exhibited. The interface should be a stable platform, but allow easy push-in donning as well as activation point for control demands. Multiple grip patterns are imperative to maximize adaptability to objects. Proprioception in body and external power help overall performance.

Conclusion

The prosthetist should not be intimidated with the fitting of a bilateral upper extremity amputee. They should begin the planning and strategy immediately and introduce a post-operative prosthesis of some type. The procedure should be staged with anticipated follow-up to allow for the evolution of interface and harness designs. The patients gadget tolerance should be constantly assessed and updated for additional components. Any issues that the prosthetist causes such as cross coupling should be addressed. The patient must feel that there is a plan in the development of the prosthesis. Particular attention should be given to the control methods to insure long term use. Hybridization of body and external power is encouraged to render the benefits of both for maximum grip strength and proprioception.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [2929-127]

Prosthesis Training with a Fully Functional, Myoelectrical Upper Arm Prosthesis

Author
Banzhaf, Andre (Tübingen DE)
Brillinger OT - Armtechnik

Coauthors
Fischer K, Gelse M

Abstract
Different case examples will show a training with two different types of upper arm prosthesis (both electrical prosthesis). Also a brief overview will demonstrate the functional differences between a conventional, myoelectrical system hand and an adaptive hand with inividually movable fingers.

Introduction
The control of myoelectrical prosthesis is becoming increasingly more complex. Therefor a complete occupational therapy training is very important.

Methods
Our concept called "Therapy and Technology under One Roof" means that an ergotherapist (occupational therapist) is involved in supporting the patient throughout the entire treatment process.

Results
Any initial technical problems can be solved and corrected quickly to ensure that the entire treatment is optimized.
Different case examples (patient treatments) have shown that there are several different options for fitting patients with fully functional prosthesis. in this respect, both training with conventional "myoprosthesis" (i.e.prosthsis equipped with electrodes), as well as training with bandage-driven (electrical) prosthesis will be demonstrated.

Conclusion
Contoling myoelectrical prosthesis is becoming more and more complex. In order to ensure that users ultimately wear their prosthesis, it is therefore of vital importance that prosthesis wearers practice and internalize the wide range of movements right trom the start of their training.

References
Brillinger Orthopädie
Handwerkerpark 25
72070 Tübingen
Germany
www.brillinger.de

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3451-626]

Development and Validity of the Children's Hand-use Experience Questionnaire

Author
Norling Hermansson, Liselotte M (Örebro SE) | Dr.
Örebro county council - Dept for Prosthetics and Orthotics

Coauthors
Sköld A, Krumlinde-Sundholm L, Eliasson A-C

Abstract
A questionnaire for evaluation of children's experiences of using the affected hand in bimanual task performance was developed. Internal scale validity and the appropriateness of the rating scale structure were confirmed by Rasch analysis. The CHEQ is a useful tool for clinical work and research.

Introduction
Children with unilateral hand impairment constantly have to deal with problems in daily activities. Their problems are in particular related to performance of bimanual tasks.
Children's Hand-use Experience Questionnaire (CHEQ) was developed to capture the child's experiences of performing bimanual activities, as reported by themselves (13-17 years) or by their parents (6-12 years). It describes the child's experiences in 31 activities, rated on three subscales: efficacy of the grasp, time taken for the activity, and, if feeling bothered by the hand function when performing the activity. Additionally, the frequency of independent performance in bimanual activities as well as the use of the involved hand is reported.
The aim of this study was to describe the development process and to assess validity of data generated by the Children's Hand-use Experience Questionnaire.

Methods
The selection of items was made by a review of the literature, by expert opinion, and by group interviews involving children with unilateral hand dysfunction. Inclusion criteria of the item were 1) requirement of the use of two hands, 2) being frequently performed by many persons, 3) possible to do in a wide age span, 4) not season related, 5) not too specific from aspects of culture and gender, and, 6) not strongly dependent on other functions, such as balance, gross motor function, or cognitive functions. Items were reduced in a stepwise procedure with field-testing and discussions, ending up in 31 suitable items.
Data on the final questionnaire was collected from 90 children, 3-17 years old, with unilateral disabilities such as upper limb reduction deficiency, unilateral cerebral palsy, or brachial plexus palsy. To assess validity, Rasch analysis according to the Rating Scale Model was performed in Winsteps 3.65.0 software (http://www.winsteps.com).

Results
Analysis of the function of the 10 category rating scales showed an inconsistent order of average person measures corresponding to thresholds between the 10 categories in all three subscales. Various alternatives for collapse were examined, following the recommendations by Linacre. The use of a 4-category rating scale was found to be the best alternative. This scale, compared to the 10-category scale, also improved reliability and separation values.

In the first analysis, several items showing misfit were present in the three subscales: Grasp efficacy, 6 items (19%), Time taken, 4 items (13%), and Feeling bothered, 1 item (3%). Hence, item reduction was done for each subscale separately, removing one item at the time until at least 95% of the items in each subscale showed good fit. The difficulty of the items was well targeted to the ability of the persons. The person separation, transformed into a strata index, showed evidence for that persons can be separated into 4-5 groups, with a reliability of 0.90-0.93, varying between subscales. The range of standard error showed evidence for acceptable precision ranging from 0.26 to 0.31. The PCA of the residuals supported unidimensionality for all three subscales.

Conclusion

The Children's Hand-use Experience Questionnaire is a promising tool for evaluation of children's experience of use of the affected hand in bimanual task performance. In addition, the items are suitable for describing a variation in hand use and the frequency of independent activity performance. The questionnaire is web-based, easily accessible and free to use (www.cheq.se). The CHEQ has therefore prerequisites for becoming a useful tool in clinical work, for treatment planning and follow up.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3172-364]

Content Comparison of Outcome Measures in Upper Limb Prosthetics Based on the International Classification of Functioning, Disability and Health (ICF)

Author
Lindner, Helen (Örebro SE) | OT, MSc
Örebro University - Caring Sciences

Coauthors
Nätterlund Sjöqvist B Dr., Hermansson LMN Dr.

Abstract
The contents of eight outcome measures designed for upper limb prosthesis users were linked to the International Classification of Functioning, Disability and Health. The items/questions in these measures measure body functions, prosthesis use in activities and participation in major life areas.

Introduction
In the last decade, several questionnaires and assessment methods have been designed and validated on persons with upper limb prostheses. The selection of an appropriate outcome measure to evaluate the functional outcomes among users of upper limb prostheses can be challenging. In other areas of rehabilitation, content comparisons of similar outcome measures using the International Classification of Functioning, Disability and Health (ICF) (1) have been performed to facilitate the selection. The ICF was developed by the World Health Organisation with the aim of creating a common language for different professionals to describe health and health-related status. A content comparison based on the ICF allows for a detailed exploration and comparison of all contents of the outcome measures. Thus, the aim of this paper was to perform a content comparison of the outcome measures that have been validated on persons with upper limb prostheses.

Methods
Searches for scientific publications on upper limb outcome measures were performed in the databases AMED, CINAHL and MEDLINE. The selection was based on two criteria: (i) the outcome measure should be designed to evaluate the functional outcome among upper limb prosthesis users. Functional outcome could include factors such as function, acceptance, usage, satisfaction, adaptation, and ability; (ii) the psychometric properties of the outcome measure should have been evaluated on upper limb prosthesis users.
In order to compare the content of the outcome measures, the assessment items (e.g. questions) in the measures were linked to the ICF. The ICF classifies different aspects of health into different components and categories. The linking process was conducted according to the linking rules suggested by ICF (1) and Cieza et al (2, 3). The process started with the extraction of meaningful concepts from every item/question. Each concept was then linked to the most suitable ICF category.

Results
Eight outcome measures were identified: Assessment of Capacity for Myoelectric Control (ACMC), Child Amputee Prosthetics Project-Functional Status Inventory (CAPP-FSI), Child Amputee Prosthetics Project-Prosthesis Satisfaction Inventory (CAPP-PSI), Orthotics and Prosthetics Users Survey (OPUS), Prosthetic

Upper-extremity Functional Index (PUFI), Trinity Amputation and Prosthesis Experience Scales (TAPES), Unilateral Below Elbow Test (UBET), and University of New Brunswick test of Prosthetic Function (UNB). The ACMC, UNB and UBET are observational assessments designed to assess the client's ability to use the device. The CAPP-FSI, CAPP-PSI, OPUS, PUFI, and TAPES are self-rating questionnaires designed to measure areas in satisfaction, performance, usefulness, difficulty and psychosocial adjustment.
The frequencies with which ICF categories were addressed in the eight outcome measures are listed in Table 1. The ACMC, OPUS and TAPES cover the categories in the "body function" component such as "hand coordination" and "emotional functions". Seven outcome measures cover the categories that classify daily activities in the "activity and participation" component. The OPUS and TAPES cover the categories "employment" and "social relationships", which are important areas in daily lives.
The concept "prosthesis" is linked to the ICF category "Assistive products and technology for personal use in daily living", which is classified under the component "Environmental Factors".

Conclusion

Each outcome measure is designed with a special focus and no one measure covers all aspects of health as demonstrated in the ICF categories. Table 1 shows the similarities and differences between the measures in relation to the ICF. The list also shows the aspects that are lacking in these measures. Aspects such as emotional functions, psychosocial adjustment, and social interaction are important for both paediatric and adult users, but only TAPES and OPUS cover these aspects. The TAPES is designed for adults and the validity of OPUS has only been evaluated in adults and paediatric lower limb users. Since there is a need for such an outcome measure for paediatric users, further validation of the OPUS for paediatric upper limb prosthesis users is thus encouraged.
In a conclusion, the use of observational assessment and self-rating questionnaires would together give a better picture on both the functional ability and the prosthesis use in everyday life.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3340-515]

Acceptance of Prothesis of the Upper Limb in Children and Adolescents

Author
Illgner, Ulrich (Münster DE) | Dr. med.
Uniklinikum Münster - Technische Orthopädie

Coauthors
Thormann J, Wuehr J, Büsch H, Rümmler M, Wetz HH

Abstract
To provide an prothesis for the upper limb in children many factors need to be considered. Parents should be informed directly after birth and prothesis supply should start early. Finding the right prothesis is an individual task that should be done step by step in a specialized unit

Introduction
Pediatric limb defiancy still means a stigma for parents and children. The acceptance of a prothesis depends on many factors such as functionality, age, gender, acceptance in the group. There is a conflict between the exspectations regarding a prothesis and reality. Still sensoric functions cannot be replaced. Regarding congenital unilateral deficiancies, children get along well without prothesis using the remaining hand. Support by the family is a important factor in acceptance of a prothesis. Because of the high costs of a myoelectrical prothesis it is important to define criteria to predict a satisfactory prothesis.

Methods
All 130 patients in the age between 0-16 years who were supplied with a prothesis at the Technical Orthopedic Ward of the University of Münster from 1984-2004 received an inventory including 13 questions about age of first contact to our ward, first age of prothesis supply, stigma of child and parents (scale 0-10), acceptance of prothesis, reasons for rejection, duration of daily use, complaints and suggestions. Reason for rejection were divided into reasons due to problems with the prothesis, problems of the arm and problems of the patient. 53 Patients answered and 51 were included (2 forms incomplete), 30 male and 21 female children. There were 45 peromelia (66% peromelia of the fore-arm) and only 4 amputations and 2 other reasons. 73% had been supplied with a passive, 15 % a myoelectrical and 12% a mechanical prothesis. At the time of the first consultation children were 2,7 years old and at the time of the first prothesis 4,6 years old.

Results
Only 26 of the 51 Patients used the prothesis (52%), 75% of the femals and only 33% of the males. Patients with a peromelia of the upper arm did not accept the prothesis. In both genders the acceptance was lower when the prothesis was supplied later (age 0-3 vs. 4-6). There was a difference regarding the type of prothesis: 70% of simple prothesis, e.g. “Lenkhilfen” (stiring aid for bicycles) and “Eßhilfen” (eating aid on a palmar plate) were used, but only 30% of the passive prothesis. A combination of passive and myoelectrical prothesis was accepted in 75%. On avarage the protheses were worn 5 hours per day. Problems with the prothesis (weight too high, restriction of movements) were in 54% the reason for rejection. In 41% patients did not see functional benefit from the prothesis. Acceptance raised when children felt stigmatized and excluded from the groupe (66% vs 46%). Parents complained about too little information after the birth.

Mostly suggested was improving information for parents and shortening the waiting time for the supply of a prothesis or the repairing of a prothesis.

Conclusion

Providing a prothesis for children still remains a challenge. Patient, parents, orthopedic surgeon, ergotherapist and technician have to cooperate to achive success. Parents need early information because the first contact to a specialized unit is still too late. According to the literature an early start of supply for example with a “Patschhand” seems to improve acceptance. Simple prothesis and on the other hand myoelectrical prothesis were better accepted, because children need to see the functional use of a prothesis. Intensiv training must be done to use the prothesis. The patient should show own initiative, communicate with the therapist and be supported by the family to increase the chance of success. Patients with unilateral congenital defiancies learn to get along with one hand and so the acceptance of prothesis is low. All of the 4 amputated patients used the prothesis to regain former function.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3461-636]

Utilization of Lower-limb and Upper-limb Prostheses by Farmers and Ranchers in the U.S.

Author
Heckathorne, Craig (Chicago, IL US)
Northwestern University - Rehabilitation Engineering Research Center

Coauthors
Waldera K, Heckathorne, CW

Abstract
Farming and ranching in the United States is a hazardous occupation. Many non-fatal farm accidents result in amputation. This paper describes the utilization of upper- and lower-limb prostheses by farmers and ranchers and improvements in prosthetic options needed for the farm and ranch envir

Introduction
Farming and ranching have been identified by the U.S. Department of Labor as being one of the most hazardous occupations. Among non-fatal accidents, amputations are a common consequence. In 2008, the National Institute on Rehabilitation Research and Development noted that farmers represent an underserved population with respect to prosthetics. In response, our Center, in partnership with the National AgrAbility Project of the U.S. Department of Agriculture, is surveying farmers and ranchers to document the utilization of prostheses and identify areas in need of further improvement. Additionally, we are surveying prosthetists who serve farmers and ranchers for their perspective on prosthetic options available to this population. The results of the survey will be used to develop educational materials and development projects.

Methods
We are using several methods to assess prostheses utilization among farmers and ranchers: interviews by phone and in person, focus groups, and self-administered surveys available in print or online. We are completing the interviews and have conducted one focus group with farmers who have upper-limb amputations. We expect to have results from the self-administered surveys by April 2010.
The interviews include questions related to the accident that resulted in the amputation, the history of prostheses used by the farmer or rancher, details about the components, construction and suspension for each prosthesis, reasons for changes in the prosthesis, history of repairs and replacements, tasks that are helped or hindered by use of the prosthesis, and resources for paying for the prosthesis.
The focus group, eight farmers, dealt primarily with problems that the farmers have had with upper-limb prostheses and the special demands that the farm environment places on prosthetic devices.

Results
Most farmers and ranchers with amputations use prostheses if they continue in that occupation. Although some farmers use electric-powered components in farming tasks, these are the minority. Most farmers and ranchers use completely mechanical components. A number of factors were identified to explain the choice of components. Durability and funding resources were primary factors. Other factors, which relate to durability, include exposure to wide temperature range, exposure to liquids, and exposure to airborne particulates. Farmers also noted the need to quickly and safely remove biological and chemical

contaminants from the prosthesis because few could afford to have an outdoor prosthesis and an indoor prosthesis. Cleaning of the prosthesis generally involved flushing and cleaning with water or liquid solution. Farmers and ranchers also commented on their ability to maintain their own prostheses, sometimes for financial reasons but often as an expression of self-reliance. The capability to do one's own maintenance is more likely with a mechanical prosthesis than with an electric-powered one.
Farmers also expressed a desire for more information. Few of the interviewed farmers recalled being given any options in the selection of components for their prosthesis. Farmers also were generally unaware of organizations such as AgrAbility and the Amputee Coalition of America that could provide beneficial resources.

Conclusion
Many U.S. farmers and ranchers who have amputations continue to farm and ranch with the use of prostheses. However, the types of prostheses they use are far less varied than what is available to the general population of persons with amputations. Primary factors contributing to this result are durability and funding resources. The farming and ranching environment places severe demands on prosthetic systems, not only in terms of the many physical tasks required in these occupations but also in the need to carry out these tasks in adverse weather conditions. There is a clear need among this U.S. population for maintainable prosthetic systems with improved performance but at a low or moderate cost.

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Session: Rehabilitation - Amputation Upper Extremity
Tuesday 2010/05/11 | 17:00 - 18:30 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3301-476]

Clinical Experience and Rehabilitation of Amputee Military Service Members at the Center For the Intrepid

Author
Ebner, Christopher (Fort Sam Houston, Texas US) | MS, OTR/L
Center For the Intrepid, Brooke Army Medical Center - Department of Orthopedics & Rehabilitation

Abstract
This lecture will discuss the clinical experiences at the Center For the Intrepid located at Brooke Army Medical Center providing rehabilitation of amputee military service members.

Introduction
Case presentations will be utilized to illustrate the team approach to provide clinically appropriate amputee rehabilitation. This cohesive effort includes surgical considerations, early prosthetic fittings, long-term prosthetic care, rehabilitation services, case management, physiological and social support services. Protocols for advanced prosthetic training will be presented with emphasis on various prosthetic componentry. Advancements in the rehabilitation of the military amputee at the Center For the Intrepid will be discussed in detail to include functional capacity evaluations, drivers training, and firearms training simulator. A case study that involves an individual who sustained a dominant upper extremity transhumeral amputation with total loss of vision will also be discussed. In addition, current and future clinical research studies of individuals who have sustained upper extremity loss and who are undergoing rehabilitation at the Center For the Intrepid will be discussed.

Methods
Comparison of the functional performance and user satisfaction of a
standard myoelectric hand with the i-Limb using the Southampton hand assessment
procedure, the Assessment of Capacity for Myoelectric Control, and the Trinity
Amputation and Prosthesis Experience Scales in upper extremity amputees. First clinical study to examine the i-Limb to a standard myoelectric terminal device. Subjects included in this prospective study were 15 OIF/OEF active duty and retired service members who have sustained an upper extremity amputation and have been fitted with both the standard myoelectric hand (Transradial amputation = Otto Bock 8E-37, Wrist disarticulation = Otto Bock 8E-44) and the i-Limb terminal device (Standard setup with internal Touch Bionics Controller with standard Otto Bock electrodes).

Results
Study results to be discussed. Final results pending complete data analysis.

Conclusion
Study conclusion to be discussed pending complete data analysis.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg235548/cg43728

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3945-None]

Benefits and Role of Good Seating and Peer Training in Less Resourced Settings

Session Chair
Rushman, Chris (Bristol GB)
Motivation Charitable Trust UK

Session Chair
Pryor, Wesley (New Delhi IN)
Handicap International

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1003023

Symposium: Benefits and Role of Good Seating and Peer Training in Less Resourced Settings
Tuesday 2010/05/11 | 17:00 - 18:30 | Subtopic/Track: Rehabilitation

Congress Lecture [4011-919]

Review of Different Approaches to Address the Needs of Children Who Require Supportive Seating in Less Resourced Settings

Author
Frost, Sarah (Bristol GB)
Motivation

Introduction
Without appropriate posture support and mobility, children are unable to access these fundamental rights.
The aim of any supportive device should be to meet the user's individual needs and environmental conditions, provide appropriate postural support, and be safe and durable. In addition, the assistive devices provided must be available, affordable and be maintainable and sustainable in the country of use1. Simple analysis of postural support devices will be presented to assess whether they meet these criteria.
The timing of intervention has a significant impact on the child's anatomical, physiological, social and personal development, and their general ability to learn and grow. Statistics from South Africa will be presented to demonstrate the importance of early, appropriate intervention limiting secondary complications. The need for early intervention is a widely recognised approach in many developed contexts but is not widely recognised or accepted in less resourced settings.

Methods
Children are commonly identified when they can no longer be carried and leaving the house becomes a problem. Delayed intervention leads to unnecessary secondary complications, and premature death.
Children's physical abilities are constantly changing due to the natural process of development. All professionals working with children who have a mobility impairment require an understanding of how to provide appropriate postural support and key functional milestones. This knowledge will impact on the child's health, communication and physical development. Working as a team as far as possible helps to ensure the child's situation is viewed and managed holistically. Regular follow-up is essential due to the growth of the child and their changes in function according to development. The child's potential for development is greatly increased with a well fitting supportive device, which facilitates better movement patterns and increased muscle strength in postural support muscles.

Results
Follow-up is extremely important; however, return for follow-up frequently poor. Training of the child/parent/caregiver is crucial for acceptance of the product, its correct use and returning for ongoing review and input.
It is through a service where the needs of a child are met. Service delivery for the mobility impaired child should include
• Early intervention
• Provision of appropriate mobility and posture support solutions
• Decisions and recommendations based on an understanding of the principles of

posture management and normal child development and function
• Training for the carers to understand and accept the product
There are many different challenges to appropriate service delivery. Many of the children live remotely, isolated from health services. There are few trained staff and those who are, frequently lack the necessary knowledge and skills to meet the child's needs. The child's family and wider community frequently lack insight into the potential of the child. Lack of government funding and the limited personal resources of families who wish to use the service, present many challenges to sustainability. Examples of how Motivation has addressed these challenges in Southern and Eastern Africa will be discussed.
• Team approach
1 WHO Guidelines on Provision of Wheelchairs in Less Resourced Settings

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1003023/cg1989214

Symposium: Benefits and Role of Good Seating and Peer Training in Less Resourced Settings
Tuesday 2010/05/11 | 17:00 - 18:30 | Subtopic/Track: Rehabilitation

Congress Lecture [4012-912]

The Role of Peer Training in Less Resourced Settings

Author
Constantine, David (Bristol GB)
Motivation

Introduction
Peer group training is the exchange of knowledge, experience and skills from wheelchair user to wheelchair user. The aim is to provide users with the daily living skills, confidence and knowledge to remain healthy, be active and promote their inclusion in society.

Results
The outcomes of peer training have resulted in greater independence and self esteem with users taking a more proactive role in their lives.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1003023/cg1989473

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3745-None]

Open Forum 2

Session Chair
Franke, Jens (Dortmund DE)
Bundesinnungsverband für Orthopädie-Technik

Session Chair
Schlierf, Christian (Nürnberg DE)
Human Study e.V. - Balkan Program

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [2910-108]

Developing a National Qualification for Orthotic and Prosthetic Technicians

Author
Adam, Ian (Glasgow UK)
Yorkhill Hospital - Alf Cairns Orthotic Unit

Coauthors
Martin C

Abstract
There has never been a nationally recognised qualification for Orthotic and Prosthetic Technicians working in the United Kingdom. This paper will explain the process of bringing the various bodies together make this long needed qualification a possibility

Introduction
This paper will explain from the first meetings with the various stakeholders in Orthotics and Prosthetics in the UK to find out if this qualification was needed. We will also explain the process of deciding the correct type of qualification and level to provide the profession and technicians with the correct skills and qualification to move our profession on provide the technician of the future.

Methods
We made contact with various qualification agencies before forming a relationship with SQA (Scottish Qualifications Agency) and NES (NHS Education Scotland). This allowed us to look at the various routes and levels of qualification available within the UK. NES were also available to provide us with funding to form a QDT (Qualification Design Team) and administer the project. The QDT then spoke to the various profession stakeholders to determine what we need to provide. We also employed a market research company to conduct a face to face and telephone survey to make sure that we were moving in the right direction. We also used our various network routes to let people know what we were planning and to also make sure that the profession was kept informed about what was happening. We all knew that technicians were leaving the profession for various reasons and we also had staff retiring that were not being replaced and we were starting to lose skills.

Results
We decided, from all the information we received that we should set our qualification at HNC level. There were various units available for the SQA catalogue that we could use in our qualification but there were no specific Orthotic and Prosthetic units in existence, these were the units that the QDT would need to write. We held 2 two day meetings with Technicians and managers from Orthotics and Prosthetics. These unit writing meetings allowed to ask these two panels what we needed to include in these units and what was the best way to facilitate this qualification. We worked through this process to develop this new qualification and take it to be validated by the profession and then launched nationally.

Conclusion
We now have a nationally recognised qualification that provides a skills escalator for technicians joining the profession. It also makes sure that the technicians that we are employing and training are being given

the correct skills for the profession to move onwards and upwards. It also provides technicians with a piece of paper that can now be recognised internationally. This can only mean that we will produce better and desirable technicians for the profession.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg33973

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3570-667]

The Redesign Implementation and Accreditation of 4 years Honours and 5 years Masters Progr. in P&O at the NCPO University of Strathclyde, Scotland

Author
Figgins, Elaine (Glasgow G4 0LS UK) | BSc Honours Prosthetics and Orthotics
University of Strathclyde - National Centre for Prosthetics and Orthotics,

Coauthors
R.J. Bowers
G. Ballantyne
D. Jones
K. D. Murray
K. Ross
H. Smart

Abstract
This paper will initially describe the review procedures of the new 4 year Honours programme at undergraduate level for the education and training for Prosthetists and Orthotists in the UK at Strathclyde University.

Introduction
The National Centre for Prosthetics and Orthotics at Strathclyde University has a long established undergraduate training and education of prosthetists and orthotists since 1972. It became a four years Honours programme in 1986. There are however many drivers in this century, such as the European Bologna agreement, a new structure to the national framework with the National Health Service in the UK and a need to produce graduates suitable for the 21st Century. The
department underwent a major review by its funders in 2002 that recommended a change management approach to looking at al its functions and processes to ensure quality and accountability of its activities. This led to the forming of an undergraduate review group to
undertake this work in this specific area of activity at the Centre.

Methods
A Literature search was undertaken and a Review of all educational development work within the relevant field since 2000 was reviewed. Stakeholder consultation was undertaken in the forms of Student focus groups, clinical placement supervisors ‘consultation events and feedback. An employer and Graduate Audit tool developed within the department had been used 18 months post
graduation for 6 year groups and the results were used. Patient users of the clinical service were consulted and educational staff (from related Allied Health professional groups) were consulted with to explore ideal learning outcomes of the ideal graduate in prosthetic sand orthotics. Lastly the National Centre Strategic Board was presented the review, restructure and implementation throughout a three year process. This Board has representation from the Government, the University, the employers, senior clinical managers in prosthetics and orthotics, and the professional body.

Results
New 4 year Honours and 5 years Masters programmes at undergraduate level were developed and implemented. This includes a revised assessment tool for clinical placement, new blended learning and teaching approaches including an interactive learn on line web based anatomy resource. These new programmes were also put through accreditation processes from The Health Professions Council and ISPO Category I to show a quality monitoring process was used to accredit the process and outcomes.

Conclusion
The new programme align with the Bologna agreement across Europe for education and have kept and further developed the expectations for training and education of a skilled graduate prosthetist/orthotist who has measurable learning outcomes whilst having an individual profile at the beginning of their professional life as a new graduate. It also allows for more potential for development of students internationally prior to graduation.
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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg69597

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3188-375]

Development of a Technology Enabled, Problem Based Learning Module for Teaching Knee Anatomy, Biomechanics and Knee Orthosis Design

Author
Goodnough, Jason (CA)
School of Health Sciences British Columbia Institute of Technology - Prosthetics&Orthotics

Coauthors
Rasche S, Kenyon D

Abstract
BCIT has developed a module for teaching knee orthotics, using the high quality graphics and easy to use interface of NGRAIN technology, which allows students to quickly and comprehensively grasp complex 3-D movements and relationships and apply them using a Problem Based Learning (PBL) approach.

Introduction
BCIT has developed a teaching module on the NGRAIN platform, covering how knee anatomy and biomechanics relate to knee orthoses design and components. This is easy to use training software effectively enhances the learning of complex 3-D information. Students often find it frustrating to visualize the complex motion of the knee and the impact of a knee components or designs on knee biomechanics. The ability to conceptualize shapes and movement, in 3-D, is key to successful clinical prosthetic and orthotic practice and teaching these concepts thoroughly requires a great deal of creativity and repetition on the part of instructors. With its ability to illustrate 3-D shapes and movement, the NGRAIN platform assists instructors in allowing students to grasp this spatial knowledge more quickly, clearly and effectively. The software phase is easy to learn to use and allows students to learn and review at their convenience, in addition to being used as a classroom tool.

Methods
This project's goal was to produce a curriculum module on knee anatomy, biomechanics and orthoses design using the NGRAIN platform. A traditional (paper based) learning plan, consisting of four sections was restructured such that learning goals were considered from the 3-D visual learning perspective. They sections are: Normal Anatomy, Pathological Joint & Motion, Orthoses and Pathological Assessment & Design. A storyboard was developed for each section. Animation segments of the knee anatomy, normal and pathological knee biomechanics and orthotics joints were developed to illustrate the principles to be covered in the module. These were supplemented by the incorporation of existing video clips, curriculum text and learning tasks developed by prosthetic and orthotic faculty. Finally, a series of problem based learning exercises based on real clinical cases, were incorporated into the module requiring the students to apply the theoretical knowledge learned in a clinical context.

Results
With the support of the BCIT Learning and Teaching Centre, the envisioned module was developed. The resulting module has four sections which cover the basics of knee anatomy, normal and pathological biomechanics, orthotic component design and clinical decision making. In each of the modules the student works from a dynamic three dimensional animation of the knee that can be manipulated so that it can

be observed from any view point. Animations, up to 25 seconds long, can be viewed so that students can dynamically observe how the application of an orthoses impacts pathological knee conditions. They can also observe how an orthotic joint's movement relates to the anatomical movement of the knee and how different trim lines or joint placements (too high/too low) result in pressure points and a poor fit. The problem based learning exercises that round out the module require the student to apply what they have learned in the first three modules. Students can move from one module to the next as they feel ready and can return to any previous module to review material.

Conclusion

The development of the learning module for the knee and knee orthotics on the NGRAIN platform resulted in a valuable addition to the technology assisted learning tools available to BCIT students. The resulting real-time 3-D simulations provide a visual, interactive element that complements existing curriculum and promises to improve learning rates and retention. The result, combining high quality anatomical animations with technical componentry, is easy to use by both instructors and students. Having already successfully developed and implemented a video based educational and clinical software for functional gait analysis in the BCIT prosthetics and orthotics department – this project continues BCIT's work in developing highly specialized educational tools for prosthetics and orthotics. It is anticipated that learning modules for other P&O applications, such as prosthetic alignment, will be developed in the future.

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Image: screenshot 1_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg39649

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3568-665]

Prosthetics & Orthotics Education and Research in the United Kingdom – The University of Salford's Newly Developed and Validated Honours Degree Program

Author
Twiste, Martin (Salford UK) | Dr.

Coauthors
Dr. Martin Twiste (PhD), Mr. John Head (BSc)

Abstract
Significant changes affecting p&o education and research have recently occurred in the UK. The University of Salford honours degree programme has been reviewed and restructured to reflect these changes in practice. The Health Professions Council commended the progr. team for consultation/preparation

Introduction
The current prosthetics and orthotics honours degree programme at the University of Salford(England) is being replaced with a new programme that will commence in September 2010. This new programme will be modernised and improved in line with numerous recommendations that emerged from 3 years of consultation and discussion with internal and external stakeholders.
The whole process of designing the new programme commenced following the 2005 review by the Quality Assurance Agency for Higher Education (QAA)1. They recommended implementing integrated placements throughout the programme, rather than at the final level of study as is currently the case, and aligning the new programme with other Allied Health Professions (AHP) programmes in England, Northern Ireland and Wales

Methods
To improve the progr., a steering group was set up, which consisted of representatives from the British Association of Prosthetists and Orthotists, National Health Service, clinical p&o, Strategic Health Authority, University of Salford academics. In addition to following QAA recommendations, the group wanted the progr. team to investigate the feasibility of a condensed, 3-year progr. that aligned with other, similar AHP programmes in England, Northern Ireland and Wales. Due to QAA recommendations and the advice by the group, a consultation process was initiated, which, in addition to the views of the group, also took into consideration the views of a number of stakeholders within various focus groups, such as p&o users, current and former students and placement educators. Information gathered was then summarised within a detailed consultation document, which precisely outlined the various, feasible models for a new progr. and distributed to BAPO, placement educators and other stakehol

Results
The group's decision for the new progr. structure was based on the QAA and consultation process recommendations. The outcome was that the new progr. should have integrated placements at each level and be condensed from 4 to 3 years. Regarding placements, integrating these throughout the programme will allow students, right from the beginning of their learning journey, to consolidate and apply the theories taught at university. This early and repeated exposure to real-life clinical settings improves the alignment of

theory with practice. It will therefore enable deep learning and allow students to undertake any placement with a knowledge base that expands vastly and rapidly and is appropriate for each relevant level of study. Condensing the progr. not only means that teaching hours per week will be increased, but that a greater focus will be on core material and less on peripheral subjects, thus emphasising more commonly practiced areas. The shortened progr. duration, and hence alignment with other AHP progr. in England, Northern Ireland and Wales, will reduce student debt, and is likely to attract more prospective applicants and therefore to improve the standard of entry and potential capabilities of future p&o. All progr. changes needed internal approval from the University of Salford's faculty and school 'Teaching&Learning' committees. Finally, external approval was required from the HPC, the regulator to protect the public due to standards for health profess. 2,3 who comme

Conclusion

Design of an AHP progr. can only succeed if consultation takes place with all stakeholders involved. It is essential that the progr. is structured to enable deep learning4,5. A very effective way of facilitating this is through integration of placements at all levels, which is only possible by carrying out appropriate assessments of placement facilities and by producing documentation that helps placement providers to facilitate the placement experience and allow an accurate record of student assessment. The content within the progr. must be weighted appropriately to reflect current practices, and investment is required in resources such as gait laboratories, CADCAM suites, anatomy rooms, PC equipment and well furbished libraries to maximise student learning. Finally, the University of Salford progr. team is grateful to those professionals who have helped and continue to help, with the delivery of the p&o progr. and fully anticipate that the new progr. will improve of education p&o.

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Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3077-275]

Upgrading Education in South East Europe on ISPO Cat.II Level for Experienced Orthopedic Technicians on the Job

Author
Schlierf, Christian (Nürnberg DE)
Human Study e.V. - Balkan Program

Coauthors
Schlierf E, Husanovic E, Schwartzkopff H

Abstract
In order to improve the quality of orthotic and prosthetic services, medical health professionals and technicians in the South East Europe region require additional comprehensive professional training which has the potential for individual professional international recognition.

Introduction
In cooperation with the Don Bosco University (UDB) and the International Society for Prosthetics and Orthotics (ISPO), Human Study e.V. (HS), a non-governmental, not-for-profit organization proposes the implementation of a qualified orthotic and prosthetic educational program in the Balkans.
The 30 month distance learning educational program is an upgrading of education directed to practitioners who have not had a formal education in the field, but have a minimum of three years prior practical experience in the orthotic and prosthetic work.

Methods
The training includes five educational modules / semester covering the important areas of orthotic and prosthetic sciences. The Distance Learning Program was officially recognized as qualified orthotic and prosthetic education on the ISPO Category II level in November 2004.
The delivery model combines several tools to deliver the educational content to the students, including: the Internet platform, videos, CD/DVD's, clinical case presentations, discussion forums, and tutoring systems. Practical and theoretical evaluation seminars are conducted after each module.
The initiative of the orthotic-prosthetic distance learning program is based on the experiences which the University of Don Bosco has developed in the field of formal orthotic-prosthetic education and training and the ISPO as the international body is involved to evaluate the program's effective quality approach and outcomes.

Results
The expected result is not only to qualify the P&O technicians that are already on the job, but to generate a critical mass of professionals that covers the service provision in the region. Additionally, through the Training of the Trainer component, future teaching capacities are build in order to facilitate the continuation of the program on local means

Conclusion
The program proves the effectiveness and efficiency of the Distance Learning Approach and should serve as a role model for the upgrading eduction of technicians that are already on the job but have never received a formal education.

References
The Program is supported by Human Study.e.V., ISPO, Don Bosco University, Handicap International and the International Trust Fund

Image: WS Mod II Beo- educator William Neumann explaining orthotic principles_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg37349

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3246-427]

University Education in Prothetics and Orthotics

Author
Anderson, Sarah (Kew AU)
LaTrobe University - Prosthetics and Orthotics

Abstract
Education in Prosthetics and Orthotics (P&O) is a relatively new health science with training for the profession changing from an apprenticeship to a University graduate degree in a relatively short period of time (Hughes, J. 1992).

Introduction
As a result of this rapid change education in P&O has become an exceptionally varied process around the world. At present a variety of levels of education exist as a result of differences in several areas, e.g., entry education requirements, availability of resources and level of development in the country (Hughes, J.1992). The Dame Joyce Daws Churchill Fellowship provided support for the author to undertake site visits to a number of educational institutions around the world. These visits provided scope for the detailed examination of education programs with an aim to define ways to improve and expand the curriculum of the National Centre for Prosthetics and Orthotics (NCPO). Improved understanding of global teaching structures will better meet the requirements of both NCPO students and facilitate their graduation as safe, competent practitioners for the Australian Health Care system.

Methods
The impetus for this research was the curriculum review of the NCPO combined with the University's directive for the NCPO to increase student numbers to meet the university requirements, the current and predicated shortfall of allied health professionals in Australia over the coming years (AHPA 2008).
During the Fellowship, globally recognized P&O educational institutions were visited including; Hong Kong Polytechnic University; Federal School of Orthopaedics Technology (BUFA) Germany; Jonkoping University Sweden; University of Strathclyde Scotland; University of Salford Great Britain; Northwestern University and the Georgia Institute of Technology, America.
A number of common issues and concerns were highlighted by staff from the programs visited, including: limited fundingthe required high ration of staff to students, small course numbers, development of new teaching mediums, access to current medical technologies and the need for P&O graduates with higher level degrees.

Results
The most positive finding from this Fellowship was the understanding that the current course provided at the NCPO is already of a very high standard, comparable with other leading global institutions. There are areas in the course that can be improved and it is important with increasing student numbers that these high standards are not compromised.
Many schools are using higher student numbers and international students to boost funding, along with approaching government and health departments for additional funding. A number of health departments fund aspects of the courses as the need for P&O in the workplace is high, in Australia, there will be a significant shortage of Allied Health including P&Os in the next 10 to 15 years (AHPA 2008).

Conclusion

In comparison the standard of education delivered in Australia at the NCPO is in line with global institutions. The NCPO faces similar challenged to teaching the program and will aim to develop improved methods aimed to meet the needs of higher student numbers. The NCPO's standing as an international educator ensures the continuing ability to attract students whilst delivering a sound, scientifically based curriculum.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg41510

Session: Open Forum 2
Tuesday 2010/05/11 | 17:00 - 18:30

Congress Lecture [3395-570]

A New Era in Prothetics and Orthotics Education at La Trobe University

Author
English, Rowan (AU)
La Trobe University - National Centre for Prosthetics and Orthotics

Coauthors
Swerissen H

Abstract
Responding to increasing health care complexity in Australia, La Trobe University has introduced an innovative curriculum incorporating interprofessional education and Enquiry-Based Learning aimed at preparing graduates for the dynamic and challenging field of prosthetics and orthotics.

Introduction
Graduates of the first tertiary P&O course established in Australia in 1976 faced a very different health care system than those graduating today. In the developed world people are living longer and more are living with disability. This has a direct impact on the demand for allied health professionals and the pressure to supply adequate numbers of quality graduates to the industry is high. In addition a shift to the provision of health care in environments other than hospitals calls for P&Os that can function competently both autonomously and within a multi-disciplinary context. The team at NCPO identified three key issues related to the traditional P&O course offered at La Trobe University in that it: failed to produce sufficient graduates for the Australian workforce; did not facilitate flexible pathways from other discipline studies; and provided little opportunity for students to develop multidisciplinary teamwork skills due to the lack of interprofessional learning opportunities.

Methods
To address the issues identified above the Faculty of Health Sciences at La Trobe developed a new curriculum model that has been implemented across the faculty. It comprises a four year program of study leading to a Bachelor of Health Sciences/Master of Clinical Prosthetics and Orthotics. The model includes a common first year and has been implemented across all allied health disciplines within the faculty, including P&O. Strategies are in place to assist students in developing discipline-specific awareness in this first year. The subjects are taken by all students in the faculty in a mixed mode. Subsequent years build on this foundation year and include more P&O specific content. The primary teaching / learning model for the course is Enquiry Based Learning (EBL). Pathway opportunities are also enhanced with the Graduate Entry Master's (GEM) program, facilitating entry of graduates from related fields, and upgrade programs for existing P&O professionals.

Results
The first intake for the new course took place in 2009, with these students scheduled to complete their degree in 2012. Initial student and staff feedback after the first semester of the new curriculum is positive. Students enjoy the interprofessional aspect of the first year of the program in that it broadens their understanding of other health disciplines and their roles within the modern health care context. In addition, the EBL model appears to facilitate the development of teamwork skills as students work

together closely in multi-disciplinary groups. Conversely, the NCPO found that one of the challenges of interprofessional education is finding the balance between facilitating interprofessional relationships and fostering a student's own sense of identity with their chosen discipline. Adjustments were made at the NCPO in semester two of the program to assist in addressing this issue. The NCPO also believes that early results indicate that the student's capacity to work autonomously is strengthened through the development of critical thinking and problem solving skills in the application of the EBL model.

Conclusion

The innovative curriculum model established at La Trobe University has provided positive results in the implementation of the first year of the program. The interprofessional nature of the program, combined with the application of EBL model, is assisting in developing graduates with attributes that will ensure that students are 'practice ready' at the completion of the degree and equipped with the knowledge and skills to meet the future demands of the profession. The NCPO at La Trobe is committed to ongoing evaluation and modification of the curriculum to ensure optimum graduate outcomes. It is also hoped that improved pathways will attract high quality graduates from other disciplines and assist in meeting the demand for P&Os in Australia.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg346626/cg43968

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3814-None]

Quantifying Trans-femoral Socket Fit

Session Chair
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Session Chair
Drerup, Burkhard (Münster DE) | Prof. Dr.
Klinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987

Advanced Instructional Course: Quantifying Trans-femoral Socket Fit
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3818-748]

The Use of Ultrasound as a Means of Quantifying Trans-femoral Socket Fit

Author
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Coauthors
K.D.Murray, P. Convery

Abstract
This instructional course will present current research methods used to quantify trans-femoral socket fit. Engineering principles and current research will be presented to enhance an understanding of ‘what is a successful socket fit’.

Introduction
A method of visualising and measuring the relative movement of the residual femur within the transfemoral socket during gait may assist in a more scientific analysis of socket fit and ultimately a means of verifying the improvement of new socket designs.
The femoral motion patterns during gait of 3 trans-femoral amputees fitted with total contact quadrilateral sockets were analysed using an ultrasound scanner to determine repeatability of individual patterns and similarity between patterns.

Methods
Two ultrasound transducers were mounted on the lateral socket wall of the transfemoral prostheses. Femoral motion can be monitored using diagnostic ultrasound when the relative orientation of the two ultrasound transducers to the femur is known at any instant of the gait cycle. The average ultrasound data for each transducer was combined to calculate the femoral motion pattern.

Results
Initial pilot studies established that the average error while using ultrasound to measure femoral motion during gait was of the order of 0.5°.
Figures 1 and 2 below indicate that all 3 subjects exhibited similar femoral motion patterns. Relative to the lateral wall of the socket the residual femur follows a typical and repeatable motion pattern during the gait.

Conclusion
This study, initially presented in 2004, was the first known method of measuring and monitoring residual femoral motion during gait within the transfemoral socket. The results indicated similar motion patterns for all 3 subjects confirming that a typical femoral motion pattern existed for amputees fitted with quadrilateral sockets. Future research will be undertaken using image processing to automate the technique to capture and track the ultrasound image.

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Image: Murray_748.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987/cg528338

Advanced Instructional Course: Quantifying Trans-femoral Socket Fit
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3819-791]

Appreciation of Prosthetic Fitting from Basic Engineering Principles

Author
Buis, Arjan (Glasgow GB) | Dr.
NCPO University of Strathclyde

Abstract
Evidence based practice is important in providing the best possible care and to enhance quality of life. However, there is no consensus about what constitutes a good socket fit.
Prosthetics and biology may be too complicated to allow identification and quantification of all relevant parameters. Nevertheless, we must endeavour to improve our understanding of the mechanisms and fundamentals of socket fit if we are to contribute to product quality.
This presentation will address three main areas of interest in socket design and illustrate the arguments with reference to trans-tibial prosthetics. The areas of interest are
• Definition of a good socket fit.
• Socket fit and related tissue mechanics.
• Implementation of a good fit.
The load transmission systems which apply may be optimised with reference to elementary Physics, Mechanics, Fluid Mechanics and Strength of Materials and will be discussed. These include:
1. Elastic, unidirectional compressions of thin layers of soft tissues,
2. Quasi-hydrost

Introduction
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• Definition of a good socket fit.
• Socket fit and related tissue mechanics.
• Implementation of a good fit.
The load transmission systems which apply may be optimised with reference to elementary Physics, Mechanics, Fluid Mechanics and Strength of Materials and will be discussed. These include:
1. Elastic, unidirectional compressions of thin layers of soft tissues,
2. Quasi-hydrostatics and tissue tension,
3. Tissue shear (over-stretching of fibres),
4. Energy absorbing transmission.
5. Muscular activity.
The philosophy of an “ideal” pressure distribution and the stiffness of the coupling will be clarified using the implementation tools of surface and volume matching.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987/cg528535

Advanced Instructional Course: Quantifying Trans-femoral Socket Fit
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3817-776]

Sonographic Investigations of the Movements of the Residual Femur in the Frontal and Sagittal Plane in Different Sockets

Author
Balcaitis, Rolanas (Münster DE) | Dipl. Ing. (FH)
Klinische Prüfstelle für orthopädische Hilfsmittel - Universitätsklinikum Münster, Klinik und Poliklinik Technische Orthopädie

Coauthors
B. Drerup, L. Linkemeyer, H. Wetz

Introduction
Restoration of function after transfemoral amputation is aimed in the care of the patients. Prostheses for the above knee amputees are designed to transmit axial forces to support the body and to transmit horizontal forces for movement control. In the provision of above knee amputees the quadrilateral and the ischial containment socket are most frequently used.
To compare the biomechanical properties of these socket types the movement of the residual femur in the socket in both anterior-posterior and in medial-lateral direction are of major importance.
It is assumed, that measurement of the femur movements during walking provides valuable biomechanical insight in understanding the function of the socket. Therefore in one patient ultrasound scanning of the femur during walking has been performed and analysed using a quadrilateral and ischial containment socket (Fig. 1).

Methods
One 70 years old patient after a traumatic transfemoral amputation has been provided with the quadrilateral and ischial containment sockets (Fig.2). Both were without liner, from Plexiglas material of about 4mm thickness. A 5MHz transducer for ultrasound imaging was attached to the socket to scan trough the Plexiglas material. Ultrasound imaging was performed with a Siemens SONOLINE device.
The combined ultrasound / 3D-Vicon / Kistler gait analysis was repeatedly performed under modified conditions:
1. quadrilateral and ischial containment sockets
2. with ultrasound measurement in medial-lateral and anterior-posterior directions
3. in two transversal planes (Fig.3)

Results
For both sockets the different patterns of movement of the residual femur in the socket could be followed. It was possible to reconstruct the movements of the femur in the sagittal and frontal plane as a function of gait phase, the forces applied and the resulting moments.

Conclusion
Based on the measurements it is shown that the amplitude of the displacement and rotation of the femur in the sagittal and frontal planes of both sockets have approximately the same magnitude. However, the maximum movements occurred at different phases of gait cycle.

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Image: US-Untersuchung des Oberschenkels-4_776.bmp (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987/cg528141

Advanced Instructional Course: Quantifying Trans-femoral Socket Fit
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3816-750]

Intra-individual Comparison of Differerent Socket Designs: Biomechanical and Prosthetic Aspects

Author
Tiemeyer, Kerstin (Münster DE) | Dipl. Ing
Universitätsklinikum Münster, Klinik und Poliklinik Technische Orthopädie - Klinische Prüfstelle für orthopädische Hilfsmittel

Coauthors
L. Linkemeyer, J. Wühr, M. Rümmler, B. Drerup, HH. Wetz

Introduction
For patients with transfemoral amputation there are mainly two types of prosthetic sockets: the quadrilateral socket and the ischial containment socket. The requirements for the sockets are equal for both types: support, stability, suspension, comfort and cosmesis. In the literature these socket types are discussed controversially. It is e.g. supposed that the quadrilateral socket shows a more pronounced vertical displacement in contrast to the ischial containment socket. At present there are only few scientific studies regarding socket designs.
Marlo Ortiz, the promoter of the ramus containment socket (Marlo Anatomical Socket) considers this socket type as a consequent further development of the ischial containment socket, providing enlarged mobility range in the hip joint, improved steering properties and excellent comfort in various sitting positions. Therefore the question is posed, whether these improvements can be assessed and which patients functionally benefit from this socket.

Methods
In an intra-individual study 6 patients were provided both with an ischial containment socket and with a quadrilateral socket. In a subsequent study with again 6 patients each patient has been provisioned both with a ramus containment socket and an ischial containment socket. After a medical examination by an orthopaedic surgeon, biomechanical measurements were taken using
• optimum fitting of the sockets was supervised by a certified prosthetist-orthotist using the L.A.S.A.R. Posture
• the opto-electronic gait analysis system (Vicon V460) in combination with 2 Kistler force plates to obtain kinetic and kinematic data
• the GAITRite for the assessment of gait parameters in special tasks
• pressure measurement in the socket with the pliance system to obtain pressure on the femoral triangle in different load situations
• 3-D measurement of the back by rasterstereography, to obtain angle-measures for the pelvic tilt, pelvic inclination and pelvic torsion.

Results
Ischial containment sockets exhibited a significantly reduced vertical displacement. Step length and stance time showed improved balance with ischial containment socket. Moreover pelvic inclination was more physiological and ventral pressure on the femoral triangle was lower with the ischial containment socket.
In the subsequent study the manufacturing of the ischial containment sockets and the ramus containment sockets has been completed.

Clinical and biomechanical tests have been completed for the ischial containment sockets, while the test with the MAS sockets are still in progress. As a trend it comes out, that especially for the "challenging stump" satisfying results can be obtained with MAS sockets, whereas in easily provisioned stumps the profit was less apparent.

Conclusion

Ischial containment sockets exhibit considerable benefit for transfemoral amputees under different aspects. No aspect was found, where the quadrilateral socket was superior. Conclusion to the MAS will be available at conference time.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987/cg527943

Advanced Instructional Course: Quantifying Trans-femoral Socket Fit
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3815-907]

Intra-individual Comparison of Different Socket Types: the Clinical Aspects

Author
Schüling, Stefan (Münster DE) | Dr. med.
Universitätsklinikum Münster, Klinik und Poliklinik Technische Orthopädie - Klinische Prüfstelle für orthopädische Hilfsmittel

Introduction
After transfemoral amputation the prosthetic provision of the stump aims at the restoration of the mobility of the patient. At the same time the integrity of the outer appearance of the patient is to be re-established. Forces involved in standing and walking must be transferred safely and comfortably between prosthesis and residuum. This is established by the socket acting as the interface. At present most prosthetic sockets belong either to the quadrilateral socket (Quad) type or to the ischial containment socket (ICS) type. The MAS socket may be seen as an enhancement of the ICS socket type. Quad and ICS sockets mainly differ by the design of the entrance plane. However, the design has implications to the comfort and the harmony of gait.
There are few objective analyses available of the effects of either socket design on transfemoral amputee gait. In this paper an intraindividual comparison of Quad, ICS and MAS sockets with and without liners is described.

Methods
In an intra-individual study 6 patients were studied with different prostheses. In all prostheses the same accustomed prosthetic knee was integrated. Only the sockets were exchanged in intervals of several weeks. Sockets were of the Quad-, ICS- or MAS type. Some of the patients tested the sockets with liners, others without liners and some with and without liners. After fabrication, fitting and aligning the sockets the patients used their prostheses for at least 4 weeks before clinical and biomechanical examination started. Clinical examination comprised – assesment of the condition of the amputee, - observation of walking and handling different tasks, – daily life management of the prosthesis and - a questionnaire concerning the experience and observations with the socket in the past weeks.

Results
Comparing the Quad and ICS socket reveals higher over-all acceptance for the ICS socket. For the sitting position, however, the Quad socket receives higher acceptance.
As the analysis regarding the MAS is still under progress, no concluding statement can be made. However, there are indications, that the so called "demanding stump" may be best provisioned with the MAS socket, whereas for a stump in a standard condition an ICS socket may be sufficient.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg524987/cg527451

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3529-None]

Orthotics for Polio and Post-Polio Syndrome

Session Chair
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Abstract
This basic instructional course focuses on when to apply lower extremity orthotics in post-polio syndrome patients; for which clinical indications and for what functional deficits. The biomechanical effects of the main types of AFO's and KAFO's will be discussed and the manufacturing of orthotics according to biomechanical principles using carbon composites. The course will be based on a case oriented approach and illustrated with 3D gait analysis data.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg56169

Basic Instructional Course: Orthotics for Polio and Post-Polio Syndrome
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3530-None]

Functional Analysis Based Prescription of Orthotics in Post-Polio Syndrome

Author
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg56169/cg56255

Basic Instructional Course: Orthotics for Polio and Post-Polio Syndrome
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3531-None]

Designing & Manufacturing Light Weight Full Contact Carbon Orthotics for Post-Polio Syndrome

Author
Noppe, Kees (Noordwijkerhout NL)
Noppe OIM

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg56169/cg56316

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3572-None]

Decision Making in Fracture Care in Relation to Mobilisation

Session Chair
Hemmen, Bea (Hoensbroek NL) | MD PhD
Adelante Zorggroep Hoensbroeck Revalidatie Centrum

Abstract
Polytrauma patients have serious injuries of the locomotor system, often combined with damage to vital organs such as the brain and lungs. After surgery, a long rehabilitation period is needed that places high demands on the patient, the surgeon and the rehabilitation physician, who all need to work closely with physiotherapists, nursing staff and, to a lesser extent, orthotists.
The treatment aim for polytrauma patients is not only fixation of fractures, but also functional after-treatment to allow muscles and joints to be exercised. To what degree this can be generalized is not clear and is often subject to debate - sometimes even controversy. In this instructional course, the speakers share their knowledge in this field by way of lectures and a workshop.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70039

Basic Instructional Course: Decision Making in Fracture Care in Relation to Mobilisation
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3573-864]

Bone Healing

Author
Brink, Peter (Maastricht NL) | Prof. Dr.
Maastricht University Medical Centre

Introduction
In this fascinating lecture, biological, biomechanical and all other aspects of bone healing will be discussed in a clear and unambiguous way. We will then look at the implications for fracture treatment.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70039/cg70195

Basic Instructional Course: Decision Making in Fracture Care in Relation to Mobilisation
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3574-865]

Different Ways of Treating Fractures in Relation to Axial Load Capacity

Author
Verbruggen, Jan (Maastricht NL) | Dr.
Maastricht University Medical Centre

Introduction
Bone fractures can be treated both operatively and non-operatively. The speaker will discuss the former from his own extensive surgical experience. In the course of this, he will question the way routine postoperative schemes for mobilisation are made.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70039/cg70238

Basic Instructional Course: Decision Making in Fracture Care in Relation to Mobilisation
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3575-866]

Axial Load Capacity and Allowing Early Functional After-Treatment in Relation to Post-Operative Physiotherapy

Author
Windolf, Markus (Davos CH) | Dipl. Ing.
AO Research Institute Davos

Introduction

Post operative after treatment and degree of load bearing of the patient is essential for a good functional outcome and also for preventing complications. In osteoporotic bone stock, fixation failures are likely to occur especially in highly loaded regions like the proximal femur or the proximal humerus. The magnitude of internal loads resulting from patient routine activities is not intuitive to quantify and seems underestimated in many cases.

Methods

The lecture presents basic biomechanical principles of highly loaded sites of the human musculoskeletal system like hip, knee, shoulder, elbow and wrist and quantifies the occurring loads in relation to body activity. Two general approaches for assessing these data are briefly introduced. Besides instrumented implants with telemetric data transmission, computational methods based on inverse dynamics are on the uprise providing enhanced insight to internal body forces. Finally, consequences of internal loading on the osteosynthetic fixation and hence, on the clinical after-treatment are discussed.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70039/cg70281

Basic Instructional Course: Decision Making in Fracture Care in Relation to Mobilisation
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3576-867]

Early Rehabilitation of Polytrauma Patients

Author
Hemmen, Bea (Hoensbroek NL) | MD PhD
Adelante Zorggroep Hoensbroeck Revalidatie Centrum

Introduction
This lecture will cover in more depth the close collaboration between Traumatology and rehabilitation medicine which is needed for the optimal treatment of polytrauma patients. This integrated, multidisciplinary treatment of trauma patients is central to the "fast track" that has been developed in the southern Netherlands. After four years, the clinical results of this are promising and a cost-effectiveness study was begun in 2008.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70039/cg70324

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3630-None]

Upper Limb Prosthetics

Session Chair
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Session Chair
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Abstract
The course covers the problems of fitting prosthetic upper limbs, the choice of components and some the technical aspects of prosthetic upper limbs. There is also a selection on the latest developments.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644

Advanced Instructional Course: Upper Limb Prosthetics
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3631-697]

Basic Structure and Function of the Human Hand

Author
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Author
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Abstract
This paper covers basic anatomy, sensory functions and movements of the joints of the digits and the wrist - Included are the different types of grip, appearance and cosmesis, the use of the hand for support (changing positions) and as an organ of expression.

Introduction
The human hand is a complex organ that enables the manipulation of objects in the environment whether they be minute or large and heavy with precision and security. An understanding of the basic anatomy of the hand is vital for the prosthetic technician.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644/cg124985

Advanced Instructional Course: Upper Limb Prosthetics
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3632-698]

The Prescription (Choosing a Limb)

Author
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Author
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Abstract
This paper covers assessments of the level of amputation, the condition of the stump, the level of activity of the amputee and a consideration of special requirements. It includes discussions on different power sources (passive to myoelectric) and choosing a terminal device.

Introduction
Each amputee has his/her expectations, demands and abilities. And assessment of each of these is an essential initial step in providing a prosthesis.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644/cg125046

Advanced Instructional Course: Upper Limb Prosthetics
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3633-699]

Matching the Prosthesis to the Amputee

Author
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Author
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Abstract
This paper covers an assessment of the requirements of the amputee (weight, cosmesis, durability & etc), the prosthetists requirements (materials, components, strength, ease of working/manufacture and ease of alignment and adjustment) and the advantages and disadvantages of the different materials that are available. It also includes socket designs, suspension systems, harnesse

Introduction
Summary: and a detailed demonstration of the range of prosthetic joints (shoulders, elbows and wrists) and terminal devices (including customised devices for sports, etc) that are available.
Introduction: While some amputees attend their first clinic with no idea of what is available in the way of prosthetic components others arrive with a list of the latest technology gleaned usually from the internet. The prosthetic technician must have a knowledge of the specifications and functional parameters of the materials and ready-made components that are available.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644/cg125168

Advanced Instructional Course: Upper Limb Prosthetics
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3634-700]

Advances in Myoelectrics

Author
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Author
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Abstract
This paper covers basic physiology of the nerve/muscle unit, electromyography and the components of a basic myoelectric prosthesis. It also includes a comparison of myoelectric versus body-powered prostheses, explaining the advantages and disadvantages of each system. Also included is an explanation of the control of myoelectric prostheses, battery durability and drain, signal processing and a section on targeted reinnervation.

Introduction
In an attempt to reproduce as life-like a reproduction of the human hand, the use of microchip technology has been utilised in a number of ways. Myoelectric upper limbs seem to be the natural progression from the mechanically operated limbs of the past.

Conclusion
The advances in myoelectric limbs in recent years has resulted in devices that challenge the power of the human mind to control them.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644/cg125230

Advanced Instructional Course: Upper Limb Prosthetics
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3635-701]

Study of Myoelectric Limbs in New Zealand

Author
Thurston, Alan (Wellington NZ) | Prof.
Wellington School of Medicine and Health Sciences - New Zealand Artificial Limb Board

Author
Beasley, Wyn (Wellington NZ)
New Zealand Artificial Board

Introduction
Myoelectric limbs have been prescribed for, and fitted on a small number of upper limb amputees in New Zealand over a number of years. The acceptance or rejection of these devices by amputees was the subject of a retrospective study.

Methods
A detailed questionnaire was mailed to amputees identified from the New Zealand Artificial Limb Centres databases as having been fitted with a myoelectric limb at any time in the past. The results were analysed and collated.

Results
Of 16 amputees only 5 had become confirmed, long-term wearers of myoelectric limbs. The most common reasons for rejection included finding a mechanical arm easier to use, the need for frequent and lengthy repairs, weight, unreliability and cosmesis.

Conclusion
Myoelectric limbs are not universally accepted by amputees and, despite considerable advances in recent years a number of concerns have yet to be addressed before they become a standard issue item for upper limb amputees.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg124644/cg125291

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3737-None]

Lower Limb Orthoses

Session Chair
Schulte, John (Chattanooga US)
Fillauer Companies

Session Chair
Owen, Elaine (Bangor UK)
North West Wales NHS Trust - Child Development Centre

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg314416

Advanced Instructional Course: Lower Limb Orthoses
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3738-854]

The Utilization of Dynamic Orthoses in Your Practice

Author
Schulte, John (Chattanooga US)
Fillauer Companies

Introduction
The attendee will, at the conclusion of this presentation benefit from the data shown that Lower Extremity joint CONTROL rather than immobilization significantly increases range of motion, circulation and bone density, while decreasing contractures in the lower limb Orthosis wearer. The previous prescription parameters of controlling joint / limb instability through rigidity, has changed since the development and utilization of dynamic orthotic knee joints, multi axis control Orthoses and user accepted lightweight materials. The devices are indicated for Orthoses wearers of all ages. This Multi-media Best Practices interactive presentation utilizes lecture, slides and printed materials.
Learning Outcomes:
1) Clinical uses of Patient Candidates of various innovative and dynamic Orthosis
2) Informed decision making through knowledge presented

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg314416/cg315056

Advanced Instructional Course: Lower Limb Orthoses
Wednesday 2010/05/12 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3812-813]

The Importance of Being Earnest About Shank Kinematics, Especially When Using AFOs

Author
Owen, Elaine (Bangor UK)
North West Wales NHS Trust - Child Development Centre

Introduction
The presentation will include:
• Important observations of normal and pathological standing and gait biomechanics, challenging some traditional beliefs; the interrelationship between segment kinematics, joint kinematics and kinetics, and their relationship to orthotic design, alignment and tuning
• A proposal for four rather than three rockers in gait
• A simple categorisation of pathological gait based on shank segment kinematic abnormality
• An algorithm for the designing, aligning and tuning of AFO Footwear Combinations (AFOFC)
• An algorithm for determining the sagittal angle of the ankle in an AFO
• Results of research on; alignment, Shank to Vertical Angle, of tuned AFOFCs; Point Loading Rockers
• Video examples of the principles of the algorithms in practice, using the ORLAU Transportable Video Vector Generator Gait Laboratory

References
Handouts will be provided.
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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3785-933]

Neuro-orthopaedics with a Focus on Orthopaedic Technology

Keynote Author
Döderlein, Leonhard (Aschau DE) | Dr. med.
Orthopädische Kinderklinik Aschau

Abstract
Orthopaedic technology has always been one of the essential pillars of therapy in neuro-orthopaedics given that most functional deficits cannot be fully repaired by surgery alone. In individual cases, maximum benefit for the patient can be gained by combining the indicated surgical interventions with orthotic and prosthetic treatments. To date, prosthetic and orthotic treatment has focused on supports and braces to externally guide the joints that muscles cannot stabilise. New developments offer an opportunity to replace these muscles, at least partially. Patients whose ortheses are equipped with dynamic control not only experience an important increase in aesthetics but also gain functionality. Naturally, these treatments focus on lower limb problems.

Introduction
Dynamic treatment methods, however, are increasingly being taken into account for upper limbs and spinal orthoses as well. Close collaboration between the fields of orthopaedic technology, operative orthopaedics, motion analysis and physical therapy is an absolute prerequisite for these novel developments.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3669-None]

Lower Limb Prosthetics - Functional Knee Components 1

Session Chair
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Session Chair
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

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Session: Lower Limb Prosthetics - Functional Knee Components 1
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2942-140]

A Novel Approach to Swing Release and Adaptive Swing Control in Microprocessor Controlled Knees

Author
Seyr, Martin (AT) | Dipl.-Ing. Dr.
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Kampas PA, van Vliet JW

Abstract
A new control method for a microprocessor controlled knee has been developed that 1. allows robust detection of swing release, 2. minimizes initial swing resistance, 3. adapts swing control in real-time for various cadences.

Introduction
Swing release is a crucial situation in microprocessor knee control since it brings the wearer into a fundamentally unsafe situation. State of the art microprocessor controlled knees mainly rely on bending moments that have to pass thresholds to detect swing. However, these moments are dependent on the wearers weight and on the tilting of the ground reaction force vector. Therefore swing release detection might be influenced by additional weight carried by the wearer or by the variability of the gait pattern.
Swing control should provide as little resistance as possible while it still has to ensure that the maximal knee angle is controlled according to walking speed, possibly independent of changing shoes or clothes.

Methods
An instrumented prosthesis is used to give inputs to a state machine controlling the knee resistance. Swing release is computed as a geometric requirement depending on the position of the force vector and not on the bending moment as it is state of the art. Various additional criteria are introduced to ensure robust swing release detection, e.g. to inhibit swing release when walking backwards.
Swing angle control is provided by a novel control surface that controls the knee resistance depending on the knee angle and knee angular velocity. This surface is adaptively parametrized to ensure constant maximum swing angle, accommodating changing conditions e.g. due to changing shoes or clothes.

Results
A microcontrolled prosthesis has been developed that incorporates a robust detection of swing phase to a large extent independent of the weight of the wearer and gait variabilities. Swing is inhibited while the wearer is walking backwards. The adaptive swing control makes swing easy, in particular at slow speeds while providing tight swing control at higher speeds.

Conclusion
Swing release is to a large extent independent of the wearers weight and gait variabilities. The novel swing control algorithm allows easy swing initiation and tight swing control adaptive to changing conditions like the shoes or clothes of the wearer. Swing is inhibited when the wearer is walking backwards.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224865/cg34773

Session: Lower Limb Prosthetics - Functional Knee Components 1
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3354-529]

Functional Added-value of Microprocessor-controlled Knee Koints on Daily Life Performance in Medicare Functional Classification Level-2 Amputees

Author
Theeven, Patrick (Hoensbroek NL) | MSc
Adelante - Centre of Expertise in Rehabilitation

Coauthors
Hemmen B, Rings F, Meys G, Brink P, Seelen H

Abstract
In this clinical study the level of functional performance of transfemoral amputees during daily activities was evaluated for 3 types of prosthetic knee joints. The majority of this heterogeneous group of prosthesis users seems to benefit from a microprocessor-controlled knee joint in daily life.

Introduction
Amputation of a lower limb changes a person's life and diminishes the ability to perform common daily activities. In case of transfemoral amputation, the type of knee joint fitted to the leg prosthesis influences the level to which functional ability is restored. Each prosthetic knee joint has specific features that may influence patient's individual performance in daily life. To date, objective evaluation of leg prosthesis usage mainly focuses on function and impairment rather than on activity and participation. However, for patients it is more important to know which daily activities they eventually can perform after rehabilitation. More insight into the effects of different types of prostheses on daily functioning is therefore necessary. Aim of this study was to assess possible advantages or disadvantages of microprocessor-controlled knee joints on daily life performance compared to mechanically controlled knee joints in Medicare Functional Classification Level-2 (MFCL-2) amputees.

Methods
30 male and female unilateral transfemoral MFCL-2 amputees, aged 18-75 years, participated in this study. In a repeated measures double cross-over design, subjects' leg prostheses were tested with their own mechanically controlled knee joint and, in randomised order, an electronic stance and swing phase controlled knee joint (C-Leg®) and an electronic stance phase controlled knee joint (C-leg® Compact) after one week of home use on each knee joint.
A new test concept called ADAPT (Assessment of Daily Activities Performance in Transfemoral amputees) was used. The test consists of 17 standardised common daily activities, perceived by transfemoral amputees to be difficult to perform. Performance time on all activities was recorded. During 3 consecutive 1-week periods subjects wore an accelerometer (Actigraph, MTI, Pensacola, Fl.) to establish a quantitative measure of the subjects' activity level in daily life. Also, 2-minute walking tests were performed in all knee hinge conditions.

Results
The accelerometer data showed large between-subject variation, indicating that the MFCL-2 amputees are a heterogeneous population. Based on clinical observation, walking speed and activity levels subjects were sub-classified into 'low', 'intermediate' and 'high' performing MFCL-2 amputee groups.

The 17 simulated daily activities from the participation circuit were grouped into three subgroups, using principal component analysis and varimax rotation (1).
In figure 1, two typical examples of differences in performance on the ADAPT-test are presented for a ‘high’ and a ‘low’ MFCL-2 amputee using both microprocessor-controlled knee joints compared to the mechanically controlled knee joint.
In general, performance times for subjects in subclasses ‘intermediate’ and ‘high’ (75% of the research population) improved when walking with an electronically controlled knee joint for one week relative to walking with a mechanically controlled knee joint.

Conclusion
Both microprocessor-controlled knee joints may provide a benefit in daily life performance for the majority of the ‘limited community ambulators’ (MFCL-2 amputees). However, this category of prosthesis users displayed a large between-subject variability in both overall activity levels and functional performance levels. Individual testing with the ADAPT test can be used to further assess the differences in functional performance levels in daily life between an electronic stance and swing phase controlled knee joint and an electronic stance phase controlled knee joint.

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Session: Lower Limb Prosthetics - Functional Knee Components 1
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3256-437]

Potential Safety of Current Microprocessor and Non-Microprocessor Controlled Prosthetic Knees

Author
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Coauthors
Bellmann M, Schmalz T

Abstract
Knee safety was tested in 11 amputees wearing NMPC and MPC knees. The objective reason for knee stability or instability for each individual trial including the reason for knee collapse was identified. This study protocol proved to be suitable for defining the potential safety of tested knee joints.

Introduction
Safe knee function under all real-world conditions is a crucial factor in the prescription of specific prosthetic knee mechanisms. Whichever prosthetic knee joint is selected, it must permit safe locomotion under all conditions that will be encountered. In the literature, it is documented that the risk of falling of above knee amputees is higher than that of non-amputees of same age as well as that of below knee amputees1. Although many amputees have reported the subjective belief that microprocessor controlled knees, especially the C-Leg, combines increased function while walking with increased safety2,3,4, there has been published only one biomechanical pilot study to support this claim till date5.
This study was designed to identify biomechanical differences that would permit objective evaluation of relative safety in critical situations of different prosthetic knee joint designs.

Methods
In the gait laboratory, 11 experienced unilateral transfemoral amputees were tested under conditions that simulated five common real world situations: walking on even ground, abruptly stopping, abruptly sidestepping, inadvertently stepping onto an object, and tripping when the knee is extending during swing phase. Subjects had to be faced with the risk of falling unexpectedly as good as possible. Throughout all the tests, the amputees were protected from falling by a body harness that glides along a track mounted on the ceiling (Fig.1).
Kinematics and kinetics of non-microprocessor controlled knee joints based on different stance phase mechanism (brake, polycentric, hydraulic) and microprocessor controlled prosthetic knees (Otto Bock C-Leg, Össur Rheo, Blatchford Adaptive) were measured using accepted gait analysis technology (Kistler force plates, VICON system).

Results
This study protocol proved to be suitable for defining the potential safety of tested current microprocessor and non-microprocessor controlled knee joints. The results from instrumented gait analysis were shown to provide an objective reason for knee stability or instability for each individual trial including the reason for knee collapse. The amputee subjects confirmed that the gait disruption occurring under the tested conditions corresponded very closely to critical everyday situations that may lead to fall. Tripping with load

depending mechanism and polycentrics result in a significant risk of falling (Fig. 2). The same is true for stepping onto an object with a Mauch or CaTech-hydraulic (Fig. 1).

Conclusion

Safety of the prosthetic knee is of primary importance in the treatment of transfemoral amputees. Falls may lead to significant impairments in amputees' health and quality of life and treatment for this morbidity can markedly increase health care costs.

The novel study design presented here permits determination of dynamic safety – the safety the prosthetic knee joints offer during ambulation - making it possible to compare the safety potential of different prosthetic designs. To accurately determine the risk of falling caused by a prosthetic knee joint it was essential during investigations that the amputee could not anticipate the critical situation. Subjects had to be faced with the risk of falling unexpectedly as is typical of falls that occur in amputees' everyday life. This important study criterion should be fulfilled as good as possible.

Because of its biomechanical performance under high risk conditions, the C-Leg appears to be the most suitable design to prevent falls.

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Session: Lower Limb Prosthetics - Functional Knee Components 1
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3208-394]

Precision Activation and Release of Weight Activated Stance Control - a New Concept in the Control of Hydraulic Prosthetic Knees

Author
Lang, Stephen (UK)
Blatchford Products Ltd - Research and development

Coauthors
Zahedi MS, Moser D, Harris G, McCarthy JR, Ross J

Abstract
A new novel approach to hydraulic knee stance control has been developed without the need to compromise knee alignment as required for conventional SNS devices. Experimental testing has been shown to provide stability and allow optimum “knee break” timing enhancing the transition into swing phase.

Introduction
The hydraulic SNS type of knee joints have been very successful and cater for a wide range of amputees from medium to high activity levels (K2-K4) as well as enabling frail amputees to sit in a safe and comfortable fashion. Their success is due to the use of hydraulics to provide a high resistance yielding function. The primary means of release from high yield is either through the use of mechanical valve control, or electronically sensed release, triggered by the abnormal application of hyperextension moments around the knee, which can result in undesirable pathological gait deviations. Often a knee may dictate control of the amputee’s gait insofar as deliberate actions may be required for the knee to operate. We sought to develop and test a new stance control principle based on optimization and matching of the knee release to amputee voluntary control and the natural coordination of locomotion.

Methods
The key challenge is to identify a mechanism capable of responding to small changes in body weight during locomotion. Gait analysis on 4 transfemoral amputees of various weights was carried out. These amputees ranged from K2-K3. The position of ground reaction force vector in relation the knee joint and centre of mass were analysed throughout stance phase and at point of release at various cadences using several knee types. The data was used to establish a model of the mechanism required signalling release of high yield and speed of response required for de-activation. From this, the design of a weight activation mechanism, a pilot valve to release the hydraulic stance, and the knee joint structure were undertaken. Through a process of validation on amputee and verification on bench testing, the selected concept design was optimised and realised into prototypes. The outcome of the following amputee trail and verification through gait analysis of 4 amputees on level walk is reported.

Results
A microprocessor weight activation control using Force Sensing Resistors proved the operation of pilot valve to optimise the response time for releasing the high resistance yield support. Multi-bar geometry was developed to provide mechanical movement in response to weight application and translate the application of body weight into operation of the pilot valve. The swing flexion control was achieved through the same hydraulic resistance chamber using an independent valve control. An extension bias spring provided

extension assistance, the rate being controlled through a separate restrictor valve, designed to match the extension response to the amputee's gait pattern.
The data for the initial model showed min. body weight of 45 kg was required provide an 8 Nm moment around the activation pivot to activate the stance pilot valve. This induced a yielding resistance to flexion, adjustable within the range of between 0.6Nm and in excess of 75Nm in contrast to the typical 50Nm flexion moment applied during stance.
The gait analysis data showed different release timing as a percentage of stance phase when compared to the SNS type, making the new design closer to the natural gait cycle. The results obtained also show the point of release in the new design to be proportional to the applied load, in both activation and release.

Conclusion

The use of pilot valve technology has facilitated the ability to fully open a hydraulic control valve through the smallest of weight induced movements within the multi-bar activating mechanism, allowing the release point to be precisely adjusted to lie within the window required for smooth and consistent release of stance support. Results from both patient trials and quantitative comparisons show the benefits of the weight activated release mechanism in providing release from high yield stance at a precise and repeatable point of the gait cycle, requiring minimal muscular effort and enabling energy efficient gait. Another benefit being the absence of inappropriate stance release while in standing postures on uneven ground through inadvertent application of a release moment.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3681-None]

Neuroorthopaedics

Session Chair
Postema, Klaas (Groningen NL) | Prof. Dr.
University Medical Center Groningen - Rehabilitation

Session Chair
Swanepoel, Jacques (Pretoria ZA)
Tshwane University of Technology - Sport, Rehabilitation and Dental Sciences

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg232562

Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3030-228]

A Clinical Tool for Assessing and Improving Seating Positioning in Children with Quadriplegic Cerebral Palsy

Author
Swanepoel, Jacques (Pretoria ZA)
Tshwane University of Technology - Sport, Rehabilitation and Dental Sciences

Coauthors
Swanepoel JS

Abstract
A standardized clinical tool for assessing and correcting seating positioning in children with quadriplegic cerebral palsy leads to significant impact for determining and improving quality of life.

Introduction
Children with quadriplegic CP are unable to walk and thus dependant on sitting most of the time needing special devices for allowing good sitting positioning and quality of life. Conventional devices are rarely sucessful. Using GMFCS for grading motor function important aspects to be addressed by good positioning are respiratory function, diaphragmatic activity, feeding ability, management of the child, pain control and spinal alignment. Sitting in the midline positively affects feeding by improving oral and pharyngeal swallowing as relationship to nutrition . It also controls hip stability, trunk control, head control, jaw stability and eventually tongue control and lip mobility as being an important influence of correct positioning on achieving oral control for feeding . The affect on pulmonary function as implication on speech, prevention of hypoxia and pulmonary hypertention. Upper airway obstruction can be addressed while the main aspect of individualizing adaptive seating.

Methods
Three groups of twenty one patients each, measuring positioning of quadriplegic cerebral palsy patients sitting in any positioning device compared with positioning in a wheelchair compared with a special designed chair insert. All of the groups were measured for pressure tolerance related to skin breakdown on sites of pressure; measuring sitting time and comfort using Dartfish® software; measuring pain levels during sitting; measuring increased lung volume during sitting in the midline through a “cough” test; collecting non-invasive data via the Stardust II® for measuring increase diaphragm activity in sitting position and measuring increased blood oxygen levels, pulse rate and respiratory effort; evaluating spinal alignment by means of Cobb Angle approximation to spinous process angles using standard radiographic imaging. All subjects are classified by means of the Gross Motor Function Classification System (GMFCS).

Results
Preliminary findings show that using the clinical tool for assessing and improving seating positioning in children with cerebral palsy has value in determining appropriate treatment for children in need of positioning devices such as in custom chair inserts. It also adds value in evidence based practice for assisting the practitioner on determining best practice for cerebral palsy patients needing chair inserts as for the sub-group of quadriplegic cerebral palsy. Generating scientific values of measurement of vital signs such as lung capacity and diaphragm activity, airflow have influence on blood oxygen saturation by means of respiratory effort and rib cage movement allows practitioners guidelines for treatment and improvement.

Preliminary findings shows a significant impact on the importance of postural control for feeding. Sitting in the midline and postural control has direct relationship with hip stability, trunk control, head control, jaw stability and eventually tongue control and lip mobility as was earlier published. Good positioning have relevance on determining measures for optimizing upright positioning for monitoring upper airway obstruction. These patients have better urological and kidney function when sitting in the midline and reflex patterns are influenced through proprioception as balance is increased through tonic labyrinthian, neck and trunk reflexes.

Conclusion

Orthotists treating patients with CP should possess a working knowledge of the disease, sub-categories as well as biomechanics. In finding solutions on good positioning for CP patients adaptive seating should be individualized to meet the needs of each child and that appropriate use of adaptive seating can lead to improvements of body functions and structures, activity and participation.
Adaptive seating therefore should be individualized for meeting the needs of each child and that therapist should demonstrate patience for the multiple adjustments to be made over a series of visits. Using a clinical tool for assessing and improving seating positioning in children with quadriplegic cerebral palsy has a significant impact on the quality of life and health status of patients.

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Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3567-657]

Treatment of the Spastic Equinus Deformity in Cerebral Palsy Patients-is it Possible to Modify the Results by Previous Botulinum Toxin Injections?

Author
Baise, Monique (Aschau DE) | Dr. (B)
Orth. Kinderklinik Aschau

Coauthors
L.Döderlein,MD
K.Pohlig,CPO

Introduction
Spastic Pes equinus deformities represents the most common gait-problems in children wit cerebral palsy. Established conservative treatment measures include plaster casts and/or Botulinum toxin injections followed by lower leg orthoses. As there is still a consensus that surgical treatment should be postponed the optimal conservative management is still under
debate. We are wanted to see whether the treatment of dynamic equinus feet is possible by using a special full time lower leg orthosis nor Botulinum toxin can modify the effect.

Methods
This study includes walking spastic hemi- and diplegic cerebral palsy children (2-18 years) without previous surgeries and dynamic equines foot deformities.
All in all 132 patients with 177 treated equines feet (79 hemiplegic,98 diplegic) were followed. All feet received a special developed below-knee orthosis with a plantarflexion stop which has to be used for 23 hours a day for a period of 6 – 8 weeks. Among the 177 feet, 69 had previous Botulinum toxin injections whereas 108 had not. Clinical investigations were made containing passive ROM measurements, visual gait analysis and clinical measurements of the spasticity.

Results
165 out of 177 feet could be corrected and showed significant clinical improvements. Interestingly feet, which had previous Botulinum toxin injections showed slightly lower correction rates and needed longer treatment periods (64 compared to 101 days).Comparing
the results of the patients with Botulinum toxin injections according to the patient ages we
found out, that patients below 4 years of age had a longer duration of treatment. In this cases, especially the hemiplegic children where affected.

Conclusion
Still a lot about the effects of Botulinum toxin on muscle spasticity has to be learned.
• Does the Botulinum toxin really is completely reversible
• Our clinical datas shows positive effects on the excursion of the muscle-tendon-unit by using dynamic orthoses with a ring-shaped-frame-design
• There is a difference in the treatment of the pes equinus deformity according to hemiplegic and diplegic children

In our cases we could not find a modifying effect combining botox-treatment with a following orthotic fitting. Furthermore the duration of treatment was prolongated, which may indicate towards a direct modification of muscle properties which is not clear. Orthotic treatment itself
seems to be quite more effective for this patient group.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg232562/cg63616

Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3022-220]

The Efficacy of Electrical Passive Pedal Cycling on Spasticity in Iranian Spinal Cord Injured Veterans

Author
Shojaei, Hadi (Tehran IR) | DR
Janbazan medical and engineering research center - rehabilitation research

Coauthors
Shojaee H ,Rayegani SM,Soroush M,Baghbani M,Shojaei AA,Allami M,Haghani H

Abstract
A major side effects of Spinal cord injury is spsticity, The purpose of this clinical trial was to evaluate the effects of Electrical Passive Pedal cycling (EPPC) usage on spasticity clinically and H-reflex electrophysiologically ,which showed positive results about therapeutic effects of EPPC.

Introduction
Nowadays due to Advanced medical and Rehabilitation technologies, complications of spinal cord injury has decreased. One of the complications of this injury is spasthic limbs that may interfere with mobility and rehabilitative procedures.This phenomenon plus consequences of their sedentary or inactivity life style,encounter muscle dystrophy, stiffness of the joints and deformity,pain syndromes,etc. physical exercises on a continuous and precise basis maintains muscle tone both in trunks and the limbs, leading to prevention of joint contracture,improving spasticity,etc.In recent years new technologies are introduced to help patients conduct physical exercises independently at home.Electrical Passive Pedaling Systems (EPPS)are among those.The EPPS has been employed for Iranian Veterans exercise therapy,and as its effect on spasticity is not yet defined.This was the major motivation for the present study to assess and evaluate the physical effects of EPPS on SCIed Veterans in Iran.

Methods
The upcoming trial is a prospective clinical research performed on 64 SCI veterans.The subjects were divided and compared in three different groups according to the cycling protocol usage,1)Control group included 21 subjects who did not use the cycling equipment,2)Intervention group1 comprised of 13 veterans who used the equipment at the moderate intensity but less than the ideal,3)Intervention group 2 with 29 veteran who used the cycling equipment according to the ideal protocol with high intensity of exercise.The investigated variables in this study include clinically spasticity scale(Modified Ashworth Scale),and electrophysiological study of:H-Reflex Amplitude,H-Reflex Onset Latency,H/M Ratio.Electrodiagnostic tests were conducted via a pair of 2-channeled TOENNIES-PLUS,German made devices in the research and academic center.The Passive Pedal Cycling Machines were Therlive 2003 and German made,too.All the info gathered with the demographic data recorded in participants'questionnaire

Results
The participants included 93.5% male veterans and 4.7% female ones, all with the average/mean age of 43 years old, of which 52 (81.3%) suffered from complete SCI while other 12 cases were with incomplete SCI (18.8%). The involved area of their body included cervical injury in 11 subjects (17.2%), upper thoracic injury in 22 (34.4%), and lower thoracic injury 44 (45.3%), and lumbar spinal injury in 2 (3.1%).The mean spasticity scale in veterans who practiced with the pedaling device to the target level or below the target

level (group 2 and 3)showed significant decrease(improvement) in comparison with the spasticity scale before providing the electric passive cycling system (P= 0.003).
There was a significant difference in average H max/M max (RT&LT) among the Veterans who had exercised with the electric passive cycling system below the target level.In fact, these findings demonstrate that EPPS has no effects on reduction of H-Reflex Amplitude.
Between onset latency and mean H/M, there is no significant alteration before and after the exercise.

Conclusion

In order to achieve the goal of this study, both objective and subjective signs in relation with EPPS were assessed. It is to be emphasized that considering objective signs are of significance because it crosses out the interference from patients, leading to the measurement of interventional factors and shows their crucial effect. These objective signs evaluated in Veterans who received the EPPS are as per follow:
•Spasticity,H-Reflex Amplitude Change
•H(max)/M(max)change,H Reflex Onset Latency Change.Meanwhile, in Group 2 who had used the EPPS less than the optimal level, the mean Spasticity Scale before application of EPPS was more than the mean Spasticity Scale after EPPS usage.Furthermore, in group 2 and group 3 there was no significant difference before and after the exercise for H-Reflex Amplitude and onset latency and mean H/M, and this is against Roshes findings through his research.though it is to be emphasized that he has not evaluated the usage of EPPS for a long period .

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Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3403-578]

The Effect of Newly-designed Dynamic Cushion System with Spring Elements on Buttocks Pressure Distribution in Patients with Spinal Cord Injury

Author
Lin, Shih-Cherng (Taoyuan TW)
Chang Gung Memorial Hospital - Physical Medicine and Rehabilitation

Coauthors
Tang FT, Chen WP, Lin SC, Cai FL, Chu NK, Wu PH, Lai KC, Chen PC , Wong MK

Abstract
In this study, the effect of newly-designed dynamic cushion system with spring element in the buttocks pressure distribution in patients with spinal cord injury was evaluated by buttock pressure measurement. The efficacy of pressure sore prevention of this cushion system was also evaluated.

Introduction
Patients with paraplegic spinal cord injuries (SCI) need to spend long hours each day sitting on their wheelchair cushions. However, long-term sitting on the wheelchair may raise the probability of pressure sore formation. Many conventional dynamic cushion systems are also heavy in weight and additional power needed. As a result, we have developed a rigid plastic dynamic cushion system that is lighter in weight and designed for the purpose of pressure sore prevention. In addition, the efficacy of pressure sore prevention of this cushion system was also evaluated by measuring the buttock pressures in spinal cord injury patients.

Methods
Twenty male and ten female paraplegic patients who injury level were below thoracic spine, were recruited in this study as experimental group. Ten male and ten female age matched healthy subject were also recruited as control group.The pressure measurement system, Novel Pliance-X (Novel Gmbh, Munich, Germany), was used to perform the measurement of buttock pressure distribution. To compare the effect of different cushion stiffness on buttocks pressure distribution, the experiment was designed as three conditions; all subjects were asked to sit on this dynamic cushion system with two different spring (6.37 N/mm and 10.73 N/mm) and rigid element respectively to operate a desktop. The order of experiment conditions was randomized. Maximum mean pressure, peak pressure, pressure-time integral and pressure-time process were analyzed by post analysis software, Novel multimask (Novel Gmbh, Munich, Germany).Statistical analysis was performed by independent-samples t test and ANOVA.

Results
In terms of SCI patients of this study, the reduction of maximum mean pressure beneath the ischial tuberosity was 13.22% and 13.77% when sitting on our newly dynamic cushion system of high and low stiffness as compared to the rigid support seat cushion. As compared to rigid cushion support, the decrease in peak pressure beneath the ischial tuberosity was 11.48% and 28.01% with high and low stiffness cushion support respectively. Pressure-time integral beneath the ischial tuberosity was reduced 12.82% and 14.58% as the cushion with high and low stiffness spring compared to rigid element. Since peak pressure distribution was altered, the averaged difference between maximum and minimum pressure during measurement process were 20.55kPa, 17.39kPa and 14.36kPa when patients sitting on rigid, high

stiffness and low stiffness support respectively. However, the datum of control group not only had similar trend, but had opposite results in three different cushion conditions as compared to experimental group.

Conclusion

Based on the experimental results, dynamic cushion system with spring elements would decrease the peak pressure in the cushion-buttock interface instantaneously. Besides, according to the data of pressure-time integral, the dynamic cushion system could relief the effect of cumulative loading effectively. So, the dynamic cushion system with low spring stiffness could reduce not only the skin pressure but the cumulative loading beneath ischial tuberosities. Therefore, this device may be used to decrease the occurrence of buttock pressure ulcer formation in patients with paraplegic spinal cord injuries.

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Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3085-283]

A new Locomotion and Dynamic Functional Orthotic Concept for Stroke Survivors Using a Functional Dynamic Splinting System and Myoorthotic Treatment

Author
Preisler, Benedikt (Egelsbach DE)
Pro Walk GmbH - Patient Care

Coauthors
Karen Eves BScPT
Bachelor of Sience in Physiotherapy
NDT trained Bobath-therapist

Abstract
The authors describe an innovative and complex treatment concept, for stroke survivors suffering from a loss of hand and arm function, and foot drop syndrome caused by a lesion in the central nervous system.

Introduction
According to the authors early intervention is essential. A functional dynamic orthosis is recommended for use when, the patient in intensive care, to prevent the development of contractures which, in the long run will make the use of the affected hand more difficult or may be impossible. The positioning orthosis is designed to allow a flexor spasm to be slowed down, rather than stopped by a rigid force, the fingers and hand are brought back into the initial position by a spring loaded system. Three different force plates are available for this orthosis.
As soon as the patient is referred to the rehabilitation department, a spring loaded dynamic functional and movement guiding orthosis for the fingers hand and elbow is prescribed. This orthosis can also be used in Physiotherapy and Occupational therapy treatments, allowing functional use of the affected side, and has great potential for improving the recovery in the patients hand and arm function.
Besides the reduced hand and arm f

Methods
Besides the reduced hand and arm function, many patients suffer from foot drop associated with stroke too. The authors introduce a FES (functional electric stimulation system). This WalkAide system is a self-contained, battery operated, single channel transcutaneous electrical stimulator, to achieve functional dorsiflexion. Functional movement is elicited through a healthy motor nerve, lower charge levels are used than in NMES therefore preserving muscle endurance and patient comfort.
It uses sophisticated sensor technology and software to analyse movement of the foot and leg. This analysis is then used to create, a unique stimulation pattern for walking. Dorsiflexion of the foot is stimulated at the appropriate time in the gait cycle, producing a more natural, efficient and safe pattern of walking.

Results
A trained medical professional team is required to asses and fit the functional dynamic orthotic system and the WalkAide system, individually for each patient. On-going follow up allows for optimisation and alterations to the programming, to maximise outcomes for the user.
INDICATIONS

Patients with reduced hand-arm function (moderate to mild spasticity) and drop foot associated with the following central nervous system conditions may benefit from this new concept.
1) CVA
2) CP
3) Head Injury
4) MS
5) Incomplete Spinal Injury
6) Other upper motor neurone lesions

Conclusion
The described treatment concept offes new option and perspectives to the patientgroup introduced above. Effectivley using the hypothesis of neuroplasticity.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg232562/cg37546

Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3052-250]

Treatment of Equinus Gait with the Pomarino® Pyramid Insoles

Author
Pomarino, David (Hamburg DE)
Physiotherapiezentrum - Physiotherapiezentrum, Forschung und wissenschaftliche Begleitung

Coauthors
Stock S, Klawonn M, Walther C

Abstract
Im PTZ-Pomarino wird der Zehenspitzengang in 3 Stufen behandelt.
Stufe 1: Versorgung mit Pyramideneinlagen nach Pomarino®, eventuell zusammen mit Physiotherapie; Erfolgsquote: ca. 90% .
Stufe 2: Therapieerweiterung um individuell angefertigte Nachtschienen.
Stufe 3: Behandlung mit Botox®.

Introduction
Infantile toe walkers alternate between plantigrade and forefoot gait pattern. Severe structural changes like deformities of the foot or irreversible contractures of the Achilles tendon could occur. The treatment of this gait variety is often delayed by patients, but an early treatment is significant for a positive prognosis. This gait pattern is treated with Pyramid Insoles by Pomarino®, physiotherapy, night splins, various orthosises, Botulinum Toxin® and surgeries.

Methods
The therapy starts with Pyramid Insoles by Pomarino® (Step 1). If there are severe structural changes Pyramid Insoles are combined with physiotherapy. At 90% of all toe walkers this method is successful. The initial examination and the follow-up examinations every 6-8 weeks evaluate the therapy process. If there is still no therapy success the second step of the Step-by-Step Concept complements the therapy. Individual adapted night splins treat efficiently 5% of the patients (Step 2). A follow-up examination controls the results every 12-14 weeks. Without a therapy succes or with an increased toe walking the third step follows. Treatment with Botulinum Toxin® (Botulinumtoxin A) is an injection into the heads of m. gastrocnemius (Step 3). In majority two applications are enough to achieve the required gait pattern. Good therapy results lead to discontinue wearing night splins and treatment with Botulinum Toxin®.

Results
Previous therapies of habitual toe walking show just moderate effects. Various insoles, orthosis, non-specific physiotherapy and surgeries to elongate the Achilles tendon were practiced. The costs – in relation to the low treatment success- were high. The use of the Step-by-Step Concept and the treatment with Pyramid Insoles by Pomarino® reduce costs but increases efficiency and potential complications could be minimised. This concept and the previous classification lead to a situation where physiotherapy is just necessary in special cases. For more serious and therapy-resistent cases mostly two injections with Botulinum Toxin are enough to avoid a surgery to elongate the Achilles tendon. From the 750 toe walkers, who were treated in the CFP until the beginning of 2009, only two were operated.

Conclusion
The toe walkers are divided into three groups:

Type 1: Children with a congenital shortening of the Achilles tendon (ca. 55%)
Type 2: Children with a genetic loading (40%)
Type 3: Children, who do not belong to type 1 and 2 (ca. 5 %)
The Step-by-Step Concept by Pomarino cured ca. 90 % of the toe walkers (type 1) within a year- as far as the child was younger than 5 years at baseline and no preterm termination of treatment happened. Patients of the type 2 were cured in 95%. Just 2 % of all patients in the CFP needed a treatment with Botulinum Toxin® in the past.

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Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [2947-145]

Properties of Vibration to Improve Standing Balance in People with Diabetic Neuropathy

Author
Postema, Klaas (Groningen NL) | Prof. Dr.
University Medical Center Groningen - Rehabilitation

Coauthors
Hijmans JM, Zijlstra W, Geertzen JHB, Hof AL

Abstract
Different types of vibration were applied to the plantar surface of the feet in five patients with Diabetic Neuropathy, in order to improve balance control. An upper cut-off frequency of 200 Hz seems to be most effective. The applied amplitude seems to be of smaller influence on the effectiveness.

Introduction
Tactile sensation from the plantar surface of the foot is important for control of balance. In Diabetic Neuropathy this is often reduced. Improvement of the tactile sensation is thought to improve balance. Previously it was shown that mechanical noise (vibration) to the plantar surface of the feet can improve standing balance capacity in people with decreased tactile sensation. On theoretical basis the effects only occur during the vibration and do not last after the vibration. The positive effects on balance of insoles with vibration, are up to now, limited. Possibly the optimal properties of the vibrations are not used. Goal of this study was to determine the optimal properties of the vibrations. We used a single case design. We made XY-plots of the COP position while using different properties of vibration and also no vibration. These plots give a good impression of the effects of the vibration.

Methods
Five patients (42-52 years old) with Diabetic Neuropathy with various degrees of sensory loss of the plantar surface were included. Balance was tested on a AMTI force plate. The patients were standing on the insoles, on the force plate, with their feet parallel (7 cm apart) and eyes closed. Three piezoelectric actuators were placed under the MTP-I, MTP-V and heel. To define the most effective amplitude and bandwith of the noise signal nine spectra of vibration were tested: three bandwidths (upper cut-off frequencies of 50 Hz, 200 Hz and 1000 Hz, each with three different amplitudes of 150, 200 and 255 (on a linear scale from 0 -255). An amplitude of 255 corresponds to a output voltage of 200V. Nine trials of 60 seconds with the different vibration properties during the last 30 seconds, in random order, were performed. The COP movements respectively between 2.5 and 27.5 and between 32.5 and 37.5 seconds were used for baseline and intervention data.

Results
The XY-plots of subject 5 (with Attention Demanding Task – ADT - and eyes closed) show clear differences between the different frequencies, in which 200Hz shows the best results. The mean velocity of the COP of the baseline measurements did show a clear variance, especially when the subject had the eyes closed. When the intervention measurements are compared with the preceeding and with the subsequent baseline measurements, the majority of the interventions show a smaller mean velocity of the COP, suggesting balance improvement. One participant showed in almost all interventions an increase in the mean velocity

of the COP. Three subjects were not able to feel the maximal ampitude. The two other subjects only consciously sensed the maximal amplitude. The figure gives an example of a CoP plot (mm) with and without vibration (white line is without and black line is with vibration).

Conclusion

The baseline measurements were not steady, but there was no consistent increase or decrease of the velocity of the COP, over time. The two interventions with ADT show, respectively, an increase and a decrease over time. Since we did not see any systematic change, this does not point to a lasting effect after turning of the vibrations, as in accordance with the theory.

The velocity of the COP decreased more in most interventions with ADT, than without ADT. This suggests that the effects of vibrations are larger when the circumstances in which the balance task is performed, are more difficult.

One subject with a severe Diabetic Neuropathy did not seem to benefit from the vibrations. In line with the theory, this suggests that vibrations may improve standing balance only in patients with minor to moderate Diabetic Neuropathy. An upper cut-off frequency of 200 Hz seems to be most effective. The applied amplitude seems to be of smaller influence on the effectiveness of the vibrations.

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Session: Neuroorthopaedics
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Bio- / Neuro Science | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3749-730]

Potential and Limits of the Conservative Treatment in Neuromuscular Disease

Author
Lebek, Susanne (Halle DE) | Dr. med.
Universitätsklinikum Halle - Klinik und Poliklinik für Orthopädie

Abstract
In a retrospective investigation it will be demonstrated which conservative treatment methods, e.g. orthotic devices, physical therapy, are provided and as such effective.

Introduction
Neuromuscular diseases are not curable. The changes influencing the quality of life often concern the skeletal system, such as muscle contractures, foot deformities like cavus foot. The efforts of the carers are aimed of slowing down the contracture development and the development of further bony deformities.

Methods
Out of the children with neuromuscular disease treated in the Social Paediatric Centre of the Charite, Berlin in the last two years were patients with Duchenne and Becker muscular dystrophy, spinal muscular dystrophy, hereditary sensory motor neuropathies whose records were analyzed retrospectively according to the provision with orthosis and physical therapy.

Conclusion
Only in the beginning of the diseases the application of orthosis can be directed to contracture prophylaxis without proving the fact of slowing down contracture development. Later in the course of the diseases orthosis and physiotherapy can only be targeted at improving passive posture. Only with combining surgical interventions with orthotics and physical therapy at the right time a measurable prolongation of standing and walking will result.
Therefore, the care for children, adolescents and adults with neuromuscular disease should be organised in interdisciplllinary manner to create best possible results.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3524-None]

Development in Lower Limb Orthotics

Session Chair
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Abstract
In recent years innovations in orthotic devices for the lower extremities have emerged after decades of inertia. Stance Control knee joints and the application of new materials, especially carbon composites are the most exciting. In this symposium the current standings regarding orthotic devices for the lower extremities in non-spastic disorders will be reviewed and future developments will be discussed. A concern is that the amount of research on the effectiveness of lower extremity orthotics is rather scarce. However, results of high-quality research will become more important in the future to demonstrate the benefits of new technology. The symposium will end with a presentation on the crucial methodological issue which outcomes should be applied in clinical trials.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg55889

Symposium: Development in Lower Limb Orthotics
Wednesday 2010/05/12 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3525-689]

Current Standings of Lower Limb Orthotics in Non-Spastic Paresis

Author
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Abstract
This presentation summarizes the lack of evidence to decide on the prescription of an orthosis and reports on the progress of an expert opinion based multidisciplinary guideline project.

Introduction
Prescribing orthoses, is a complex process, due to the large variety in musculoskeletal abnormalities, such as the extent and distribution of muscle weakness, secondary deformities and the wide range of available devices. There is a scarcity of orthotic guidelines on how
abnormalities in the musculoskeletal system should be corrected or supported. This likely results in poor clinical decision-making and sub-optimal orthoses. Over the last years new technologies have become available for leg orthotics and further developments are in progress. The major areas of developments include carbon composite shelf materials and stance phase control knee joints. In the future the application of robotics in
orthoses are anticipated. The use of gait analysis increases to determine and optimize the biomechanical action of orthoses. A relevant issue is the appreciation of orthotic devices. Do they meet the patients needs and are they used in daily life? The aim of the guideline project is to develop and implement a guide

Methods
Literature search, opinions of 14 experts in orthotic management including clinicians from different disciplines, orthotists, biomechanical engineers, insurance representatives and patients. Based on the ‘Process Description for Devices’ all steps in the prescription process will be described and protocolized. This will be done using the results of scientific research (evidence-based) and consensus meetings.
The guideline will be formatted as a handbook.

Results
There is few evidence from clinical trials that is helpful in deciding which orthosis should be applied or preferred. At present the guideline is being developed and will become available
medio 2010. Afterwards a trial implementation will be executed in two clinical settings and 20 patients will be treated according to the guideline. Supported by the mandating organizations, societies and companies, this will be followed by grade-by-grade implementation rollout.

Conclusion
Despite all these developments there is a lack of high quality clinical studies on the efficacy of orthotic devices. An evidence and expert opinion based guideline is being developed for the application of orthoses in clinical practice. This guidelines aims to improve health care efficiency. Efficient use of orthoses is required, especially with the increasing costs of orthoses due to the available, expensive new technology. Convincing evidence demonstrating
its superiority is needed for reimbursement.

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Symposium: Development in Lower Limb Orthotics
Wednesday 2010/05/12 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3526-765]

Finding the Optimal Ankle Foot Orthosis - The Influence of Mechanical Characteristics on Walking Efficiency

Author
Bregman, Daan J.J. (Amsterdam NL) | Drs.
VU University Medical Center - Rehabilitation Medicine

Coauthors
V. de Groot, MD, PhD ; J. Harlaar, PhD

Abstract
The mechanical AFO characteristics, such as the stiffness and neutral angle around the forefoot and ankle joints, need to be well-tailored to the patients gait related problems in order to improve walking efficiency. AFOs with different stiffnesses have different effects throughout the gait phase.

Introduction
In stroke and multiple sclerosis patients gait is frequently hampered by a reduced ability to push off with the ankle, caused by weakness of the plantar flexor muscles[1]. To compensate for this impaired push-off, work can be delivered around the hip joint, although from modeling studies this is known to be mechanically inefficient[2]. To enhance the impaired push-off, and to increase walking efficiency, carbon composite Ankle Foot Orthoses (AFO) are often prescribed[3]. These AFOs act like a spring; they store energy at the beginning of the stance phase and return energy at the end of the stance phase. Our computer simulations suggest that there is an optimal AFO stiffness at which gait is the most efficient. In the current study we will focus on the role of the AFO characteristics as measured in patients. We hypothesize that the attunement of the mechanical AFO characteristics to the patient's gait related problems are of influence on the patient's walking efficiency.

Methods
To test our hypothesis, we first developed a device named BRUCE to measure the mechanical AFO characteristics, specifically the stiffness and neutral angle around the ankle and forefoot joints. The design was based on a replicated human leg, which continuously registers joint configurations and forces applied onto the leg by the AFO (Figure 1a). From the forces and joint configurations the stiffness and neutral angle around the ankle and forefoot joints are calculated. Together with the information from 3D-instrumented gait analysis, the stiffness and neutral angles were used to asses the mechanical contribution of various AFOs throughout the gait cycle. To determine the benefit from the AFO, the energy cost of walking was measured with a portable breath-by-breath gas analysis system during 6 minute walk tests with and without the AFO.

Results
A reliability study revealed that mechanical characteristics of the AFO around the ankle and forefoot joints can be measured reliably, with ICC values ranging from 0.79 to 1.00.
Gait analysis in seven patients revealed that AFOs with low stiffness (.19 Nm/degree) were found not to have a substantial contribution to the ankle moment and power throughout the stance phase. However, these AFOs resulted in a decrease in energy cost of walking in patients with a drop-foot, resulting from the relatively large moment supplied in the swing phase. In contrast, AFOs with high stiffness (2-4 Nm)

had a substantial contribution both throughout the stance phase and the swing phase, which resulted in a decrease in energy cost of walking in patients with reduced push-off.
Figure 1b gives an example of a measurement of the mechanical characteristics of an AFO with a stiffness of 2.67 Nm/degree and a neutral angle of 2.1 degrees plantar flexion, prescribed to a patient with reduced push-off. Walking with the AFO resulted in a decrease in energy cost of walking of 59%. Figure 1c shows the ankle joint power while walking with this AFO and walking without the AFO. It shows that during walking with the AFO more positive and more negative ankle power is generated. Moreover, almost all ankle joint power can be attributed to the AFO (dotted line).
Although it is clear that walking with this AFO was more efficient than walking without the AFO for this patient, one can wonder whether this is the most optimal AFO stiffness at which t

Conclusion

The mechanical AFO characteristics, such as the stiffness an neutral angle around the forefoot and ankle joints, need to be well-tailored to the patients gait related problems in order to improve walking efficiency. For patients with a reduced ability to push-off with the ankle, it is expected that there is an optimal stiffness at which gait is the most efficient. Currently, we investigate the influence of variations in AFO stiffness on energy cost within these patients.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg55889/cg56068

Symposium: Development in Lower Limb Orthotics
Wednesday 2010/05/12 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3527-721]

Current and Future Trends for Stance Control and Powered Assist Orthoses

Author
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Abstract
The role of the orthotist is changing from a provider of passive devices to a clinician that provides intelligent assistive devices that adaptively control motion and, in the near future, actively enhance mobility. Recent advances will be discussed for stance control orthoses provide a wide range of control options and powered lower extremity orthoses.

Introduction
Stance control orthoses typically make a decision as to when the user is in a potentially unsafe condition and then changes the orthosis function to provide safe locomotion. These control methods vary from monitoring changes in ankle angle, knee angular velocity, to sensor-based monitoring of weight-bearing. Selecting the best approach for the consumer is important since the smaller-lighter devices typically have a trade-off in terms of functional capabilities and safe operating ranges.
Following this stance-control orthosis development, an even more difficult technical challenge is providing appropriate powered assistance for motion within a wearable device. Within the research realm, new technologies are evolving that will help to address this need to improve mobility by enhancing moment generation in the lower extremities. Current technologies involve free-standing walking frame and powered assist units that are incorporated into lower extremity orthoses.

Methods
Critical review of commercial products, literature, and patents related to stance control orthoses and powered assist devices for the lower extremity (orthoses and exoskeletons). Databases reviewed include scholar.google.com, Medline, CINAHL, IEEE Xplore, and Compendex.

Results
In the stance control orthosis area, three classes of devices were assessed: Joint-limb angle controlled (Otto Bock Free Walk/Becker UTX, Becker Safety Stride, Swing Phase Lock), limb loading controlled (Horton Stance Control Orthosis, Becker E-Knee, Otto Bock Sensor Walk, Ottawalk, Power Harvesting AFO), Angular velocity controlled (Ottawalk-Speed).
In the powered assist area, technologies reviewed include free-standing exoskeletons (Power Assist Suit, HAL – Cyberdyne, Rewalk – Argomedtec) and wearable powered orthoses (fluid powered AFO, pneumatic muscle actuators, spring-motor actuator, Tibion, Honda Walk/Stride assist).

Conclusion
Stance control and powered assist technologies are providing new approaches for improving mobility. Today’s and tomorrow’s orthotists will require new skills and training to work with these intelligent mobility devices.

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Symposium: Development in Lower Limb Orthotics
Wednesday 2010/05/12 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3528-763]

Considerations on Outcome Assessment in Clinical Trials on Lower Limb Orthoses

Author
van Schie, Carine (Amsterdam NL) | Dr
Academic Medical Centre, Amsterdam - Rehabilitation

Coauthors
Brehm MA, PhD; van Schie C, PhD; Nollet F, MD, PhD

Abstract
This paper considers the outcome measures advocated in the literature that are most valid and applicable in clinical trials on lower limb orthoses to evaluate gait and functioning.

Introduction
Lower limb orthoses are often prescribed in patients with gait abnormalities. The most typical application of a lower limb orthosis is to optimise the biomechanics of walking by applying a mechanical constraint to the ankle and/or knee, thereby aiming to improve the gait pattern. It is assumed that improving the gait pattern will, in turn, improve a patient's functioning. In order to achieve this goal, an appropriate prescription of the orthosis is requisite. Therefore, the prescribing physician must clearly understand the biomechanical consequences and functional implications of the orthotic design. So far, this understanding has mostly been based on clinical experience, whereas evidence-based knowledge, based on proper outcome assessments is lacking. This paper therefore discusses some of the issues surrounding outcome assessment in clinical trials on orthotics, and it considers the most applicable and valid instruments in this area as primary qualifiers to evaluate gait and functioning.

Methods
In considering applicable outcome measures to evaluate gait and functioning, it is important to select suitable clinical tests, which ideally should (i) measure at the level of outcome (i.e. relate to the aimed treatment goal), (ii) be practical and feasible, and (iii) have good psychometric properties. In this context we suggest that the concurrent use of quantitative measures of gait and functional measures would be superior to either measure alone. Hence, a literature search was conducted for outcomes measures in the following domains of the International Classification of Functioning, Disability and Health (ICF): those that provide an assessment of body functions & structures; those that evaluate a person's capacity and performance to engage in activities of daily-life, and those that measure a person's quality of life. Outcomes measures aimed to evaluate patient-relevant problems and user-satisfaction are also considered.

Results
Our search of the literature revealed many different outcome measures that can be used to evaluate gait and functioning. We only considered those outcome measures with good overall psychometric properties. Furthermore, from the perspective that each orthotic intervention should be evaluated with respect to both its biomechanical and functional indication (i.e. treatment goal), outcome measures were considered at all levels of the ICF.

At the level of body functions/structures we propose using instrumented gait analysis to evaluate biomechanical working mechanisms. Especially in the context of complex clinical questions and for scientific purposes this instrument has shown to be of surplus value. (1) For the purpose of evaluating functional outcomes, time-scored walking tests at the level of capacities can be used. Examples include the 6-minute Walk Test (6MWT), or the 2MWT for patients who are unable to complete the 6MWT. (2,3) Supplementary outcome measures at the level of performance, perceived with questionnaires, such as the Short-Form 36 (SF36), are suggested for the assessment of a person's capability to engage daily-life activities. In case of more specific indications, the addition of extra outcome measures should be considered. These can include outcome measures to evaluate pain, frequency of falls, energy cost of walking, and activity monitoring (1,4). Individualized outcome measures, such as the Goal Attainment Scale (GAS) can be used to evaluate specific and individual patient problems. (5) Final

Conclusion

The aim of the present paper was to consider the most applicable and valid instruments from a number of frequently used instruments in patients with gait abnormalities for outcome assessment in clinical trials on orthotic devices. Based on the ICF, a core set of outcome measures should bedefined including all levels of functioning. This core set should be used in all studies on orthotic devices to enable the comparison of results. Depending on the specific aim of a study, the primary outcome(s) can be specified.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3679-None]

Foot & Shoe - Diabetes and Rheumatoid Arthritis

Session Chair
Bagherzadeh Cham, Masumeh (IR)
Iran University of Medical Sciences (IUMS) - orthotics and prosthetics

Session Chair
Burgwal , Holger (Fulda DE) | Dipl.-Ing. (FH)
Fuß+Schuh Breidbach Orthopädie GmbH & Co. KG Sitz Fulda

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2893-91]

Pressure Relief by Means of a Lower-leg Total Contact Cast (TCC) in the Treatment of Diabetic Foot Ulcers - Results of a Multicenter Study in Germany

Author
Zink, Karl (Bad Mergentheim DE) | Dr.
Diabetes Klinik Bad Mergentheim GmbH & Co KG - Diabetische Fußambulanz

Coauthors
Klare WR, Liesenfeld B, Risse A, Clever HU, Tigges, W, Koggel, A

Abstract
Multicentre prospective clinical evaluation conducted at six DDG (German Diabetes Association)-certified foot treatment facilities to verify the efficacy and usability of the bivalved Total Contact Cast (TCC) for pressure relief in patients with diabetic foot ulcers.

Introduction
Effective pressure relief is an essential component of therapy for diabetic foot ulcers. The total contact cast (TCC) is a method for pressure relief that is well documented in literature. In Germany, the TCC is still relatively uncommon, although it is cited as a method of pressure relief in the practical guideline on „Diabetic Foot Syndrome“ by the DDG (Deutsche Diabetes Gesellschaft, German Diabetes Association) (1). The present multicentre post-authorisation study was conducted at six DDG-certified foot treatment facilities to verify the efficacy and usability of the TCC in patients with diabetic foot ulcers.

Methods
To date, a total of 50 patients with neuropathic foot ulcers (Wagner grade # 2, at least one palpable foot pulse or ABPI > 0.8, no infection) have been treated in this post-authorisation study. Treatment was administered on an outpatient basis; it involved a combination of phase-specific moist wound management and pressure relief by means of a TCC consisting of a fibreglass cast (Cellacast®TCC) in bivalve technique to ensure problem-free wound control / wound management. Depending on the specific circumstances at the individual facilities, the TCC was fitted either by a wound care specialist, an orthopaedic shoemaker, a diabetologist, or in cooperation with the hospital’s orthopaedic ward.

Results
In 46 patients, the ulcers had completely healed after an average period of 37 days (SD: +/- 27 days; minimum 7 days, maximum 154 days). TCC treatment had to be prematurely discontinued in a total of 4 patients; this was due either to a stagnation of wound healing (1 pat., amputation lesion following amputation of the big toe), pain in the leg (1 pat.), or reasons of compliance (2 pat.).

Conclusion
The fast healing rates achieved with a TCC in these ulcers—some of which had persisted up to for 4 years—are convincing. With professional guidance, the application of the TCC can be easily learned and performed even at foot treatment facilities of a predominantly internistic character. Close monitoring of patients for early detection of potential complications (e.g. development of new pressure points) has shown to be beneficial particularly in the initial phase of TCC treatment. The greater amount of time required to

prepare the TCC is justified by the fast healing of the ulcers and the fact that patients can be treated on an outpatient basis. With a view to recurrence prophylaxis, it is indispensable that patients be fitted with adequate orthopaedic footwear once their ulcers have healed.

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2892-90]

Off-Loading of Diabetic Foot Ulcers: Experiences with the Bi-valved Total Contact Cast Using a Synthetic Cast Material

Author
Trentmann, Hermann (Hamburg DE)
Trentmann - Gromotka Orthopädie-Schuhtechnik GmbH - Orthopädie-Schuhtechnik

Abstract
The bivalved Total Contact Cast is a highly effective method of pressure relief. When the TCC is applied by well educated personnel, this method is well suited for the off-loading of the diabetic foot, even for the treatment of "problem feet".

Introduction
Diabetic foot ulcerations are worldwide a most common precursor of lower-limb amputations. Especially the absence of sensory feedback warnings bear high risks of developing foot ulcers. An effective off-loading of the diabetic lesions has been recognized as an essential part of the ulcer treatment. Whilst Total Contact Casts (TCCs) are considered the „gold standard“ of the pressure-relieving methods in many other countries (e.g. United States(1)), this off-loading principle is only poorly applied in Germany so far.

Methods
The Total Contact Casts applied by us consist of a skin protection, diverse padding materials and multilayered fiberglass cast (Cellacast® TCC). For regular wound inspection and wound care, the TCCs are opened and fixed again with hook and loop fasteners.
In contrast to prefabricated devices, one advantage of the TCC is the possibility to adapt the cast to the individual anatomic situation of the patients foot, in particular in patients with foot deformities or anatomic specifics due to anterior amputations on the foot.
Starting in 2006, until today approximately 240 patients have been treated with the bi-valved Total Contact Cast and our experiences are described in this presentation.

Results
Most of the small wounds on the forefoot healed under Total Contact Cast treatment within a period of 1.5 to 5 weeks, greater wounds showed a time to complete wound closure between 4 and 8 weeks, special cases (e.g. Charcot foot) had to be treated up to 5 months until wound healing. From the approximately 240 patients treated only in 8 cases treatment had to be terminated due to an allergy (1 patient), non-compliance (4 patients), heavy exsudating wound (2 patients) or disapproval of the attending physician. Over the years we developed special techniques for difficult to treat feet as well. In addition to the common techniques of total contact casting some of these techniques are introduced in the presentation.

Conclusion
Our good experiences with the Total Contact Casts underline the efficacy of this off-loading method. In particular patients with “problem feet” benefit from individually adaptable casting techniques and this concept of treatment is worth to be implemented in the therapy of diabetic foot ulcers in Germany.

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2842-58]

Medial Longitudinal Arch Breakdown as a Trigger-mechanism for the Charcot Foot Syndrome

Author
Burgwal , Holger (Fulda DE) | Dipl.-Ing. (FH)
Fuß+Schuh Breidbach Orthopädie GmbH & Co. KG Sitz Fulda

Coauthors
Jahn M, Peikenkamp K, Zink K

Abstract
Analyse the “medial longitudinal arch” (MLA) (Fig 1) and the extension of the first metatarso-phalangeal joint during the stance phase of gait. Detection of causes of the Charcot foot and thereby risk factors for the affected patients.

Introduction
The Charcot Foot is one of the severest complications of the diabetic foot syndrome and can destroy the whole foot integrity. Due to loss of sensation diagnose and treatment of fractures and pathological changes of bones and joints is often too late. The reasons for the Charcot Foot are object of the current scientific discussion. But biomechanical knowledge is marginal. Therefore the aim of this study is to find possible reasons for the Charcot Foot. Thus, risk factors for the affected patients should be detected.

Methods
7 patients with a diabetic neuropathy (DNP) (Age=57 years, Weight=110 Kg, Height=1.84 m) and a Charcot Foot (Ch) in the metatarsal (Sanders II, III), whereas the non-affected side had no pathological findings (NoCh) were analysed. 5 age matching control subjects (CO) (Age=58 years, Weight=86 Kg, Height=1.70 m) without diabetes or any injury of the lower extremity were analysed.
Every Subject walked a 9m walkway for at least 4 valid steps. An In-shoe pressure measurement (FASTSCAN) with 100Hz and 2D video analysis (COVILAS) with 50Hz were performed. The parameter of In-shoe pressure measurement were the force rate and momentum and of the video analysis the angle of first metatarso-phalangeal joint (MTPI), „medial longitudinal arch“ (MLA), Achilles tendon and ankle joint during the stance phase. With a Mann-Whitney U-Test ($p<0.05$) all parameters between CO and both sides of DNP and with the Spearman correlation ($p<0.05$) between the range of the MLA angle und MTPI joint were analysed.

Results
The range of the MLA-angle, momentum and double support phase on both sides of the patients are significant higher.
MLA-Range MTPI-Range
CO-NOCh p=0.045 p=0.006
CO-Ch p=0.068 p=0.1
The MTPI-joint angle and force rate of the patients are significant lower. There is a high significant (p=0.001) negative correlation (r=-0.732) between the range of the MLA angle ant the MTPI-joint.

Conclusion

With the MLA it is possible to assess the movement of the os naviculare [1] and the DNP shows a drop of the MLA-angle. This naviculare drop results in incongruent joints in the metatarsal and higher mechanical stress to the bones and ligaments of the foot. Finally, it can cause stress fractures of the bones. The coherence of the range of the MLA-angle und MTPI-joint means: The higher the MTPI-joint extension the lower is the drop of the MLA. The atrophic muscles [2] of the patients cannot impede the naviculare drop [3]. The muscles cannot react on impact forces because of the neuropathy. Thereby the higher momentum damage the passive structure and causes injuries. The longer duration of the double support phase and stance phase is an indication for unstable gait and a lower speed of gait [4].
A preventative support of the MLA [5] with appropriate individually insoles is indicated. The insole can be part of orthopaedic shoes. These orthoses should be produced by an experienced and qualified orthotist or ortho

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Image: MLA_None.jpg (see online)

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2845-61]

Is it Possible to Correct the Foot Position of Patients Suffering from Diabetic-neuro-osteo-arthopathy with a Lower Leg Orthosis?

Author
Stumpf, Jürgen (Fulda DE)
Fuss und Schuh Breidbach Orthopädie GmbH & Co. KG - Orthoädieschuhtechnik

Abstract
Analysis of the question, if it is possible to correct the foot position of patients suffering from Diabetic-Neuro-Osteo-Arthopathy with a lower leg orthosis. Demonstration with case reports approving this procedure.

Introduction
Diabetic-Neuro-Osteo-Arthopathy deformed feet usually need individual orthopedic shoes to maintain further carrying capacity. Such feet are comparatively steady when in Sanders location II/III in stage 3 according to Levin. Concerning feet in the early stage 1 according to Levin: It is possible to work against further skeleton deformation. The patient needs supply with a lower leg full-contact orthosis, after having taken a precise plaster cast in neutral position. A very special challenge is the foot health care in stage IV according to Sanders. Depending on the question if the medial part of the upper ankle joint is concerned with the result of a varus foot deformation (or vice versa) the possibility of fixing the foot in correcting position in a lower leg orthosis should be seriously thought of. If this is not considered often in progress the foot deformation reaches a stage where only by surgical intervention the carrying-capacity of the foot can be maintained.

Methods
Case reports

Results
Neuropathic feet can be kept long-term carrying capable in lower leg orthosis. It is possible that a shortening of Achilles tendon results in an intensified pes equinus. This is much easier to be taken care of in long-term view.

Conclusion
We know from experience that it is possible to keep neuropathic feet long-term carrying capable in lower leg orthosis by means of classical orthopedic correction techniques for axial perpendicular fixing of the foot, even if such feet show extreme axial diffenrences as well in varus as in valgus position. During correction of the foot it is possible that a shortening of Achilles tendon results in an intensified pes equinus, which is much easier to be taken care of in long-term view as the axial difference in terms of a Varus/Valgus foot defective position.

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2869-69]

Prof. Seyfrieds Functional Concept for the Rheumatoid Foot – Proof of Concept

Author
Biber, Daniel (Fulda DE) | Diplom-Sportwissenschaftler
IETEC Orthopädische Einlagen GmbH Produktions KG - Forschung und Entwicklung

Coauthors
Gruber,AJ

Abstract
Using kinemetry, pedobarography and electromyography, we investigate the effectiveness of orthotic treatment following Prof. Seyfrieds theory - Based on the functional conditions of the lower extremity and an appropriate staging treatment.

Introduction
New in this intervention is the classification of the patient-collective in 3 separate collectives due to specific functional testing of the lower extremity. The aim of this orthotic treatment is to eliminate pathomechanics by using a stimulation module respectively a complete support of the first ray and therefore substitute the deviancy of M.peroneus longus. Following Prof. Seyfrieds theory the deviancy of the M.peroneus longus leads to compensatory overloading at for instance the hallux valgus right up to malpositions like pes planovalgus or so called pseudo valgus knee. By use of the stimulation module respectively the complete support of the first ray the active load locus under MTP I is re-established enabling a physiological rocker-mechanism.

Methods
For a proof of concept X patients will be introduced to a biomechanical gait-analysis including video-analysis, plantar pressure measurement and electromyography while walking at self-selected speed and with three different predefined paces. Previously the patients have been subdivided into three different specific functional rheumatic groups using the standardized functional Seyfried-tests. Solely functional class I and II will undergo analysis before and after specific functional orthotic treatment. By means of a significant change in the patterns of the lower the legs kinematics, the plantar pressure measurement in predefined areas, or a possible temporal change in the innervations of M.peroneus longus the biomechanical effectiveness of the Seyfried-foot-concept shall be proven.

Results
The final results of this study are expected end of 2010. To date only available data can be presented.
A comparable study in 2004 is able to confirm the Seyfried-concept rudimentarily. The aspect ratio showed normalization of plantar pressure indices. Video-analysis showed more dynamic use of rocker-function including larger joint angles and shorter floor contact phases. Final outcome was a significant decrease of pain.

Conclusion
The intention of the present study is to proof the Seyfried-concept for the rheumatoid foot. Results show than a successful treatment has to be individual, interdisciplinary and integrated. In addition feet should not

be considered as separate parts of the lower body because there is a functional interaction with the upper segments. Segregation into three functional classes refers to the progressive character of the rheumatoid arthritis. Compared to the popular standard treatment there certainly is an additional expenditure of time and effort, but with this approach optimal individual biomechanical conditions can be restored in a focused manner.

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Session: Foot & Shoe - Diabetes and Rheumatoid Arthritis
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3334-509]

Effect of Rocker Shoes on Pain, Disability and Activity Limitation in Rheumatoid Arthritis Patients

Author
Bagherzadeh Cham, Masumeh (IR)
Iran University of Medical Sciences (IUMS) - orthotics and prosthetics

Coauthors
Mohammad Sadegh Ghasemi
Bijan Forogh
Mohammad Ali Sanjari

Abstract
Rheumatoid arthritis is chronic inflammatory disease that affects the foot and ankle. Rocker shoe prescribed for the symptomatic foot in RA. For 20 RA patients was prescribed heel-to-toe rocker shoe for 30 days and measurement pain, disability and activity limitation with FFI questioner.

Introduction
Rheumatoid arthritis is a chronic inflammatory articular and systematic disorder that affects approximately 0.3% to 1.5% of the population worldwide and affects woman two to three times more than men.
Foot and ankle involvement in RA is extremely common affecting 16% at diagnosis and 900-100% in patient with 10 years history. The feet of patients with rheumatoid arthritis are often affected by pain and multiple deformities.
The goals of foot care for RA patients are decrease and control pain and joint stiffness, maintain functional mobility and improve the quality of life using safe and cost effective treatment, such as prescribed foot orthoses and specialist footwear.
The rocker sole are the most commonly prescribed external shoe modification by clinician to relieve foot pain and normalize gait in rheumatoid patients.
The aim of this study was to determine the effect of rocker shoe in pain, disability and activity limitation in rheumatoid arthritis patients.

Methods
Twenty rheumatoid arthritis patients were evaluated with foot and ankle pain with or without foot deformity between 20-65 years and in remission phase of disease without foot ulceration or lower limb history of operation.
Heel-to-toe rocker sole made of 25mm thick ethyl-vinyl-acetate (EVA) with standard hardness (shore-A 30-40) for midsole and 5mm carbon rubber with hard hardness (shore-A 50-60) for outer sole were prescribe for each patients.
Every subject answered a questioner including basic demographic data and foot function index at the firs time. Subject who came back for follow-up were asked to fill in a second FFI questioner one week after and 4 week after firs visit again.

Results
Patients demographic data are in table1.

Only nineteen patients completed the trial. With the use of rocker shoes, foot function index values decreased in all subscales (pain, disability and activity limitation). This reduction was noted in the first visit and was maintained throughout the trial.

Conclusion

The results of this preliminary study show that rocker shoes significantly reduced pain, disability and activity limitation, as measured by the foot function index, in patients with rheumatoid and foot pain and all subjects reported improved comfort levels.

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Image: table.1_None.bmp (see online)

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Congress: 13th ISPO World Congress
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Session [3691-None]

Rehabilitation - Gait Training

Session Chair
Oehler, Simone (Berlin DE) | Dipl.-Ing.
Technische Universität Berlin - Fachgebiet Medizintechnik

Session Chair
Linberg, Alison (Washington DC US)
Walter Reed Army Medical Center - Military Advanced Training Center

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3193-380]

How Should we Define the Rockers of Gait and are there Three or Four?

Author
Owen, Elaine (Bangor UK)
North West Wales NHS Trust - Child Development Centre

Abstract
A three-event ankle model of the rockers in gait is inadequate. A four-event segment and joint model is preferable.

Introduction
Perry first described the rockers of gait; Initial/First Rocker in loading response (LR) Mid-stance Rocker in mid-stance (MST) and Terminal Rocker in terminal stance (TST).1 She renamed the rockers, Heel Rocker during LR, Ankle Rocker during MST and Forefoot Rocker during TST and pre-swing (PSW).2 She attributes the purpose of the rockers to production of tibial advancement during stance. Perry's rockers have been reinterpreted as solely relating to ankle kinematic and they have been renamed 1st, 2nd, 3rd ankle rockers; 1st plantarflexion, LR; 2nd dorsiflexion, MST and TST; 3rd movement from dorsiflexion to plantarflexion, TST and PSW. Confining interpretation of the rockers to ankle kinematic does not recognise: the original purpose of describing the rockers, to describe the pivot mechanisms by which normal shank kinematic is produced; the original differentiation between second and third rocker, heel rise, at 30% gait cycle (GC) at start of TST; 4 events of ankle kinematic in stance.

Methods
Tabulation of kinematic data by subdivisions of the GC. Segment alignment is described in degrees of recline and incline from the vertical

Results
Tabulation reveals four events and four pivots producing the normal shank kinematic of stance phase of the GC.

Conclusion
Definitions of 4 rockers are proposed: The mechanisms of the ankle and foot that produce shank kinematic during stance phase GC; 1st Rocker, LR, pivot heel, movement ankle joint; 2nd Rocker, MST, pivot ankle, movement ankle joint; 3rd Rocker, TST, pivot forefoot/metatarsal-phalangeal joints (MTPJ), movement MTPJ; 4th Rocker, PSW, pivot toe, movement MTPJs and ankle joint. Perry has recently renamed the forefoot rocker occurring in PSW as 'toe-rocker'.3
A four event model recognises; 1) the four pivot mechanisms by which shank kinematic is produced; 2) the original differentiation between 2nd and 3rd rocker, heel rise at 30%GC at the end of MST, start of TST; 3) the ankle is not in motion throughout stance. During TST the ankle is 'virtually locked', in dorsiflexion.1, 2, 4 The movement that advances the shank occurs at the MTPJ. The stiffness of the ankle in TST is essential for heel rise and the ability to achieve maximum knee extension at 40% GC, maximum hip extension at 50% GC.1, 2

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Image: 4 Rockers table_None.jpg (see online)

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3347-522]

Reference Values for Gait using Outcomes of the Gait Analysis System RehaWatch

Author
Hofmann, Marc (Magdeburg DE)
Hasomed

Coauthors
Adolf D, Liedecke W

Abstract
The knowledge of reference values is useful for the interpretation of gait analysis results. We present a method to receive reference values from measurements with healthy subjects. These standard values are determined depending on age, body height and gait velocity, based on a linear model.

Introduction
Gait analysis plays an important role in the neurological or orthopedic rehabilitation process for the assessment of the rehabilitation progress. The gait analysis system RehaWatch is denoted as a portable and easy to use gait analysis device. The basic principle is the usage of motion sensors fastened near the left and the right malleolus by special brackets. The related RehaWatch PC software computes from the measured acceleration and rate of turn values a set of time and space related variables, parameters and symmetry indexes, e. g. double step time, cadence, stance time, swing time, velocity, step length, sagittal foot angle. An important prerequisite for the evaluation of gait analysis results is the existence of reference values gained on the investigation of healthy subjects. These subjects should represent a profile of the adult population. The usability of such reference values increases by including biometric values such as gender, body height and age.

Methods
119 subjects took part on the measurements for the gain of reference values. The absence of former or actual diseases was excluded by an interview with standardized questions. The 119 subjects consist of 58 women from 20 to 74 years of age and 61 men from 19 to 73 years of age.
Each subject passed 3 measurements on an even course of 20 meters. This procedure took roughly 10 minutes per subject. All measurements were analyzed by the RehaWatch software, this means, the gait parameters were calculated. All results were exported to EXCEL and SPSS and given to statistical estimation.

Results
We performed correlation analyses to decide on independent variables. In the results of this examination we found age, body height and gait velocity. Then we used these variables for linear regression analyses and found significant relations for the prediction of stride time, stride time variability, stance duration, stride length and sagittal foot angle. Using linear regression analysis is based on the simplifying assumption, that we have linear relationships between these and other gait variables.
By means of the estimated regression parameters, we calculated auxiliary quantities by appointing a comparative person that is 50 years old, 170 centimetres high and has gait celerity of 1,4 meter per second. Although all of the calculations and the final percentiles are gender-specific, we don’t have to take sex

into account here. The comparative person's characteristics are arbitrarily chosen and just figure in the mathematical background.
Having these auxiliary quantities, we ensured that they were approximately normally distributed and transformed them into standardised normally distributed values by subtracting the mean and dividing by the standard deviation. Then it was possible to calculate percentiles of the derived standardised normally distributed variables.
In order to compare a new patient's gait analysis outcome the user has to input age and height. The resulting quantile is given automatically and can then be compared with the pre-specified percentiles.

Conclusion

The presented method allows the evaluation of gait parameters whether they are to low, to high or in the same range like the reference values taking into account biometric values like body height, gender and age. As a further step this method should be transferred from a particular excel sheet to an integral part the program code of the RehaWatch software. This would be an easement in the process of gait results interpretation.

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3348-523]

Mobility Measurements of above Knee Amputees - Results of a 12 Months Field Study

Author
Oehler, Simone (Berlin DE) | Dipl.-Ing.
Technische Universität Berlin - Fachgebiet Medizintechnik

Coauthors
Pusch M, Westebbe B, Thiele J, Dobat A, Kraft M

Abstract
A six degree mobile measuring system was developed to investigate the mobility and activity of above-knee amputees with focus on the loads applied to the structure.
The results of a one year study with 15 subjects will give insights into daily activities and loads for future standard testing.

Introduction
There is little knowledge how prostheses are used and stressed in everyday life. To answer this question a mobile measuring system was developed that can easily be integrated in a prosthesis and is able to measure forces and moments in three dimensions.
Components of prostheses are tested to harmonized standards, e.g. ISO 10328 [1], in order to certify that they are able to withstand the applied everyday loads. The underlying testing parameters should reflect the intended use within a typical time of usage. However, they were acquired more than 30 years ago. Since then technology has improved and led to higher functionality which allows increased patient mobility, this will alter strength requirements.
Therefore one essential purpose of the project was to build a new reliable database that represents the loads applied to the prosthesis over a representative period of time. Furthermore daily activities of the subjects were measured, identified and compared to healthy subjects' data.

Methods
The system had to meet the requirements of fitting standard prosthetic adapters and having the same height as a rotation adapter so static alignment does not change when they are replaced by one another. Its CAD-Design was optimized via FE-Analyses to withstand the required testing loads and to optimize the position of the strain gauges. With two angle sensors at thigh and shank and a datalogger the system was integrated into 15 above-knee prostheses. The assembly position was directly below the socket in order minimize influences of additional weight. Data acquisition was operated at a sampling rate of 256Hz and a resolution of 12bit. For validation of the 3D calibration and the overall performance the systems data was compared to gait lab and load cell data. The measured differences to load cell data were below 3% of the measuring range. All 15 subjects (10 with C-Leg®, 5 with 3R60®, different mobility grade MOBISTM 2 - 4) recorded their activities during a whole year of observation.

Results
Recorded data was transformed to relevant joints and analysed via different algorithms. All results were written into a database and can be filtered via queries.

To identify different gait patterns the algorithm was fed with parameters to distinguish between level walking, stairs, sitting, cycling etc. Besides the percentage and absolute numbers of occurrences for each gait pattern we also calculate the activity as a summary of all cyclic loads in relation to the measured time. Preliminary data of two subjects for two months shows activities of 12.5% for subject A and 13.7% for subject B.
So far we analysed data of 30 days for each season and extrapolated the results. The stated total number of gait cycles also considers standing under load and kneeling because the prosthesis is loaded with more than 2/3 of the body weight. For the most active subject we recorded 2 million load cycles per year for the least active subject only 250.000 load cycles. Looking at the number of load cycles per day it becomes clear that weekdays are in general more active than weekends. For comparison, healthy subjects walk 5931 ± 3664 steps a day [2].
We also looked at seasonal changes. For these first results one can deduce that seasonal changes have no essential influence on most subjects' activities. Histograms with corresponding values show the loads of realistic gait data as it occurs. They are available for every maximum and minimum and further special signals like heel strike and toe off.

Conclusion

So far measurements only allowed statements over a short period of time. With the results of this study we will be able to get a deep insight into the daily activities carried out by above-knee amputees of different mobility grades and knee joints. Additionally we get information about the loads and loading cycles applied to the prosthesis. Based on this realistic field test data the criteria for ISO 10328 testing can be reviewed. With this activity information it is possible to build load collectives which take into account principles of cumulative damage analysis. Subsequently, the system aids to compare different prosthetic knee joints, can help determining patient mobility and serve as a mobile (kinetic) gait analysis.
All this will help to optimize products, improve component selection, define service life and give input for rehabilitation and gait training. All this would improve the mobility and safety of above-knee amputees and, ultimately, of all lower extremity amputees.

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Image: ISPO_Oehler_02_None.JPG (see online)

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3076-274]

Reliability of Five High-level Activity Measures established for Military Service Members with Traumatic Lower Limb Loss

Author
Linberg, Alison (Washington DC US)
Walter Reed Army Medical Center - Military Advanced Training Center

Coauthors
Scoville C, Gomez-Orozco C, Roach KE

Abstract
Inter-rater and test-retest reliability was determined for five measures of balance, coordination, power, speed, and agility on 83 Military Service members with war-related traumatic amputation. The results demonstrated excellent inter-rater and test-retest reliability for the five tests.

Introduction
Functional assessment tools for individuals with lower limb loss such as the Amputee Mobility Predictor (AMP) are widely used to determine readiness to ambulate with a prosthesis and to guide rehabilitation (1). Military Service members who have sustained traumatic amputation frequently demonstrate physical capabilities beyond those measured by current assessment tools (2). There is a need to develop an instrument for this high functioning population that can help to determine higher-level physical capabilities. In an uninjured population, the following five tests have been utilized to measures of balance, coordination, power, speed, and agility: Single Limb Stance (STS), Medicine Ball Put (MBP), modified Edgren Side Step Test (mEST), T-Test (TT), and Illinois Agility Test (IAT). The purpose of this study is to examine the inter-rater and test-retest reliability of these five tests among Military Service members with and without lower limb loss.

Methods
Data was collected at each of the following locations: Womack Army Medical Center, Fort Bragg, NC; The Center for the Intrepid, Brooke Army Medical Center (BAMC), San Antonio, TX; and The Military Advanced Training Center, Walter Reed Army Medical Center (WRAMC), Washington, DC. All five measures were administered in a standard sequence (SLS, MBP, mEST, TT, IAT) as part a functional capacity assessment currently under development for the military. Subjects were tested twice within a 24 to 48 hour period. Each subject was tested simultaneously by two raters: Rater 1 gave the instructions for each test while Rater 2 demonstrated the test. Subjects were allowed up to 3 attempts to complete each test and were given a rest period between tests. The same rater team tested the same subject on both testing days. The interclass correlation coefficient (ICC) derived from the analysis was used to determine the inter-rater and test-retest reliability.

Results
Ninety-seven active duty United States Army Soldiers (n=97) underwent testing at Womack Army Medical Center, Fort Bragg, NC, and were used as the control group to establish normative data for the five tests. Eighty-three Military Service Members with 5 levels of amputation (unilateral transtibial [n=42] and transfemoral [n=20], bilateral transtibial [n=8] and transfemoral [n=7], and transtibial/transfemoral [n=6]) underwent testing at BAMC and WRAMC. The mean age ± SD for the amputee and active duty military

service members was 28.51 ± 5.6 and 26.1 ± 5.5 years. SLS was not analyzed for the control group because all participants were able to stand for 30 seconds on each limb. Table 1 describes the inter-rater and test-retest reliability for the 5 measures for the active duty and amputee service members. The inter-rater reliability was excellent for both the active-duty control group and amputee military service members, with ICC scores ranging from .924 to .995 for the control group and .97-.99 for the amputees. The test – retest reliability was higher for the amputee military service members when compared to the control group due to the large variance in test scores. Performance effort may have also been a factor in lower test-retest reliability scores for the control group.

Conclusion

In summary, inter-rater and test-retest reliability was established for the SLS, MBP, mEST, TT, and IAT for a population of Military Service members with and without traumatic lower limb loss. These findings established excellent reliability between raters and when administered twice within a 24 to 48 hour period for the five high-level activity measures of balance, coordination, power, speed, and agility for both populations. The inter-rater and test-retest reliability was higher in amputee military service members when compared to the active duty service members. The results can be used to describe the current physical capacity and functional state of Military Service members with limb loss

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Image: Table 1_Reliability ISPO (3)_None.docx (see online)

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3074-272]

Speed and Agility Testing of Military Service Members with Traumatic Lower Limb Loss

Author
Gaunaurd, Ignacio (Miami US)
Bruce W. Carter Department of Veterans Affairs Medical Center - Research

Coauthors
Gailey RS, Raya MS, Campbell SM, Roach KR

Abstract
Sixty-two Military Service members with lower limb loss performed 3 speed and agility tests: modified Edgren Side Step Test (mEST), T-Test (TT), and Illinois Agility Test (IAT). Significant differences were found between service members with and without limb loss and between levels of amputation

Introduction
Military Service members who have sustained war-related traumatic amputation frequently demonstrate physical capabilities beyond those measured by currently available assessment tools (1). The goal of rehabilitation clinicians is to restore the amputee service members to the highest level of function possible. This allows physically capable service members the option to return to active duty. Specific functional outcome measures need to be examined for this population to determine ability to perform high level activity with a prosthesis. The mEST, TT, and the IAT are valid measures of speed and agility. Raya et al (2009) found a strong correlation between the mEST, TT, and IAT among 97 active duty male United States Army Soldiers (2). The purpose of this study is to determine if there is a difference in performance based upon level of amputation when performing the mEST, TT, and IAT to Military Service Members with unilateral limb loss.

Methods
Data was collected at: Womack Army Medical Center, Fort Bragg, NC; The Center for the Intrepid, Brooke Army Medical Center (BAMC), San Antonio, TX; and The Military Advanced Training Center, Walter Reed Army Medical Center (WRAMC), Washington, DC. Medically stable Military Service members 18-40 years of age without significance neurological and/or orthopedic injury preventing them from performing speed and agility tests were recruited for this study. All tests were administered in a standard sequence as part of 5 item functional capacity assessment currently under development for the military. The mEST measures lateral sidestepping distance along a 4 meter course in 10 seconds. The TT is a timed test that requires negotiating a 10x10 meter course forward, side-to-side, and backwards. The IAT is a timed test that requires the ability to rapidly move forward, diagonally, and weaving along a 10x5 meter course. Subjects were allowed up to 3 attempts to complete each test.

Results
Ninety-seven active duty United States Army Soldiers (n=97) underwent testing at Womack Army Medical Center, Fort Bragg, NC, and were used as the control group to establish normative data for the three tests. Sixty-two Military Service members with unilateral transtibial (n=42) and unilateral transfemoral (n=20) amputations underwent testing at BAMC and WRAMC. The mean age ± SD for the active duty and amputee military service members was 26.1 ± 5.5 and 28.16 ± 5.8 years, respectively. Table 1 describes

the mEST, TT, and IAT test scores for the active duty and amputee military service members. Analysis of variance demonstrated significant differences between test performance of the active duty and the amputee service members for the three tests. More specifically, active duty service members performed better than the unilateral transtibial and transfemoral amputees on all three tests. The unilateral transtibial amputees performed better than the unilateral transfemoral amputees on all three tests. Additional analysis determined that 51% of the unilateral transtibial amputees performed within the range of scores of the active duty service members for all three tests. None of the unilateral transfemoral amputees performed within the range of scores of the active duty service members for the three tests.

Conclusion

In summary, valid functional tests were utilized to measure speed and agility in Military service members with and without traumatic lower limb loss. The three measures were able to discriminate between the control group and the unilateral transtibial and transfemoral amputees. Unilateral TTA's mEST scores were higher and TT and IAT times were faster when compared to unilateral TFA's. Future research is warranted to determine: 1) if the mEST, TT, and IAG can discriminate between bilateral and multi-level lower limb amputees; and 2) what amputee service member characteristics predict performance comparable to the active duty service members. These future findings could help to direct clinical goal setting and treatment planning, measure change over time, and provide relevant information in regards to return to duty.

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Session: Rehabilitation - Gait Training
Wednesday 2010/05/12 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3227-409]

Balance Capacity and Confidence following a Wii Fit Video Game Intervention among Children with Unilateral Lower-limb Amputation

Author
Steinnagel, Bryan (Toronto, Ontario CA) | BPE, CPc
Bloorview Kids Rehab - Clinical Technology

Coauthors
Steinnagel B, Andrysek J, Moody KD, Salbach NM, Glasford S, Mascarenhas V, Klejman S, Zabjek KF, Torres-Moreno R

Abstract
A pilot study was conducted to examine the feasibility and potential benefit of Wii Fit games in promoting symmetrical shifting of weight between the sound and prosthetic leg in children with leg amputation. Compliance was high and small immediate improvement in mobility and balance was observed.

Introduction
For a new lower-limb amputee, learning to shift weight onto the prosthesis is key to successful rehabilitation but poses a challenge(1). Since the Wii Fit video game is controlled by shifting the center of mass, it has the potential to be a more engaging and fun approach than conventional exercises to increase weight shifting and weight acceptance onto the prosthesis. The potential advantages of the Wii Fit are that feedback to the amputee is immediate and the game can be played at home. Therefore, the objectives of this study were to evaluate the potential benefits of, safety and patient compliance with Wii Fit video game playing as a therapeutic means to improve balance and mobility among children with a new lower-limb amputation.

Methods
A single group repeated measures pilot study was conducted. Children aged 8 to 13 years that had experienced a unilateral lower-limb amputation were recruited. Subjects were required to provide informed consent prior to participation. At baseline, balance confidence and capacity were assessed using the Activities-Specific Balance Confidence (ABC) scale and the Community Balance and Mobility (CB&M) scale respectively. Subjects also underwent a biomechanics evaluation while playing two preselected games on the Wii Fit (Table Tilt and Tightrope Walk). Subjects were then sent home with a Wii game console and a Wii Fit balance board. They were asked to play each game for 20 minutes per day, four times per week for four weeks. A mid-protocol telephone interview was conducted to determine if problems had been encountered. Subjects recorded compliance with the protocol in a logbook. Subjects were then retested at the end of the 4-week intervention and eight weeks post-intervention.

Results
Five lower-limb amputees (mean ± SD; 10.6 ± 2.1 years of age) were recruited. All had been amputated within 32 months (21.2 ± 8.4 months) and were community ambulators using prosthesis. The ABC scores increased between 1% and 7% from baseline to post-intervention. During the 8-week follow-up period, ABC scores decreased between 9% and 14%, while the score for one participant increased by 5%. Follow up data for one participant were excluded because her prosthesis was replaced post-intervention. The CB&M scores increased between 1 and 5 points from baseline to post-intervention. During the 8-week follow-

up period, CB&M scores changed by -1 to +2 points. No problems were reported during the mid-protocol telephone interviews. Game scores appeared to increase during the 4-week intervention but with only five subjects there is no clear correlation between this and balance and mobility. Results from analysis of the biomechanics data are not yet available. The log book records indicated that subjects found the games fun initially, but repetitive by the end of the protocol. In terms of compliance, subjects completed 16 out of 16 Table Tilt sessions and also 16 out of 16 Tightrope Walk sessions prescribed. The average duration of play each session was 21.7 ± 10.0 minutes for Table Tilt and 19.9 ± 9.1 minutes for Tightrope Walk.

Conclusion

The study shows that a 4-week home intervention appears to have a small positive effect on balance and mobility, but that these benefits were not sustained for some participants once treatment ceased. It also confirms that playing these games at home is safe and that compliance is good. Although small improvements in scores on the ABC and CB&M scales were measured, it is not possible to attribute these changes to the Wii Fit therapy without a control group. Findings from analysis of the biomechanics data may more accurately show changes in ability to weight shift than the two scales. It also appears that the intervention period may not have been adequate. In future work, 12-16 weeks of treatment would be more likely to yield a significant effect. However, a longer intervention would require the use of more games to prevent boredom and maintain compliance. Further study is needed to evaluate the effectiveness of the Wii Fit game system for augmenting conventional physical therapy.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Poster Session [3700-None]

Prosthetics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg240353

Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3155-353]

Osseointegrated Titanium Implants for Limb Prosthesis Attachment - Infectious Complications

Author
Tillander, Jonatan (Gothenburg SE)
Sahlgrenska University Hospital - Dpt of Infectious Diseases

Coauthors
HAGBERG K, HAGBERG L, BRÅNEMARK R

Abstract
Despite frequent colonization of the skin/implant interface by potentially virulent bacteria, such as Staphylococcus aureus (S. aureus), and bacteria associated with biomedical device infections, such as Coagulase-negative staphylococci (CoNS), this method gives rise to few severe infections.

Introduction
The concept of orthopedic osseointegration involves a direct contact between titanium implant and residual bone assuring a stable attachment for prostheses. Since 1965 this principle has been in successful clinical use for prosthetic replacement of teeth. Many individuals using conventional socket prostheses report problems and impaired quality of life.. Bone anchored, skin penetrating implants made of other metals have previously failed, mostly due to infection. Medical device infection is predominately caused by staphylococci, of which the CoNS are the most common.. Our aim was to describe the frequency, type and outcome of infectious complications and to analyze the bacterial flora at the skin-penetration area and its relation to the development of local and implant related infection.

Methods
This is a cross-sectional study of bacterial colonization and infectious complications in 39 consecutive arm and leg amputees with a mean age of 49 years. The cohort was thereafter followed longitudinally for three years regarding implant infections. All amputations were due to trauma or neoplasia and 33 implants were femoral. The total number of implants was 45. At inclusion and at follow up a clinical examination was performed and a questionnaire was answered regarding infectious complications and antibiotic use during the six months preceding the visit. Routine bacterial cultures were taken from the skin-implant interface and plain x-ray films were examined for signs of implant infection at both times. Based on these findings patients were defined as having: Definite implant infection, probable implant infection, possible implant infection, local infection in the skin-penetration area, bacterial colonization around the skin/implant interface.

Results
The frequency of patients with definite/probable/possible implant infections were 5% at inclusion and 18% at follow up. Clinical presentations varied: A) Chronic implant infection (femur) with skin fistulas caused by S. aureus/CoNS and Group B streptococci (two patients). B) Infection around implants (femur and humerus) with poor primary osseointegration caused by CoNS and E.coli respectively (two patients). C) Distal infection (femur) involving bone and soft tissue with good primary osseointegration. Mixed ethiology with S. aureus/CoNS, and S. aureus/E. faecalis were suspected (two patients). D) Acute osteomyelitis around a femur implant caused by S. aureus (one patient). The four latter patients underwent surgical revision and prolonged antibiotic treatment. In five of seven patients with implant infection at follow up,

prosthetic use was not significantly affected. At both first and second culture the most common bacteria at the skin/implant interface were S. aureus and CoNS. In three of seven patients with implant infection at follow-up, inclusion cultures from the skin-implant interface yielded the same species as the suspected infectious agent. Seven patients had a history of local infection at the skin-penetration area during the six-month period before inclusion and eleven patients at follow-up. Four patients did not participate in the follow-up protocol. The admitting medical centers were contacted and no implant infections were reported.

Conclusion

We found that the osseointegration method with titanium implants and skin penetration of the titanium system in leg and arm amputees caused few severe infectious complications. However, infection occurred in about two fifths of the patients during a three-year period, mostly as local infections in the skin-penetration area and more rarely as low-activity implant-associated infections. S. aureus and CoNS were the most commonly cultured bacteria in the skin-penetration area. A favourable outcome with a retained implant is attainable with surgical debridement and culture guided prolonged antibiotics in some patients. In our opinion, the frequency and severity of infection does not appear to be an obstacle to the use of this method. Future studies with longer follow-up will shed further light on the usefulness and specific infectious complications of this method.

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Image: Schematic drawing_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [4072-908]

Self Organized Real Time Control of an Anthropomorphic Hand using Nerve Signals

Author
Franke, Marc (Leipzig DE)
University of Leipzig - Department of Computer Science, Computer Engineering Group

Coauthors
Marc Franke and Martin Bogdan

Abstract
We show that it is possible to process nerve signals to control complex motions of a human-like robot hand in real time. The hand reacts with movement patterns induced by the class and frequency of the nerve signal. These are excellent qualifications for applications in the field of hand prosthetics.

Introduction
Hand prostheses need to be lightweight, robust and forceful. They should replace the function of the human hand in the best possible way. Furthermore, their appearance should be as naturally as possible.
The aim of our study is to investigate fundamental issues related to the design and fabrication of a new generation of microsystems applicable as neural prostheses.
Nerve signals will be recorded and amplified by a regeneration-type neurosensor. Then an artificial neural network (ANN) is applied which classifies the resulting signals in order to assign certain limb movements to the signal classes.
A control unit processes the resulting information to regulate the movement of the prosthesis.
In this paper, we show the possibility to process nerve signals and to control an artificial hand in real time using recordings from the stomatogastric nervous system (STNS) of the crab cancer pagurus.

Methods
Peripheral nerves of vertebrates will regenerate if severed.
For this reason, a peripheral nerve can be surgically severed in order to insert a sensor chip [Sti96].
The sensor is fabricated of polyimide perforated by multiple via holes. The axons regenerate and nerve signals can be recorded by electrodes, which are enclosing some of the via holes.
A circuitry amplifies and preprocesses the nerve signals. The amplified signals are transfered to the units which are controlling the prosthesis.
For separating the different nerve signals from the recorded mixture of different axons grown through a single electrode, we are using INCA, presented by Jutten and Hérault [Jut91].
Since the recordings have been obtained by in-vivo tests with animals, there has been no defined target pattern corresponding clearly to the recorded nerve signal [Bog01]. Thus we are going to apply Kohonens self-organizing map (SOM) [Koh95].
A more detailed description of this method is given in [Bog01].

Results
After classifying the nerve signals to their corresponding clusters, the occurance of a nerve signal of a certain cluster has to be assigned to a corresponding action.

In fact we use only two of the six classified clusters to remote the artificial hand. One corresponds to the information close grasp, the other one to the information open grasp. Using these two clusters we encode the first control degree of freedom of the processing unit, the direction of the movement.
The kinematic structure of the artificial hand itself has been based on rapid prototyping models of the human finger bones [Fra09].
Their geometries have been derived from MSCT images of a human hand. The 3D CAD Data of the bone structures was reconstructed from the MSCT images, then manufactured by rapid prototyping. With this method, we gained lightweight but very rugged artificial bones. We call this approach the Virtual Replication Method.
The finger's joint capsules were constructed by using technical silicone. They stabilize the joints and enable a slight rheonomic deformation. The result is a soft, but robust and lightweight artificial hand of anatomically correct size.
It's kinematic structure is very close to the individual human hand. It provides holding forces up to 100 N per finger [Fra09]. By applying an underactuated control system, we were able to produce life-like movements. The result is a biologically inspired artificial hand controlled by nerve signals in real time.

Conclusion

We proposed a modus operandi to process recorded nerve signals using artificial neural nets.
We demonstrate that it is possible to process nerve signals and to control different complex motions of a human-like soft underactuated robot hand in real time.
The recorded nerve signals have been classified and clustered by Kohonens Self-Organizing Map (SOM) and referrenced to a defined repertoire of grip patterns.
The artificial hand reacts with a defined movement pattern induced by the class (type of movement) and frequency (speed) of the nerve signal.
The kinematic structure of the anthropomorphic hand has been deveoped based on detailed studies related to the biomechanical properties of the human hand.
The artificial bones building its endoskeleton have been virtually reconstructed from CT images of a human hand and then manufactured by rapid prototyping. A procedure we call the Virtual Replication Method [Fra09].
These are excellent qualifications for applications in the field of hand prosthetics.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3414-589]

The Effects of Increasing Toe-out Alignment Angle on the Mechanical Behaviour of Prosthetic Feet

Author
Major, Matthew (Salford GB)
University of Salford - Centre for Rehabilitation and Human Performance Research

Coauthors
Twiste M, Kenney L, and Howard D

Abstract
During the alignment of a modular trans-tibial prosthesis, the prosthetic foot is externally rotated relative to the plane of walking progression for functional and cosmetic reasons. This study measured the mechanical behaviour of three prosthetic feet at four different toe-out angles.

Introduction
Proper alignment of a modular trans-tibial prosthesis is critical for a stable, naturally appearing and energy efficient gait. Sagittal plane alignment is considered to have the largest effect on gait as the range of motion is greater in this plane than in any other. Thus, a majority of studies have investigated the effects of varying sagittal plane alignment on the biomechanics of gait [1, 2]. Fewer studies have investigated the effects of transverse plane alignment, specifically changes in the toe-out angle [3]. Initial toe-out alignment, when the medial border of the foot is parallel to the plane of walking progression, can be as much as 7 degrees from neutral [4]. The effects of varying sagittal plane alignment on the mechanical behaviour of prosthetic feet have been studied [5], but no such investigation has been made of transverse plane alignment. Therefore, this study measured the mechanical behaviour of three commonly prescribed prosthetic feet at different toe-out angles.

Methods
The design characteristics of the prosthetic feet tested differed greatly in order to provide good variation among the captured data. The chosen models were a SACH foot, a Flex-Foot and a Single-Axis foot of 27, 27 and 26 cm length, respectively. The roll-over shape of each foot [6] was measured at four different toe-out angles using a custom loading device (Figure 1) and motion capture system (Vicon Ltd, Oxford, UK). The toe-out angles were neutral (0), 5, 7, and 12 degrees, and chosen according to the typical range of toe-out angles and a maximum condition of twice the average of that range [4]. A constant vertical load of 400 Newtons was applied to each foot during the tests. Changes in the Effective Foot Length Ratio (EFLR) [7], a ratio of effective roll-over shape length to foot length, quantified any within-foot differences between roll-over shapes. Statistical differences were analysed using ANOVA with Bonferroni adjustment for multiple comparisons (significance set at $p<=0.05$).

Results
No noticeable differences between roll-over shapes of the Flex-Foot and SACH foot at each of the four toe-out angles were found. The linear compression that either of these feet experienced and the general appearance of the roll-over shape remained invariant to changes in toe-out angles. However, for the Single-Axis foot, there was a difference in the linear compression, presumably because motion around its pivot takes place in only one plane. When in neutral, this plane closely aligns with the plane of walking

progression, but the pivot joint becomes less effective once the foot is rotated away from this plane. For the neutral angle, the EFLR was 0.95, 0.86 and 0.85 for the Flex-Foot, SACH foot and Single-Axis foot, respectively. Compared to neutral, the EFLR was larger at 5 degrees and smaller at 7 and 12 degrees for all feet. Statistically significant differences were found between the EFLR for the 5 and 12 degree angles for all feet. This indicates that the effective lever arm of the prosthetic foot under loading is greatest with an intermediate toe-out angle of 5 degrees and smaller beyond that. A marked decrease in this lever arm implies that an amputee might potentially suffer from drop-off as a stable base of support during terminal stance is reduced. This would explain why, in a previous study, a decrease in prosthetic limb stance time was observed during gait with an increase in toe-out alignment angle [3].

Conclusion

This study investigated the effects of changes in toe-out angle on the mechanical behaviour of prosthetic feet. Increasing toe-out angle does not seem to noticeably alter the roll-over shape of the SACH foot and Flex-Foot, but does so with the Single-Axis foot. An increase in toe-out angle reduced the amount of linear compression of the Single-Axis foot. A toe-out angle of 5 degrees was seen to extend the effective lever arm of the foot, which would be beneficial for amputee stability during late stance. However, an increase beyond this angle reduces this lever arm below that of a neutral angle. These results help explain the relationship between excessive toe-out angle and reduced prosthetic limb stance time during gait [3]. A limitation of this study is that the feet were tested under constant load which approximated only half the body weight of a typical male. Further gait studies would be useful to observe how the in-vivo roll-over shape is affected by changes in toe-out angle.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3015-213]

Electromagnetic Compatibility in Myoelectrode Amplifiers: Isolation, Impedance and CMRR

Author
Poulton, Adrian (Milton Keynes UK) | Dr
The Open University - Communication and Systems

Abstract
Electromagnetic compatibility of myoelectrode amplifiers for prosthetic control is important for safe operation in electrically noisy conditions. Factors affecting susceptibility to interference (impedance, common mode rejection ratio (CMRR) and isolation) were studied using a commercial amplifier.

Introduction
Electrical interference can enter the system either directly between the active electrodes as a differential signal, or via the common electrode as a common mode signal. The direct path is susceptible to interference due to the high gain of the amplifier. Shielding and electrode geometry design can help reduce the effects. A notch filter is generally used to reduce greatly the amplifier gain at mains frequency, though harmonics are still passed. Common mode interference is mitigated by the normally very high CMRR of the amplifier; however, common mode signals can also be converted to differential signals through imbalances in electrode impedances (Winter and Webster, 1983; Scott and Lovely, 1986). Common mode interference mainly enters via the power and output leads of a myoelectrode amplifier, so effective isolation should reduce the effect.

Methods
Two Otto Bock 13E125 active myoelectrodes were used for the investigations. Sinusoidal signals of different frequencies were applied in differential and common mode configurations and the output measured. The myoelectrode and measuring equipment were all battery powered to avoid conductive mains interference.
Connection to the electrode contacts was through an assembly of spring-loaded platinum contacts, and the myoelectrode was shielded from the external environment in a die-cast box. Measurements were made with different balanced and unbalanced input impedances to represent the skin interface. The measurements were made with the myoelectrode alone and also in combination with an isolation amplifier (Burr-Brown ISO124), and a d.c.-d.c. converter (Murata MEA1D0505SC) to provide isolated power.

Results
The d.c. input impedance and intrinsic CMRR of the myoelectrode amplifier were extremely high by design (>40 M# and >90 dB). The response to differential signals was greatest at 200 Hz to 1 kHz, with a sharp notch at 50 Hz. The CMRR was significantly reduced for a.c. signals if the electrode impedances were unbalanced. As the amplifier gain was non-linear and frequency dependent, a protocol was followed where the imbalance in electrode impedances was adjusted to give the same output as a known differential input. Thus the effect of impedance imbalance could be separated from the intrinsic CMRR of the amplifier. The results obtained fitted the Winter-Webster model with input capacitances of 400 pF. The centre earth electrode was found to be strongly coupled to the 0V lead at a.c. via a capacitance of 1 µF. Isolating the amplifier improved the rejection of common mode signals introduced via the 0V lead. There was a 20 dB increase in CMRR with the isolation components used.

Conclusion

Common mode interference can enter via the leads of a myoelectrode amplifier. Even if the intrinsic CMRR of the amplifier is very high, common mode is converted to an interfering differential signal if the electrode impedances are unbalanced. This is very likely to be the case, due to differences in skin contact. It has been demonstrated that the common mode route can be blocked by an isolating amplifier and dc-dc converter, though at the expense of extra complexity and the need to power these components. Practical implementations may come from developments in low power circuitry for applications such as wireless sensor networks.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3280-455]

Conceptual Design of a Powered Humeral Rotator for Upper Limb Prostheses

Author
Troncossi, Marco (Forlì IT) | PhD
University of Bologna (Italy) - DIEM - Department of Mechanical Engineering

Coauthors
Caminati R, Davalli A, Parenti-Castelli V

Abstract
A new electromechanic device that actuates the humeral intra/extra rotation of upper limb myoelectric prostheses is presented. The main element of the kinematic chain is a special planetary geartrain that allows respecting the required performance and limiting the mechanism global size and mass.

Introduction
Current commercial prostheses (which, at most, comprise the active hand, wrist rotator, elbow joint, and a number of passive joints) could be inadequate for those patients with a high level amputation that require a high functional autonomy in the everyday living. Our team is developing new powered joints in order to satisfy the needs of most amputees. The long term goal is providing shoulder-disarticulated patients with high-functionality prostheses that would allow them to perform the main activities of the daily living. Our upper limb prosthesis, apart from the mentioned commercial joints, nowadays comprises also the prototype of a shoulder having two powered joints and a passive frictional humeral rotator [1]. The current step of the project is focused on the design of a powered humeral rotator that is needed since all the commercial solutions for humeral rotators are adjustable passive joints. Only two powered rotators were prototyped and proposed in the literature [2, 3].

Methods
Due to many reasons, the global strategy of our approach is to build up more and more functional prosthesis architectures by proceeding step by step with the introduction of new powered joints into the current prosthetic solutions, rather than conceiving from the beginning a complete artificial limb. Several kinematic and kinetostatic analyses were carried out to set the reference technical specifications (range of motion, loads…) and to guide the design of the new rotator [4]. A number of power transmission chain schemes, different in the arrangement of the motor and output axes and the motion transmission components, were studied as possible solution for the mechanism layout. The feasibility studies –based on the reference technical specifications– and the evaluation procedure to choose the best solution took systematically into account the advantages and drawbacks of each layout, with a particular attention to the overall dimensions (axial and radial) and to the mass of the device.

Results
The designed humeral rotator is powered by means of a commercial DC micromotor, with integrated incremental encoder.Its characteristics are: nominal voltage U=6 V, maximum output power P=11 W, no-load speed n0 = 7100 rpm, stall torque MH =59.2 N·mm. The power transmission chain basically consists of three stages and provides a total reduction ratio of 1:480 (the arm is required to manipulate 1 kg object).Two conic friction wheels form the first stage, with a unitary transmission ratio as they are needed only to

transmit the motion between orthogonal axes.The friction wheels make it possible limiting the noise.The second stage is composed of a spur gearing that provides a reduction of 1:6. The third stage is the most relevant, being a special planetary geartrain that provides a significant reduction ratio of 1:80 and that is very compact and lightweight.The spontaneous inverse motion is prevented because of the low efficiency of the mechanism (expected about 35%), mainly due to the presence of the planetary geartrain.Two microswitches are included in the device in order to define the range of the admitted angular motion (0°-200°) and to set an absolute zero position for the incremental encoder embedded in the motor.The designed device is within a cylindrical case of 74 mm diameter and 68 mm height (excluding the mechanical connections with the elbow and shoulder articulations).The estimated mass is 0.42 kg (Aluminium alloy and plastic material are used for ad-hoc built parts).

Conclusion

A prototype of the humeral rotator is under construction (Fig.1).The new device will be subjected to bench tests in order to experimentally estimate its actual payload and velocity, current draining, efficiency… Next, it will be introduced in the mentioned INAIL prosthesis, just above the elbow joint: different combinations are possible depending on the presence of one, two or none of the active joints that form the shoulder.By controlling the resulting limb at the test bench (also testing some advanced control strategy, e.g. based on vocal commands), it will be possible to evaluate the global performance of the different prosthetic solutions that we can offer to high-level amputees.Then the entire prosthesis will be tested by shoulder-disarticulated patients to investigate the effectiveness of the clinical application of the rotator and to get precious feedback for its final design optimization (intended to solve criticisms and to reduce the device size and mass, currently excessive).

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2993-191]

Clinical Factors and the Level of Physical Fitness Affecting Successful Prosthetic Rehabilitation in Geriatric Lower Limb Amputees

Author
Maeda, Noriaki (Tatsuno JP) | Clinical factors and the level of physical fitness affecting suc
Hyogo Rehabilitation Centre at Nishi-Harima - Physical Therapy

Coauthors
T Chin2), H Oyabu2), I Takase2), K Machida1), K Sakuma1), Y Azuma2), Y Tezuka2), A Nakatsuka2) , H Kouno2) , S Sawamura2)
1) Hyogo Rehabilitation Center at Nishi-Harima
2) Hyogo Rehabilitation Center

Abstract
In this research,logistic analysis showed that physical fitness was the most important predicting factor,and the ability to sustain an exercise intensity of 53.9% VO2max can be regarded as a guideline value for the level of fitness required for successful prosthetic ambulation in geriatric amputees.

Introduction
In recent years, the underlying condition which led to lower limb amputation in geriatric population can be peripheral arterial disease. In general, they had their deconditioned state before the start of prosthetic rehabilitation. Thus, lower success rates in prosthetic ambulation are reported among geriatric high level lower limb amputees1,2).
To the best of our knowledge, there have been few reports of research investigating predicting factors for Successful prosthetic rehabilitation and describing any specific guideline for physical fitness.
The aim of this research is to investigate the clinical factors to predict successful prosthetic rehabilitation in geriatric high level lower limb amputees, and to specify the level of physical fitness required for successful prosthetic ambulation.

Methods
The patients were 60 unilateral amputees who were hospitalized at this center for prosthetic walking training. Patients who could walk at least 100 meters without ambulatory aids or with only one cane were classified as success group. All others were classified as failure group. Information about each patient was collected retrospectively from clinical charts. This information included cause of amputation, number of co-morbidities, ability to stand on the non-amputated leg, physical fitness (%VO2max) and rehabilitation period. Ability to stand on the non-amputated leg, physical fitness were evaluated before rehabilitation was started. Student’s t-test and #2 test were used to compare mean differences between the two groups. The variables that achieved statistical significance were then included in a logistic regression analysis. The ability to predict the successful outcome was assessed by the receiver operating characteristic (ROC) curve. Significance was set at P less than 0.05.

Results
In the prosthetic ambulation-ability evaluation, there were 40 success group (27 men and 13women), of whom 10 were hip disarticulation amputees aged 66.7 +/- 5.1 years. There were 20 failure group (12 men

and 8 women) aged 68.7 +/- 5.6 years. There was a significant difference between the two groups in cause of amputation, the number of co-morbidities ($p<0.001$), ability to stand on the non-amputated leg, physical fitness. No significant difference was observed between the two groups in age, rehabilitation period.
Cause of amputation, number of medical complications, possible one leg standing, %VO2max were subjected to logistic regression analysis as a dependent variable. Based on the calculated OR, %VO2max was found to be significantly related to successful rehabilitation ($P < 0.05$; Table 1).The ROC analysis showed that %VO2max best differentiated subjects who belonged to success from those who belonged to failure at a threshold score of 53.9 (sensitivity 80%; specificity 90%) and AUC of 0.87 ($P = 0.0001$; Figure 1).

Conclusion

It can be concluded that cause of amputation, a lower number of co-morbidities , and a good ability to stand on non-amputated limb are the most valuable factors contributing to successful prosthetic ambulation in geriatric amputees. These results were congruent with previous reports3-5). In addition, 53.9%VO2max can be regarded as a valid initial guideline level for the physical fitness required for successful prosthetic rehabilitation. Our results could provide useful information in the clinical field of rehabilitation of geriatric amputees.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3617-680]

Development of Dynamic Casting System (DCS) for Artificial Leg Socket Modeling Using Computer Interface

Author
Sasaki, Kazuhiko (Sanda JP) | PO& PhD
Kobe college of medical welfare SANDA canpus - Prosthetist and Orthotist Course

Coauthors
Tsutomu Kubo

Abstract
Dynamic Casting System#DCS# was developed to shorten the long length of time for making an artificial leg, by applying powder technology. The socket shape modeling including test walking was completed in 40 minutes in 10 trans- tibial amputees and practical socket shapes were obtained.

Introduction
Making of an artificial leg takes the long length of time because of the repetition of the test walking and the socket shape modification. One reason of the repeated shape modification is the lack of the method for the exact stump shape modeling during walking. As a previous study, the CAD/CAM systems for accurate stump modeling have been developed (1). However, the accurate stump model under non-load condition does not necessarily provide the suitable shape for walking. A tulip limb socket system had been proposed that a flat particle containing bag is wrapped around the stump, stiffened the bag by applying negative air pressure, and connected to artificial leg parts using a flower petal shaped part(2). The tulip limb system attained early stage rehabilitation, however, the shape of the wrapped flat bag was not sufficient as a socket shape. In this study, we developed the DCS which enables immediate test walking and the casting repeatedly without plaster bandage.

Methods
The configuration of the whole DCS system is shown in Fig.1. The system consists of a compressor to pressurize the bag, three electro-pneumatic regulators to control the air pressure in each airbag, a vacuum pump for the rigidity control of the particle bag socket, and a computer as a pressure controller. Moreover, it has six contact pressure sensors which detect the contact pressure at the MPT, the medial condyle of the femur, the head of the fibula, the tuberosity of tibia, the end of fibula and the distal end of the tibia etc. Three air pressure sensors are also installed to detect the internal pressure in each airbag of the particle bag socket. DCS adapts its shape to the stump by changing the air pressure in the compression bag quantitatively.

Results
Clinical practicality of DCS was evaluated in 10 trans- tibial amputees. The Positive model taken a casting by DCS were 16 8.7 mm smaller than the amputees' stumps at around the MPT level. In other words, the compression bag of DCS reduced the circumferences 2-6%, because the soft tissue is easily compressed. The several percent of compression is a common technique in the conventional casting using plaster bandage. It appears adequate that DCS showed the several percent of compression. The shape modeling including test walking with DCS was completed in 40 minutes in all 10 amputees and satisfactory shapes

were obtained. The contact pressure during walking with DCS was compared to a conventional resin socket. The End of tibia contact pressure with DCS was 30kPa while with the conventional socket it was 90 kPa. The capability of DCS to reduce the excessive contact
pressure at End of tibia was demonstrated. On the other hand, the contact pressure at Medial condyle of femur with DCS was 30kPa greater than with the conventional socket. The peak pressure at End of tibia was 2 times greater than at Medial condyle with DCS, while the ratio with a conventional socket is 5 times. In terms of the pressure distribution, it was suggested that DCS provides more uniform pressure distribution.

Conclusion

We developed the Dynamic Casting System, which enables immediate test walking and the immediate socket shape modification using computer interface, which reflects the subjective evaluation about tightness. The shape adaptation performance of DCS was evaluated in 10 trans-tibial amputees. The test walking and shape modeling was successfully performed in 40 minutes. A more uniform contact pressure distribution was obtained. It was demonstrated that DCS is clinically highly practical.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3352-527]

Improved Stability and Comfort Due to Changes in Ground Reaction Force (GRF)

Author
Daniels, Tom (NL)
Össur - Prosthetics

Coauthors
Nicholls M, Ludviksdottir AG

Abstract
A new technology has been developed to address prosthetic comfort and stability via changing the GRF. This technology when applied to a composite design foot leads to subjective improvements in stability and comfort. Biomechanical analysis indicates a possible explanation for this improvement.

Introduction
In a prosthetic clinic lack of comfort while wearing a prosthesis is one of the most common patient complaints[1]. A study by Schoppen et al illustrated the impact that the comfort of wearing a prosthesis can have[2]. The study of 322 lower limb amputees determined that prosthesis comfort was the most important amputation related factor indicating successful job reintegration. However a study by Dillingham et al showed that the majority (57%) of persons living with trauma-related amputations were not satisfied with prosthetic comfort[3]. Stability is another important aspect of a prosthesis. Lack of stability reduces patient confidence causing them to decrease their activity in order to reduce their chance of falling[4]. Furthermore lower limb amputees have rated stability while walking an important aspect of their prosthesis[5]. To address these issues a new technology that changes the GRF was applied to a popular composite design foot and analysed via user trials and in a gait lab.

Methods
Nine current Vari-Flex users were directed to walk a 20 metre course with no shoes, when wearing sports shoes, and when wearing smart shoes. Users then rated their perception of comfort, stability, rollover and toe-off using five point Likert items. Subsequently the users were fitted with a new foot, including the new technology and asked to repeat the exercise.
This entire exercise was repeated at a second trial after the users had been wearing the new design for two weeks. This time the new design was tested first followed by their previous prosthesis.
The results were analysed using the Wilcoxon Signed Rank test.
The kinetics and kinematics of two users were measured in a gait lab while performing the same exercise. As there were only two participants no statistical analysis was performed. Instead the results were graphically tabulated and examined for any obvious differences.

Results
A statistically significant improvement was seen for user perception of comfort, stability, rollover and response at toe-off in all three situations.
The usual representations of kinematic and kinetic data failed to account for the change in user experience. However the combined tabulation of ground reaction force and centre of pressure in a Butterfly diagram

provides a plausible explanation for the improvements encountered by the users. The butterfly diagrams show the change in both the centre of progression and ground reaction forces to be smoother.

Conclusion

The prosthesis with the new technology leads to an improvement in user perception of comfort, stability, rollover and response at toe-off. This improvement may be due to the change in progression of centre of pressure and ground reaction force.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3277-452]

Gait Characteristics of People with Lower-limb Amputations: Relationship to Balance Confidence and Fall History

Author
Lung, Stephanie (Halifax CA) | Bachelor of Arts Degree (BA) and P & O Diploma
Nova Scotia Rehabilitation Centre - Prosthetics and Orthotics

Author
Durnford, Ryan (CA)

Coauthors
Hanada E, Adderson J

Abstract
A pilot study to explore the relationship between temporospatial gait measures, gait variability measures, and balance confidence. Preliminary results with 19 people with unilateral lower-limb amputations indicate that there are strong relationships between balance confidence and gait measures.

Introduction
Individuals with lower-limb amputations have reduced capabilities of maintaining balance(1) A study found that about half of community-living persons with lower-limb amputations had fallen within the past year and had a fear of falling.(2) In a study comparing fallers to non-fallers with people with transtibial amputations, differences were observed in the kinetics of the prosthetic limb and swing time duration variability of the intact limb.(3) Measurement of gait variability, temporospatial gait parameters and stride-to-stride changes over time during gait, has differentiated between fallers and non-fallers in other populations.(4) Increased understanding of the mechanisms of stability and balance may help improve the success rate of prosthetic alignment and ambulation post amputation. The objective of our pilot study was to explore the relationship between temporospatial gait measures, variability of gait measures and self-reported balance confidence and fall history.

Methods
Convenience sampling was utilized to recruit 6 females and 13 males through the Prosthetics Department at a tertiary rehabilitation centre. Participants had been fit with a unilateral prosthesis for at least 6 weeks, while providing a count of the number of falls that have occurred over the past year. Balance confidence was obtained through the use of the Activities-specific Balance Confidence (ABC) Scale(5) which has been a validated measure for the lower-limb amputee population.(6) Gait temporospatial parameters such as velocity, cadence, stride length, and stride-to-stride variability were quantified with the GAITRite(TM) system, a 5.5 m long and 0.6 m wide electronic walkway. Participants were asked to walk over the electronic walkway 6 times at a self-selected speed. Measures indicating variability of gait included the coefficient of variation (CV) in stride velocity, step length, step width, and swing time.(4)

Results
Participants had a median age of 60 years (range 30 – 85 years of age) and 11 had lower-limb amputations due to vascular reasons. The median number of falls per year was reported to be 2 with a range of 0 to 40 falls per year. The median ABC score was 76.9 with a range of 31.25 to 98.4. Spearman correlation

coefficients were found between ABC, self-reported falls per year and gait measures. Most correlation coefficients between ABC scores and gait measures were in the moderate to high range, -0.58 to -0.77 (P <0.005). Only the relationship between ABC score and time spent in swing was not significant, with a r value of -0.33 (P=0.08). The highest correlation coefficient obtained was between the CV of stride velocity and ABC score, as illustrated in Figure 1, with a r value of -0.77 (P=0.000). The only significant relationship between falls per year was with the ABC score, with a r value of -0.49 (P=0.02). All other relationships between falls per year and temporospatial gait measures were non-significant with low coefficient values (r<0.28).

Conclusion

The results of this study are preliminary and part of an ongoing pilot study. Using self-report measures, research has also shown that ABC scores are related to mobility capacity and performance but not self-reported fall history.(2) Our results suggest there may be a strong relationships between ABC scores and mobility capability as indicated by temporospatial measures, specifically the CV of stride velocity. Similarly, preliminary correlation coefficients obtained do not indicate any linear relationships between temporospatial measures and self-reported number of falls per year. Our next step will be to separate the population based on fall history, ABC score, and reason for amputation to see if differences exist between groups. As recent research has shown that temporospatial gait parameters and variability measures can be velocity dependent, future analysis will adjust for differences in walking velocity.(7)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3319-494]

Assessing the Tightening Torque of Two Osseointegrated Transfemoral Implant Systems

Author
Mechefske, Chris K (Kingston CA) | PhD, P.Eng
Queens University - Department of Mechanical and Materials Engineering

Coauthors
Thompson ML, Branemark R, Mechefske CK

Abstract
Two osseointegrated transfemoral implant systems have been investigated to evaluate the current manufacturers specified tightening torque of 12Nm. Results suggest tightening the assembly beyond this recommendation may increase assembly strength.

Introduction
Osseointegrated transfemoral implants have been introduced as an alternative prosthetic attachment method from conventional, socket-based prostheses for above knee amputees. This method is showing promise by providing prosthetic solutions to individuals that cannot be accommodated by socket-based devices; however, component failure is considered a shortcoming of the technology. In an effort to decrease the occurrence of failures, a new design has been proposed. This design uses a Morse taper connection between the implant and abutment instead of the conventional hex based connection. The Morse taper has been successful in improving strength and loading response in oral implants of a similar design [1,2]. This study investigates the manufacturers specified tightening torque and the preload stress experienced by the bolt of the two transfemoral systems to evaluate the current specification, and determine whether unique tightening regimes are required for each assembly design.

Methods
The current manufacturers specified tightening torque was first explored using a protocol proven during tests of dental implants with a similar assembly [3]. Elongation of the bolt was recorded after applying known torques using a digital torque wrench, to a maximum of the manufacturers specification (12Nm). Ten bolts of each connection design were tested randomly to a total of 5 trials each. Torque elongation was evaluated during incremental tests, following [3], and direct tests, following a protocol that more accurately mimics the in vivo, surgical, tightening regime. Using the elongation data, preload stress and force acting on the bolt were calculated and compared to accepted bolt theory regarding appropriate preload levels [4]. These tests were followed by torque to failure tests to determine the torque to induce component failure. Five bolts of each assembly geometry were tested. Of the five, three bolts had been used during the torque elongation tests, two were new.

Results
Figure 1 illustrates the mean results (incremental and direct) bounded by one standard deviation with regards to applied torque, and the associated preload stress and percent yield stress for both the Hex-based (V1) and Morse taper (V2) assemblies. It can be seen that the behaviour at 12 Nm is comparable between the incremental and direct testing groups. The mean stress at tightening for the incremental tests was seen to be 198.3 MPa, or 23.9%YS for V1 and 227.0 MPa, or 27.4 %YS for V2. Direct testing

achieves a slightly higher preload stress with equal or smaller standard deviations between samples/trials. The observed stress for the direct testing was approximately 200.9 MPa, or 24.3% YS for V1 and 237.4 MPa or 28.7 %YS for V2. Based on a two-way repeated measures ANOVA, the mean difference between incremental and direct testing is not measured to be statistically different, however, there appears to be a significant effect in mean preload stress achieved by V1 versus V2 ($p < 0.05$).
The mechanical failure tests show relatively high torque requirements to cause failure of the bolts. The values for the V1 and V2 connection types ranged from 34.15-38.31Nm and 41-78-41.85Nm respectively for the new bolts and 32.76-38.24Nm and 33.59-34.32Nm respectively for the previously tested bolts. Due to the limited sample size, no statistical evaluation could be carried out with the torque to failure results.

Conclusion
These results indicate that when tightened to the manufacturers stipulated tightening torque of 12Nm, all cases fail to meet the minimum recommended preload stress, based on accepted bolt theory [4]. This suggests the samples could accept additional torque to strengthen the assembly without inducing plastic deformation of the components.
All bolts failed well above 30Nm. The small sample size limits the ability to suggest an optimized tightening torque specification, but it can be seen that both the pre-tested and new bolts accepted considerable torque prior to failure. The results of the pre-tested bolts suggest that the V1 and V2 connection types do not require significantly different tightening specifications, however, the new bolts introduce a larger separation in their ultimate torsional strength. Additional tests must be carried out.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3464-639]

Development of New Circular Woven Fabrics for Prosthetic Sockets

Author
Jung, Sunghee (Incheon KR) | MS
Korea Orthopedics & Rehabilitation Engineering Center - Division of Advanced Materials

Coauthors
Song JS, Cha GC, Lee SM, Mun MS

Abstract
Thermoplastics and fiber-reinforced plastics have been used as socket materials for limb prostheses. Among them, fabrics such as glass or carbon fiber have been popular, but they are expensive and cause skin trouble during working. We attended to adopt a new woven fabric material as socket material.

Introduction
Thermoplastics and fiber reinforced plastics(FRPs) have been used as socket materials for lower and upper limb prostheses. The lamination sockets and direct casting sockets are examples of FRP sockets. FRPs are composed of fiber and a thermosetting resin such as acrylate or epoxy as binding matrix. The glass or carbon fibers replacing fabrics such as cotton and Kevlar, have lightweight, a good impregnation with resin, and a good thermal durability against frictional heat generated in grinding. They are rather expensive, and may cause skin trouble to workers, unless properly protected when exposed to debris of fibers cut during fabrication process. The purpose of this study is to make a socket of new materials having thermoplastic property and the same strength, which enable to give durability of socket and to reduce skin trouble.

Methods
As fibers that we used as the composite materials in this study, were carbon fiber, PVA fiber, and PP fiber. The strength of fiber was compared by using a cord & yarn grip with the Universal Testing Machine (UTM, Instron 5565, USA). To compare the resin contents and strength of the socket material, epoxy and PU resin were used to impregnate carbon and PVA fiber, respectively. The impregnation with resin was determined by preparing same sized fabric; impregnating with the resin; measuring the weight after curing; and comparing the resin contents. The strength of the socket was determined by cutting the 4mm-thick specimen into five with 15mm x 100mm, and measuring the 3-p flexure strength using the Tensile Test Machine (TTM, Instron 8511, USA). To find the shape and size of debris particles by fiber, carbon fiber and PVA fiber were impregnated with epoxy, particles at grinding were collected, and observed using the scanning electron microscopy (SEM, JSM-5310, JEOL, Japan).

Results
In Fig. 1, the tensile strengths of the fibers were as followings: carbon fiber of 58.8MPa, PVA fiber of 54.6MPa, and polypropylene fiber of 12.7MPa, and carbon fiber shows very high modulus.
The carbon and PVA fabric were impregnated with epoxy and PU resin, respectively, and the contents of resin by weight of fiber was compared. Carbon fabric shows high contents of PU resin and PVA fabric shows high contents of epoxy resin. The resin content impregnated in the PVA fabric was about 20% higher than carbon fabric. This may be due to difference hydrophilicity between fibers (PVA or carbon fiber) and matrix resins (PU or epoxy), but further study will be conducted for adjustment.

The flexure strength of socket was measured as shown in Fig. 2. The specimens were prepared by combining carbon fabric and PU resin (C-PU), PVA fabric and PU resin (PVA-PU), and PVA fabric and epoxy resin (PVA-epoxy). The flexure strength of C-PU and PVA-PU were similar and that of PVA-epoxy was higher.
The size and shape of debris particles generated at grinding were observed with SEM, as shown in Fig. 3. For (a), resin and carbon fiber exist separated from matrix and the particle is in a 19-44# chopped bar shape. It can be absorbed on skin surface causing dermis trouble, and may be sometimes, without proper protection, inhaled through the respiratory. In contrast, chopped PVA fibers were conglomerated and coagulated with the matrix resin and the scattering of chopped fibers was prohibited.

Conclusion

Carbon fiber widely used as the composite material is good for the socket material of limb prostheses in property and performance. However, workers rather tend to avoid it due to skin or respiratory trouble which may occur in fabrication sockets.
PVA fiber maintains the strength of the socket. Comparing PVA fiber with carbon fiber, PVA fiber shows competent value as socket material in tensile strength. PVA fiber has about 20% more resin contents than carbon fiber, and shows similar results in the flexure strength test.
When observing debris particles generated in the grinding operation, PVA fiber particles do not appear separately from the matrix, and their scattering in the air can be reduced effectively.
Further studies on surface treatment methods for PVA fiber will be conducted to investigate the adhesion and impregnation of fiber and matrix and then to improve the mechanical characteristics of sockets using PVA fiber. A matrix resin suitable for PVA fiber will also be studied on

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3356-531]

Recovery from a Trip in Transfemoral Medicare Functional Classification Level-2 Amputees Using Different Prosthetic Knee Hinges

Author
Theeven, Patrick (Hoensbroek NL) | MSc
Adelante - Centre of Expertise in Rehabilitation

Coauthors
Hemmen B, Geers R, Meys G, Rings F, Brink P, Seelen H

Abstract
Trip recovery in transfemoral amputees was tested for 3 different types of prosthetic knee joints. The protocol was able to detect relevant differences in trip recovery between prosthesis conditions. However, in MFCL-2 amputees, walking speed and perceived stability should be taken into account.

Introduction
Whereas many transfemoral amputees are quite able to successfully counteract balance perturbation during e.g. ambulation, others may have more difficulties. The ability of recovering from a trip has been investigated by many, especially in Medicare Functional Classification Level (MFCL) 3 and 4 amputees. In MFCL-2 amputees however, risk factors may be more diverse. Clinical experience suggests that the MFCL-2 amputees group is not a homogeneous group. Blumentritt et al. (1) developed a protocol to systematically test amputees' ability to recover from a trip or a trip-like situation and the influence of prosthesis characteristics on this ability. Aim of the present study was to assess the sensitivity of this protocol to detect differences in trip recovery in transfemoral MFCL-2 amputees using 3 different kinds of prosthetic knee hinges.

Methods
20 unilateral transfemoral MFCL-2 amputees, aged 18-75 years participated in a double cross-over design study. Subjects were fitted with a mechanically controlled knee hinge and, in randomised order, an electronically stance phase controlled knee (C-Leg® Compact) and an electronically stance and swing phase controlled knee hinge (C-Leg®). Subjects were trained by a physiotherapist in order to use either knee hinge safely during daily ambulation. After 1 week of home use, subjects visited the lab for trip testing and gait analysis. Cameras recorded performance. At irregular times subjects were tripped during early swing phase of the prosthetic leg. Trip recovery was scored on a 10-point scale by 2 therapists blinded for prosthesis condition. Also a questionnaire on self-perceived performance, stability and safety was used. Based on clinical observation, walking speed and activity levels, subjects were sub-classified into 'low', 'intermediate' and 'high' performing MFCL-2 amputees.

Results
In figure 1, boxplot results of the video raters' scores on trip recovery for all three knee joint conditions are displayed. Overall (median) scores from the 'low' subclass for all three knee joint conditions were higher than the scores of the 'intermediate' and 'high' subclasses.

In the mechanically controlled knee joint condition, mean walking velocity was 2.9 km/h, 3.6 km/h and 3.8 km/h for the ‘low’, ‘intermediate’ and ‘high’ subclasses, respectively. In the C-leg and Compact conditions this mean walking velocity was 2.8 km/h, 3.5 km/h, 4.4 km/h and 2.8 km/h, 3.7 km/h, 4.2 km/h, respectively. Self-perceived stability scores indicated a decreased sense of stability in the ‘low’ subgroup compared to the other subgroups. Perceived stability increased in both microprocessor-controlled knee joint conditions for all subgroups. Fear of falling was higher in the ‘low’ subgroup compared to the other subgroups.

Conclusion

Firstly, the tripping protocol showed that within-subject differences in trip recovery between prosthesis conditions can be detected in MFCL-2 subjects.
Secondly, data, contra-intuitively, suggest that ‘low’ MFCL-2 amputees seem to better recover from a trip than ‘intermediate’ and ‘high’ MFCL-2 amputees. However, both walking velocity and perceived stability were lower in ‘low’ MFCL-2 subjects. Apparently, there is an interaction between trip recovery and walking speed, the latter of which may be mediated by perceived stability. These parameters should be incorporated in any new protocol in which tripping in amputees wearing a leg prosthesis is assessed.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2953-151]

Turkish Reliability and Validity of Satisfaction with Prithesis (SATPRO) Questionnarie in Patient with Lower Limp Amputation

Author
Yazicioglu, Kamil (TR) | Professor, MD
Gülhane Military Medical Academy - Department of Physical Medicine and Rehabilitation, Turkish Armed forces Rehabilitation Center

Coauthors
Safaz I,Yilmaz B, Goktepe AS, Taskaynatan MA

Abstract
Abstract

Introduction
The aim of the study is to adapt the Satisfaction with Prosthesis Questionnaire (SAT-PRO) into Turkish and to assess the reliability and validity of SAT-PRO in lower limb amputees.

Methods
SAT-PRO was administered to 74 lower-limb amputee patients wearing prostheses. One month later, retest was applied to 35 patients. SF–36 was also applied to the same group of 35 patients for validity.

Results
Turkish version of SAT-PRO fitted the one-dimensional construct that the scale was intended to measure and demonstrated good reliability. Cronbach's alpha was 0.83 and items-total correlation ranged from 0.25 (item 3) to 0.80 (items 1). Test-retest correlation coefficient was 0.79. Correlations with SF–36 subscales (except general and mental health subscales) was statistically significant, and ranged from 0.35 (physical functioning) to 0.52 (pain)

Conclusion
We conclude that the Turkish version of SAT-PRO demonstrates good reliability and validity for measuring satisfaction with prosthesis in people with lower-limb amputation.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2998-196]

The Time Course of Depression and Anxiety after Amputation; a Follow Up Study

Author
Singh, Rajiv (Sheffield UK) | Dr
Sheffield Teaching Hospitals - Rehabilitation Medicine

Coauthors
Venkateshwara G, Munjal RK,

Abstract
Follow up of a cohort of predominantly lower limb amputees over 2 years, found that the incidence of anxiety and depression was initially high and reduced gradually from 14.7 and 16.3% to 10.8 and 9.5% for depression and anxiety respectively. There was however no association with mortality.

Introduction
Depression and anxiety symptoms are common after amputation and reported at between 21-41%. (Refs 1-3) However most of these are cross sectional rather than prospective and cannot describe the exact course and frequency of symptoms over a period of time. We decided to look at a population of predominantly lower limb amputees to ascertain the exact time course of depressive and anxiety symptoms after amputation and again at 2 year follow up after prosthetic rehabilitation.

Methods
We followed up a cohort of 184 consecutive referrals with limb amputation at a teaching hospital in Sheffield, United Kingdom between 2005 and 2007. Hospital Anxiety and Depression Scale (HADS) on referral and at 2 years were completed and compared to demographic and patient features. A cut-off of between 8 and 9 has been found to show best diagnostic discrimination.(Refs 4,5)

Results
In 184 consecutive patients, 140(76%) were male, 97(52.7%) were transtibial, 56(30.5%) transfemoral and 29(15.8%) bilateral. There were two upper limb amputees. The majority (159) were vascular in aetiology with another 22 resulting from trauma. Patients were seen on average 6 weeks after amputation. Initially 27(14.7%) and 30(16.3%) patients had symptoms of depression and anxiety respectively. After 2 years, 35 patients had died and in the remainder, 16(10.8%) and 14(9.5%) had depression and anxiety. Symptoms were unrelated to the aetiology or level of amputation or gender ($p>0.05$) but there was an association between having symptoms of both depression and anxiety ($p<0.0001$). Significantly, there was no relationship between mortality at two years and initial symptoms. Those with symptoms were younger than those without; depression 59.4(SD14.0) vs 64.2(14.2), $p=0.02$; anxiety 58.8.0(14.1) vs 64.4(14.0), $p=0.04$.

Conclusion
Depression and anxiety are common after amputation and remain high at two years although the incidence dropped. This may be due to rehabilitation and limb-fitting. While symptoms of both anxiety and depression are associated with each other and with being younger, significantly there is no association to cause or level

of amputation and none to mortality. In future work, we intend to look closely at the outcomes associated with having psychological symptoms

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3036-234]

Analysis of the Process of TF Prosthetic Gait Training Using a Special Prosthesis for Non-amputated Persons

Author
Ojima, Isao (Kobe JP) | Analysis of the process of TF prosthetic gait training using a s
Kobe gakuin University - Faculty of Rehabilitation, Department of Medical Rehabilitation,

Coauthors
Nakagawa A, Okubo S
Faculty of Rehabilitation, Department of Medical Rehabilitation, Kobe gakuin University

Abstract
We made an experiment to analyze the process of TF prosthetic gait training. We made the kinematic, physiologic and metabolic measurement. We could distinguish the difference in the voluntary control means of the knee during stance phase, decrease of energy expenditure and increase of walking speed.

Introduction
Prescription of lower limb prosthesis is based on the physical ability of the amputee to extract the best performance of the gait. Gait training for the lower limb amputees is performed taking into account of variety of the physical conditions. The amputees can show better function with newly developed prostheses, still the importance of the gait training stays unchanged. It is considered that the amputees can train themselves with the objective parameters by measuring their physical condition.
The amputee can reduce the movement of the centre of gravity and energy expenditure and can obtain better gait pattern by gait training, there are few papers to trace the change of these parameters.
This research evaluates the gait training using a special prosthesis for non-amputated persons by the gait analysis system and the metabolic measurement system.

Methods
1. Subjects and training
Three non-amputated sound adults were employed. The prosthesis is composed of a 3R15 knee and a single axis foot. Enough experienced PT set the static and dynamic alignment for each subject. The load baring brake was loosened to eliminate the effect of the brake. Each subject received the training for 40 minutes/day, 3 times/week.
2. Gait analysis and metabolic measurement
We used the 10 camera MAC3D gait analysis system with four force plates. The metabolic measurements at 20, 40, 60, 80 m/min are based on the following protocol. The subjects sat for three minutes, one minute of warming up at the standing position on the treadmill, then walked at each speed for six minutes. We analyzed the data from four minutes after starting to walk to five minutes, then averaged the data during these period.
3. PT evaluation
10 meter comfortable walking speed, 10 meter best effort walking speed, cadence and functional reach test (FRT) has been measured.

Results
1. Gait Analysis Measurement

1) Knee flexion angle
The Knee flexion angle was constant from foot flat (FF) to toe off (TO) after the first training. On the other hand, it was flexed at FF but it extended at Mid Stance and kept constant until TO after the third training. (Fig.1) This indicates that the subject voluntarily controlled the prosthesis.
2) Rotation of Pelvis
The rotation angle of pelvis became symmetric after the third training.
2. 10 meter walking speed, cadence and FRT
Walking speed became faster after third training in all cases. Comfortable walking speed was 13.3 sec at the first and 7.4 sec at the third, the best effort walking speed was 9.7 sec at the first and 6.1 sec at the third. Cadence was 75 step/min at the first and 105 step/min at the third. FRT was 28.7 cm at the first and 33.7 cm at the third.
3. Energy Expenditure
Energy expenditures were low after the second and the third training. They were the lowest at 80 m/min. They were 1.5 times the normal gaits. This experiment showed that the twice training of 40 minutes is enough as training.

Conclusion
The subjects used the alignment stability at first but they used the voluntary control of the knee after receiving training. The movement of the pelvis was more symmetric after the third training. The walking speeds, the cadence and the FRT were increased. Energy expenditure was decreased, it was 1.5 times the normal gait. The TF amputee gait needs more energy expenditure than the normal gait because the amputees lost the knee function.1) To obtain the smooth gait, sufficient training of voluntary control of the knee joint by the hip extensors and control of pelvis is inevitable.2) JM van Velzen reviewed papers related to the relation between the amputee's physical ability and gait performance and reported that the mechanism to improve the gait performance is uncertain, more parameters should be researched to make it clear.
This research is to make this clear by measuring the change of parameters with progress of training.

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Image: Fig.1 Subject-1 Knee angle(stance phase)_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2918-116]

Gait Adjustments in Obstacle Cossing, Gait Initiation and Gait Termination after a Recent Lower Limb Amputation

Author
Vrieling, Aline (Haren NL) | dr.
UMCG - Rehabilitation

Coauthors
Vrieling AH, van Keeken HG, Schoppen T, Otten E, Halbertsma JPK, Hof AL, Postema K

Abstract
The study decribes the adjustment strategies that subjects with a recent lower limb amputation developped in obstacle crossing, gait initiation and gait termination during the rehabilitation process. Innovations in prosthetic design or training methods may ease the learning process of these tasks.

Introduction
During rehabilitation amputees learn to adapt their gait pattern to the prosthesis by training new motor strategies and by adjusting the existing motor strategies. Successful rehabilitation of an amputee does not only include the ability of steady-state level walking, but also the performance of more complex motor tasks such as obstacle crossing, gait initiation and gait termination. In early rehabilitation amputees are inexperienced in walking with a prosthesis and have not yet developed any adjustment strategies. Up to now, it is not known how and when subjects with a recent amputation develop the adjustment strategies that are necessary to step over an obstacle, to initiate gait and to terminate gait in a safe way. The goal of the current research is to establish the changes in several gait characteristics of obstacle crossing, gait initiation and termination that occur during the rehabilitation process in subjects after a recent lower limb amputation.

Methods
Subjects with a recent unilateral transfemoral, knee disarticulation or transtibial amputation were asked to participate in the study. The study was performed in a motion analysis laboratory, which is equipped with a walkway and force plate. Four assessments were performed; T1 when the subject walked approximately two weeks with a temporary prosthetic device, T2 when the subject walked approximately two weeks with an individually fitted prosthesis, T3 two months after T2, and T4 six months after T2. Outcome parameters in obstacle crossing were success rate, gait velocity and hip and knee joint angles in the prosthetic limb. Outcome parameters in gait initiation and termination were the center of pressure (COP) shift and the anteroposterior component of the ground reaction force (GRF). Outcome parameters were assessed separately for the leading and trailing prosthetic limb and non-affected limb.

Results
Seven transtibial, 4 transfemoral and 3 knee disarticulation subjects agreed to join the study. The study group included 11 male and 3 female subjects with a mean age of 57.3 (45.8 - 69.4) years. The cause of amputation was vascular disease in twelve subjects, a tumour in one subject and infection in one subject. In obstacle crossing amputees increased success rate, gait velocity and swing knee flexion of the prosthetic limb. Knee flexion in transfemoral and knee disarticulation amputees was not sufficient for safe obstacle crossing, which resulted in a circumduction strategy. In gait initiation and termination amputees increased

the anteroposterior ground reaction force and the centre of pressure shift in the mediolateral direction in both tasks. Throughout the rehabilitation process the centre of pressure was shifted anteriorly before single-limb stance on the trailing prosthetic limb in gait initiation, whereas in gait termination the centre of pressure in single-limb stance remained posterior when leading with the prosthetic limb. See attached figures that show the COP patterns of an amputee at T1 (grey line) and T4 (black line). (A) In gait initiation the COP is shifted toward the forefoot at the moment of single-limb stance on the right trailing prosthetic limb. Compared to T1 the forward COP was less at T4. (B) When leading gait termination with the left prosthetic limb no anterior COP shift was seen. From T1 to T4 the COP was shifted more towards the heel.

Conclusion

Transtibial amputees required less time to perform the necessary adjustment strategies in obstacle crossing than amputees with a higher amputation level did. Knee flexion in the prosthetic limb of transfemoral and knee disarticulation amputees remained small as time since amputation progressed. In gait initiation and termination amputees could not shift the anteroposterior COP in an active manner when standing in single-limb stance on the prosthetic limb, because the prosthetic limb lacks the ability to actively control ankle plantar and dorsiflexion moments. In general, throughout the rehabilitation process amputees increased the COP shift and the propulsive and braking GRF in both the prosthetic and non-affected limb. In other words, subjects with a recent amputation developped adjustment strategies to improve obstacle crossing, gait initiation and gait termination. Innovations in prosthetic design or training methods may ease the learning process of these tasks.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3389-564]

Low Cost Prosthetic Knee Joint

Author
Lee, Peter (Melbourne AU) | Dr
University of Melbourne - Mechanical Engineering

Coauthors
Bentley R, Rafferty D, Wang SQ, Gao Y

Abstract
The study aims to improve the functionality of the ICRC's trans-femoral prosthetic knee joint. Knee stability was provided using a prototype Wedgelock unit. The free-swing motion of the ICRC's knee joint was analysed using computer simulation.

Introduction
Today's trans-femoral prosthesis incorporates sophisticated knee mechanism that adequately restores an amputee's gait. However, the cost associated with these technologies usually renders it unsuitable for use in developing countries. The International Committee of the Red Cross (ICRC) produces a low cost trans-femoral prosthesis based on the ICRC's polypropylene technology [1]. The prosthetic knee joint is a simple single axis knee joint. It consists of a polypropylene shell and a stainless steel shank. Other mechanisms include a locking lever and a stop bumper made of elastomeric material. In this study, the aim is to improve the existing functionality of the ICRC's knee joint by integrating simple and low cost mechanisms to (a) provide knee stability during the stance phase, and (b) regulate the swing phase during gait. In addition, the improvements would be made with minimal changes to the existing ICRC's knee design.

Methods
Knee joint stability during the stance phase of gait: The advantages offered by the 'safety-knee' are well established i.e. ability to bear weight on a flexed knee. In this study, a Wedgelock design was proposed, using angled washers and a wedge piece attached to the shank section of the prosthesis. When a force is applied, the wedge section squeezes in between the washers and the T-section; effectively tightening the bolt and providing friction to prevent rotation and collapse of the flexed knee (Figure).
Regulating swing phase of gait: A computer simulation was developed using MATLAB to solve the equation of motions for a 2D double pendulum, representing that of the prosthesis. Using experimental data from normal human walking, optimal spring and damper constants were calculated. These parameters were physically implemented onto the ICRC's knee joint using spring. Following, the free-swing motion of the ICRC's knee was compared to that of the Otto Bock 3R90 knee joint.

Results
Wedgelock unit: A prototype of the Wedgelock unit was fabricated (Figure). Initial tests showed that the wedge could be trapped after load application. Changes to the design to prevent jamming have been proposed and currently being tested. They include a stepper wedge angle (i.e. increased sensitivity to load), and nylon washers with larger surface area for increased friction.
Swing phase control: The computer simulation identified the optimal spring and damper constants to be k = 5 N.m.rad-1 and c = 1 N.m.s.rad-1 respectively. Using a simple linear spring attached to the ICRC's knee shell, and an adjustable sliding bracket attached to the prosthesis shank, the spring tension could be increased or decreased (by adjusting a distance (x) between the knee and bracket). Following, a free-swing

motion of the ICRC's knee was compared to the Otto Bock 3R90 knee. The prostheses were attached to a SACH foot and set at 90 deg knee flexion on an inverted fixture. The leg was then released and allowed to swing until vertical. The experiment was filmed with a video camera set perpendicular to the plane of the leg's motion. Tests were performed on: the original ICRC knee, the modified knee and the Otto Bock knee. Tests were also performed for various spring extensions by adjusting the distance (x). The Figure shows the swing phase motion of the prostheses.

Conclusion

The Wedgelock mechanism met the required criteria of low cost and minimal changes. The design was able to introduce friction during the stance phase of gait, capable of bearing weight when the knee is flexed. However, further improvement is needed in order to prevent the knee from jamming after the application of load. The study also showed that the ICRC's knee swing phase could be controlled using a linear spring. Nevertheless, the main difficulty is to develop a robust spring mechanism suitable for usage in the field.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2950-148]

Numerical Topology Optimization in the Development of Prosthetics

Author
Andrysek, Jan (Toronto CA) | Dr.
Bloorview Kids Rehab - Research Institute

Coauthors
Andrysek J, Reist T, Cleghorn W

Abstract
This work investigates the application of topology optimization to prosthetic design, and details the structural optimization of a new prosthetic knee joint. A material reduction of 14% was achieved along with a decrease in overall deflection and a final design suitable for injection molding.

Introduction
Topology optimization is a powerful computational technique for improving the structural performance and reducing the mass of mechanical parts subject to operational loads. As such, topology optimization can facilitate the development of prosthetic components that are lighter, thus improving their utility and performance. It can also reduce the reliance on high-strength materials such as aerospace alloys, thus reducing cost. To demonstrate the application of topology optimization in prosthetic design, the optimization of a prosthetic knee joint that is currently under development was performed using the software suite HyperWorks, which was generously provided by Altair Engineering Inc. The objectives were to i) investigate the potential use of modern topology optimization software in prosthetic design, ii) through material reduction, minimize the mass of an existing prosthetic knee joint prototype, and iii) achieve an injection moldable design for less costly production.

Methods
Based on the original prosthetic geometry (Fig. 1a) an optimization design space was created (Fig. 1b) in which the final structure must reside. All finite element (FE) conditions were specified including element types, material properties, loading conditions (specified by ISO-10328 standards for the LCI, LCII, and the knee-lock (KL) tests)[1], optimization objectives (minimize volume) and constraints (stress below the yield strength and injection moldability). Running the optimization in OptiStruct generated the element density iso-surfaces shown in Fig. 1c. These iso-surfaces represent the optimum distribution of material within the design space, such that the structural criteria are met. This surface geometry was used to create discrete CAD geometry by manually ‘tracing’ over the iso-surfaces, as exemplified in Fig. 1d. FE analysis was performed on this optimized geometry and refined to produce the final optimized parts (Fig 1e). The final optimized prosthetic assembly is in Fig. 1f

Results
The results of this optimization can be viewed through several measures. First, an overall reduction in mass of 14% was achieved through this optimization. Secondly, the compliance for each load conditions, in most cases, decreased. A lower compliance indicates a decrease in the structure’s strain energy and an increase in its stiffness, which is desirable so long as the structure is strong enough to support this increase in rigidity.

It was found that the compliance under LCI remained almost constant, for LCII there was a significant decrease and for KL it increased. Overall, the structure's compliance decreased by 55.1%. The effects of this lowered compliance can be seen in the deflection of the prosthetic. For LCI and LCII there was a decrease in the maximum deflection between the original and optimized designs which corresponds to a decrease in the compliance as noted above, while the maximum deflection for KL increased slightly, along with the compliance. The optimized design has an improved stress distribution throughout, which is desirable so as to use the material more efficiently, yet the maximum stress is similar to the original design and occurs at the pin joint holes due to the bearing loads. The final result is a prosthetic which is lighter in weight, more rigid, and as strong as the original component. Due to injection moldability constraints imposed on the optimization, the final design is also injection moldable for low cost production.

Conclusion

Topology optimization methods are becoming evermore utilized in the design of lighter and stronger aircraft and automotive components, but to our knowledge, this project is one of the first to demonstrate its application to prosthetic design. Using topology optimization in accordance with ISO-10328 specifications, an existing design was optimized to reduce material usage by 14%, reduce the structure's compliance by 55%, and reduce the overall deflection, in addition to achieving a design that is suitable for injection molding. Here, the optimized design has been arrived at numerically, but as part of future work physical verification is needed. The FE analysis results for the original prosthetic agree well with the results of previous structural tests; this lends credibility to the results obtained herein, however structural testing is still required to verify the numerical results.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3000-198]

Pressure Distribution between the Foot and Insole and Subjective Evaluation of Various Alignments during Gait in Transtibial Amputees

Author
Svoboda, Zdenek (Olomouc CZ) | PhD
Faculty of Physical Culture, Palacky University, - Department of Biomechanics and Engineering Cybernetics

Coauthors
Janura M, Rosicky J, Parakova B, Honzikova L

Abstract
Prosthetic alignment is a process based on subjective evaluation by the prosthetist and the patient. One way of objectifying this process is to measure the load between the foot and the insole. Misalignments of the prosthesis length or prosthetic foot position increase loading in unaffected limb.

Introduction
The prosthetic component design, selection and prosthetic alignment are all directed toward obtaining optimal gait (Barth, Shumacher & Thomas, 1992). At optimal alignment, ground reaction force does not cause prosthesis rotation because it influences interaction between the prosthesis and the residual limb (Seymour, 2002). The quality of prosthetic alignment is influenced by subjective evaluation by the prosthetist and the patient (Fridman, Ona & Isakov, 2003; Blumentritt et al., 1999). It is, therefore, necessary to objectify these evaluations.
The aim of this study is to compare loading between the foot and the insole with subjective evaluation of patients using prosthesis at different prosthetic alignment.

Methods
The observed group consisted of 5 men with unilateral transtibial amputation (age 62.6+-6.80 years, weight 89.0+-17.87 kg, height 1.78+-0.07 m, duration of prosthesis use 7.1+-2.01 years). Each subject has experience with the Sureflex prosthetic foot that was used at measurement.
Six gait cycles at each prosthetic alignment (1 – optimal, 2 – shorter prosthesis (-1 cm), 3 – longer prosthesis (+1 cm), 4 – foot with plantar flexion (+5º), 5 – foot with dorsal flexion (-5º)) were measured.
For pressure analysis we used the Footscan Insoles (version 2.39, RSScan, Belgium) with frequency 500 Hz. The evaluated areas were the toe, 1st-5th metatarsal heads, and the medial and lateral heel. At each area we determined the relative contact duration, maximal pressure and pressure impulse. The obtained data was statistically processed by nonparametric test in the Statistica programme (version 6.0, Stat-Soft, Inc., USA). Each alignment was evaluated by subjects.

Results
Subjects indicated longer prosthesis to be worse than the shorter prosthesis. Pressure distribution analysis failed to confirm this conclusion. For both alignments, in comparison with optimal alignment, we found greater maximal pressure and pressure impulse in the medial heel and the first metatarsus of the sound foot ($p<0.05$). On the lateral side of the prosthetic forefoot, the maximal pressure and pressure impulse decreased ($p<0.05$).

Prosthetic foot alignment with increased dorsal flexion in four out of five subjects evaluated to be worse in comparison with alignment with increased plantar flexion. The same result was found at pressure distribution analysis on the contact foot and sole. During alignment to dorsal flexion we found the greatest number of statically significant differences with regard to optimal alignment on both the sound and prosthetic feet. On the prosthetic limb, the relative contact duration of the forefoot was longer. Maximal pressure and pressure impulse in the lateral part of the forefoot (3rd, 4th, 5th metatarsal heads) were smaller ($p<0.05$). On the medial side of the sound foot (toe, 1st metatarsal head, medial heel) relative contact duration, maximal pressure and pressure impulse were higher ($p<0.05$). For maximal pressure and pressure impulse on the sound limb, we found similar differences in prosthetic foot alignment with greater plantar flexion.

Conclusion

The changes in prosthetic alignment in unilateral transtibial amputees within the range of daily activities (prosthesis length ± 1 cm, plantar or dorsal flexion of the foot ± 5º), influence the magnitude and distribution of pressure on contact between the foot and sole. These changes in comparison with optimal alignment increase the load on the sound limb. Loading asymmetry between the prosthetic and sound limbs is greater. The largest differences in pressure variables were found for alignment with greater dorsal flexion when increasing the load mainly on the medial side of the sound limb.
Subjective alignment evaluation of the patient corresponds with the objective pressure analysis on the contact foot and insole at different alignments of the prosthetic foot (plantar and dorsal flexion), but does not corresponds at different prosthesis length.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3463-638]

Analysis of Stance Phase Mechanics of Active Foot Using FEM Model

Author
Cho, Hyeon-seok (Inchon KR) | Analysis of stance phase dynamics of active foot using finite el
Korea Orthopedics & Rehabilitation Engineering Center - Computer Analysis Engineering

Coauthors
Yoon-Hee Chang, Gyoo-Suk Kim, Shin-ki Kim, Mu-Seong Mun

Abstract
The objective of this study is to find design shape of keels for prosthetic foot which have a good active In this study we would find proper design shapes of keels have a good active performance by comparing the finite element analysis results with the experimental results of commercial active foot.

Introduction
Most of trans-tibia amputees can play daily sports activities with prosthetic foot due to their physical characteristics and many of them got these benefits because of advanced prosthetic foot techniques. But these feet are hardly used by amputees in developing country because the prices of that are very expensive.
Active prosthetic foot should have high energy return and natural walking performance. Many of commercial active feet are correspond to the type that realize ankle joint with a set of keels made of carbon fiber reinforced composite having a good elastic performance. Some products realize it with mechanical rotational joints and spring-damper units.
High active Feet have very long and rounded upper keel, like C shape, or multiple keels. In this cases, the active performances are increased greatly but the length of tibia stump is largely limited to amputees who want this unit due to the structures are complex and large.

Methods
We have done thee point bending tests of keels and obtained the material properties for the simulation model. We consider the dosi and plantar-flex performance only because it is the major performance. Accordingly, we could use isotropic material in spite of keel having anisotropic characteristics.
The conditions of simulations are pushing down the foot tilted with dosi and plantar direction. Tilting angles are 20 degrees for both cases. Feet are push down in line with vertical axis and then feet are contacted with floor. We investigate the load-displacement relationships, stresses, and internal energy of keels. The load-displacement relationships of simulations are compared with that of experiments with commercial feet. Then we correct keel shapes from this results and iterate this procedure to find the final model.
The simulation is processed using PAM/CRASH for analyzing large displacement and dynamic models easily.

Results
Heel and toe loading simulation results are compared with two commercial feet, low profile Veri-flex by Ossur © and FS2000 by Freedom ©. These feet are designed for amputee having long tibia stump and basic structures are similar to our model for developing.

The load-displacement curves of the final model obtained by iterating this process are met with that of veri-flex. When keel is downed by 20mm, the heel load is 2400N and the maximum strength is 500MPa less than break strength(600Mpa). When keel is downed by 35mm, The toe load is about 3000N and the maximum strength is 575MPa close to break strength.
As the keels are compressed, the internal energy of keels are exponentially increased in both cases. The foot with toe loading shows that the internal energy of lower keel is twice as much as that of lower keel. In case of toe loading, lower keel has little internal energy and almost energy stored in upper keel.
We found that the minor shape change can affect the mechanical performances of keel seriously from the simulations about various models had been processed until the final model was obtained. We found some critical conditions in keel design and that are as follows.
The fine changes of thickness along the length direction of upper keel dominate the performance of toe-off action. As the load is increased in toe, stress concentrated regions move to the proximal in upper keels and is wider.

Conclusion

The foot model for the diffusion was developed from this study. We obtained the material properties of keel from three point bending test with prototype keels. It is designed that the simulation results are similar to the experimental test results of commercial products about heel and toe loading conditions.
We found the basis for engineering design and evaluated the mechanical characteristics of foot according to the design conditions.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2904-102]

A Method to Assess the Effects of a Lightweight Prosthetic Knee in Poor Performing Amputees

Author
de Laat, Fred (Tilburg NL) | MD
Rehabilitation Centre Leijpark - erwachsenen rehabilitation

Coauthors
Vlaanderen P

Abstract
To assess the effect of a lightweight prosthetic knee, we composed a single-blinded study with 4 transfemoral or knee disarticulation amputees, replacing their knee of stainless steel by the same knee of titanium. The assessment (walking speed and experienced weight) was feasible and sufficient.

Introduction
Many lower limb amputees complain of the heavy weight of their prosthesis. Therefore manufacturers introduced lightweight prosthetic components like titanium. Scientific research did not show any beneficial effect of altering weight, but most of the studies were done with young, active amputees, while the vast majority of the amputees are poor performers. The only study with dysvascular transfemoral amputees showed no effect of added mass to the prosthesis, and half of the subjects preferred an added mass condition. The effect of lowering the mass of the prosthesis in poor performing amputees is never investigated. Therefore the aim of the study was to develop a method to assess the effect of lightweight prosthetic components in poor performing amputees.

Methods
Subjects:
Two transfemoral amputees (TF), mean age 65 year, and two knee disarticulation amputees (KD), mean age 63 year, were selected. They were used to a four-bar linkage knee of stainless steel (TF: Otto Bock 3R20®, mass=755g, KD: Otto Bock 3R21®, mass=875g).
Protocol:
T0: assessment (see below), then OB3R20® is added with 310g (plate of lead) behind the knee, under the cover; OB3R21® is added with 220g.
T1:assessment, then OB3R20® with 310g is replaced by OB3R36® (titanium knee, weight 445g) added with 310g, (mass=755g); the OB3R21® is replaced by OB3R30® (titanium knee, weight 755g) added with 220g, (mass=875g).
T2: assessment, then the added weight is removed, so only the lightweight device is built in.
T3:assessment.
The interval time between the assessments was 3 weeks, to get used to the new weight.
Assessment:
Heart rate in rest and while walking in a self selected walking speed along a figure-of-eight path measuring 25 meters. The PCI was calculated.Experienced weight.

Results

Before the first change of the weight all amputees experienced their prosthesis to be heavy and expected to walk easier and faster with a lightweight prosthetic knee.

All amputees were able to walk the circuit. The walking speed was stable after one figure-of-eight, the heart rate was stable after 4 figures-of-eight (100m).

The resting heart rate before walking differed a lot, moreover two of the amputees had altered their #-blockers during the study, so the PCI was not a reliable parameter.

Three out of four amputees didn't notice any difference in weight in the 4 assessments and they had no change in walking speed (v>30m/min). Only the amputee with the lowest self selected walking speed (v=24 m/min) noticed both the heavier weight and the lower weight. With the heavier weight, her speed didn't change, but it did increase with the lightweight knee to v=27 m/min.

Conclusion

In poor performing amputees, it is possible to replace heavy, stainless steel components in lightweight components. To test the effect of lowering weight in transfemoral or knee disarticulation amputees, an assessment is described, consisting of walking, including turning, and a question about experienced weight is feasible and sufficient. The PCI is not an appropriate parameter. Preliminary results show that only a very poor performing amputee (walking speed less than 30m/min) benefits of a lightweight prosthetic knee component.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2917-115]

Balance Control on a Moving Platform in Unilateral Lower Limb Amputees

Author
Vrieling, Aline (Haren NL) | dr.
UMCG - Rehabilitation

Coauthors
Vrieling AH, van Keeken HG, Schoppen T, Otten E, Halbertsma JPK, Hof AL, Klaas Postema K

Abstract
Balance control on a moving platform was tested in unilateral lower limb amputees and able-bodied subjects. The results indicate that amputees compensate for the loss of ankle strategy by increasing movements and loading in the non-affected limb.

Introduction
Lower limb amputees are unable to use the same motor strategies for balance control as able-bodied subjects and therefore have to adjust the habitual stance control strategies and develop new strategies. Static balance tests may not be sufficiently challenging to detect essential strategies for maintaining balance in daily activities, since balance control is often required during ambulation. In this study we focused on the performance of more complex balance tasks in amputees by moving a platform, depriving vision and adding a dual task. The first aim was to establish the balance control strategies of the prosthetic and non-affected limbs in amputees and of able-bodied subjects during standing on a moving platform. The second aim was to study the influence of visual deprivation and an acoustic dual task on balance control strategies.

Methods
Unilateral transfemoral and transtibial amputees and able-bodied control subjects were included in the study. Balance measurements were performed on the Computer Assisted Rehabilitation Environment system (CAREN) which consists of a platform that can rotate around three orthogonal axes and translate in three directions along these axes. The platform contains two built-in force plates to register ground reaction forces (GRF). Balance control was tested while the platform moved in the anteroposterior direction under three conditions: eyes open, blindfolded and while performing a dual task. Outcome measures were weight bearing symmetry, anteroposterior GRF and centre of pressure shift (COP).

Results
Eight amputee subjects and nine able-bodied subjects agreed to participate in the study. Amputees significantly preferred to bear weight on their non-affected limb in all three conditions. The Weight Bearing Index (WBI) in amputees was significantly more asymmetric than in able-bodied subjects. In amputees 62–63% of the body weight was loaded on the non-affected limb. The anteroposterior GRF in the non-affected limb of amputees was significantly larger in comparison with able-bodied subjects in all three conditions. The anteroposterior GRF in the prosthetic limb of amputees was also larger than in able-bodied subjects, but only significantly in the normal condition. In the normal and dual task conditions the anteroposterior COP shift of the non-affected limb in amputees was significantly larger than in able-bodied subjects. The anteroposterior COP shift under the prosthetic limb in amputees was lower than in able-bodied subjects

in the blindfolded and dual task conditions. A typical example of the anteroposterior GRF and COP in the prosthetic and non-affected limbs of a subject in the amputee group during the normal condition is presented in the attached figure. The only significant effect of condition was demonstrated in able-bodied subjects in which the anteroposterior COP in the blindfolded condition was increased compared to the normal condition.

Conclusion

Compared to able-bodied subjects, in amputees the anteroposterior GRF was larger in the prosthetic and non-affected limb, and the COP displacement was increased in the non-affected limb and decreased in the prosthetic limb. In amputees body weight was loaded more on the non-affected limb. Blindfolding or adding a dual task did not influence the outcome measures importantly. The results of this study indicate that experienced unilateral amputees compensate for the loss of ankle strategy by increasing movements and loading in the non-affected limb. The ability to cope with balance perturbations is limited in the prosthetic limb. To enable amputees to manage all possible balance disturbances in real life in a safe manner, we recommend to improve muscle strength and control in the non-affected limb and to train complex balance tasks in challenging environments during rehabilitation.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2955-153]

Segmental Contribution of the Lower Limbs to the Center of Gravity Velocity for the Trans-femoral Amputee During Running

Author
Nagakura, Yuji (Kumamoto JP) | Segmental contribution of the lower limbs to the CG velocity for
Kumamoto Health Science University - Rehabilitation

Coauthors
Matsubara S, Kaburagi M,Sasakawa T,Yamamoto S

Abstract
Contribution of thigh and pelvis to the center of gravity (CG) velocity coused difference between prosthetic side and that of sound side during trans-femoral(TF) amputtee running.
These results indicated that this technique used in predicting on the segment a contribution to the CG velocity.

Introduction
Motion analysis is an effective tool for evaluating and quantifying effects of a rehabilitation on a amputee running.
Detection of how generated the acceleration area during running was based on finding significant differences of between prosthetic limb and that of sound limb.
In addition, there has been considerable interest in how lower limb segments contribute to the CG velocity during running.
There fore, comparing contribution of the affected of lower limbs to the CG velocity with unaffected in trans-femoral (TF) amputee has a special sginicance.
The purpose of this study was to investigate the segmental contribution of the lower limbs to the CG velocity for the TF amputtee during running.

Methods
The running up on TF amputee(25years,174cm, 67kg) was analyzed. After the explanation of the procedure and safty of the experiment, informed consent was obtained from the subject. Three dimentional coordinates of 39 reflective markers attached to the subject were obtained with an optical motion capturing system (motion analysis) with six cameras operating at 120Hz, which was synchoronized with three AMTI force platforms.
Subject was asked to run at a self-selected speed on the laboratory floor under which the force platforms mounted.
Prosthetic which used in this study was OTTOBOCK 3R55 and OTTOBOCK SPRINTER.
Each subject’s running kinematics of the pelvis, thigh, shank and foot of lower limbs during running were calculated useing methods described by previous study.
Cotributions to the CG velocity of the pelvis, thigh, shank and foot segmental and impulse duing a running were also calculated useing methods described by previous study.

Results

Figure 1 shows grand reaction forces in the stance phase for the TF amputee's running. In the medio-lateral grand reaction forces in the stance palse, while the medial value of the affected was greater than that of unaffected the affected limb and unaffected limb was indicative of similer pattarn.
In the positive impulse of the unaffected limb (18.59 kg#m/sec) was greater than that of the affected (7.03 kg#m/sec).In the negative impulse of the unaffected limb(-16.84 kg#m/sec) was greater than then that of the affected (-2.21 kg#m/sec).
Figure 2 shows vector of grand reaction forces with stic picture inthe stance phase. In the rate of stance phase, fore-aft garand reaction forces of the affected was smaller than that of the unaffected.
Figure 3 shows vector of grand reaction forces and segment angular velocity with stick picture.
At the foot-flat, thigh and shank angular velocity of affected limb neutralized each other while thigh and shank angular velocity of the indicated oppsite anguler velocity.

Conclusion

Prothetic side doesnt take part from contribution of acceleration and the deceleration few in the control of the transport speed for sound side.
Speed up becomes possible by choosing the category of the foot-ankle assembly that suits the stump muscular power and running speed though the category of prothetic foot has been decided by weight and briskness.
The speed is controlled by thigh and shank angular velocity of affected limb neutralized each other this.
The difference between prothesis and sound by the stance phase had angular velocity with which thigh and shank conflicted by sound, and there was angular velocity to the same direction in prothesis.
It was thought that this movement was controlled by pelvis and the body trunk to compensate for the movement of prothesis side.
The difference at the speed in both sides will decrease if it comes to be able to do the movement similar to sound side in prothesis side.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3167-358]

Prosthetic Rehabilitation of Patient with Transfemoral Amputation Due to Vascular Complications after Intra-venous Drug Addiction

Author
Vitaz, Mirjana (Belgrade RS) | Mrs.
Specialized Hospital for Rehabilitation and Orthopedic Prosthetics - physical therapy

Coauthors
Teofilovski M, Majkic G, Janjic Z

Abstract
WHO:‘‘Drug is a chemical substance, such as a narcotic or hallucinogen, that affects the central nervous system, causing changes in behavior , personality and perception”.The most difficult complications are occlusions of blood vessels, gangrene, amputation on different levels and mortality.

Introduction
Drug addiction is a global medical and public health-care problem.There are three categories of changes which are developed as a consequence of drug abuse: behavior, social and physical changes.Infections in groin are a common clinical problem in these patients. Severe vascular complications are rare but if they occur, therapy is difficult and requires emergency management and surgery because of bleeding problem.Intravenous drug abuse is a specific health care problem. Vascular complications following intravascular inguinal self-injection of addictive drugs are rarely seen. An efficient therapeutic concept is needed because, besides the risk of vascular injuries, infections ranging up to systemic inflammatory response syndrome or sepsis might occur.

Methods
A male patient at the age of 32 , a long lasting intravenous drug addict, with hepatitis C, and transfemoral amputation on right side, was observed in our hospital. At the beginning of treatment, a therapeutic evaluation was performed, also the anthropometric measurements, such as manual muscle test,range of motion, Narang Test,circumference of valid and residual limb, patient’s height and weight. We performed specific excerscises on a balance board,weight bearing, weight shifting activities.We used the elements of PNF (proprioceptive neuromuscular facilitation)technique, which included a phenomenon of irradiation, successive induction, rhythmic stabilization, initiation, agonist reversaand . The patient was given bandaging in preprosthetic phase of rehabilitation. All the time the patient was on methadone therapy, as a substitutive therapy of drug addiction. The members of patient´s family were not active participants in this treatment, inspite of necessity in this delicate case.

Results
After the prosthetic team evaluation , the patient got a transfemoral prosthesis with quadriaxial prosthetic knee joint (3R20 Otto Bock)in our prosthetic department.During a prosthetic rehabilitation, patient learnt how to use the prosthesis while walking on different surfaces,indoors and outdoors, going upstairs, downstairs, uphill, downhill..At the beginning of gait training he used below-elbow crutches,but at the end he walked with one outdoor and without any indoor (Narang II level).Patient has succeeded to achieve control of requested positions with prosthesis, swing phase and stance phase.Weight bearing and weight

shifting were improved. In activities of daily living the patient has improved the functionality and self-confidence.

Conclusion

Amputation moreover mean a loss in mobility, a great psychological trauma for the patient who, besides, may fear that the amputation reduces acceptation by others. Apart from this, the loss of part of the body changes the self-image of the patient and his or her self-esteem.The great deal in successful recoverment and reintegration has a team-work, which includes a cooperation between physician (and other specialists), physiotherapist, prosthetist, nurse, psychologist, social worker and patient and his family.
A long lasting history of drug addiction has a huge influence and complicates the rehabilitation of amputees. There are three categories of changes which are developed as a consequence of drug abuse: behavior, social and physical changes.
Complications are developed due to way of taking in, length of consumption and the sort of drug. . That requires a specific therapeutic treatment and education of all members of prosthetic-rehabilitation team.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3253-434]

Development of Sport Prostheses: the Experience of the INAIL Prostheses Centre

Author
Boccafogli, Enrico (Vigorso di Budrio (BO) IT) | engineer
Centro Protesi INAIL - R&D

Coauthors
Hamoui G, Cutti AG

Abstract
A description of the activity of the "Centro Protesi INAIL" in design and application of prosthetic devices for sports.
Devices tests in applications for Paralympics athletes
Test results

Introduction
“Centro Protesi INAIL” is one of most important prosthetic centers in Europe,
One of the main activities of the Research Division is the design of different prosthetic limbs for a variety of sports and recreation activities.
The development of effective prosthetic devices for use in sport engages a number of scientific disciplines, including kinesiology, bio-mechanical engineering, structural engineering (design and construction principles), materials and fabrication experts (optimal metals and composites), coaching input, and the athlete. Once operative, a prosthetic used in sport will involve the ongoing support of experts from the sports medicine, orthopedic medicine, physical therapy, and athletic therapy disciplines.
The Research division of “Centro Protesi” developed in last years some kind of prosthetic devices for sport activites, like:
• Running
• Long jump
• Swim
• cyclism
and we tested our solutions internally, on the patients of the Center.

Methods
The prosthetic design methods (socket, modular components, artificial joints etc.).
Construction of prosthesis
Test on the patients

Results
Evaluations of the "on the patient" tests results, finalized to the improvement of the prosthetic devices for sports.

Conclusion
The prosthesis designed and made by Centro Protesi INAIL have been tested and evaluated by a heterogeneous group of amputee patients.

From paralympic athletes to a common activity level amputees, in each case we had good results in terms of performance, but specially our main goal is the reintegration of the patient in everyday life.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3275-450]

Investigation of the Effects of Passive Realignment of a New Ankle/Foot Prosthesis on Trans-tibial Amputee Gait

Author
Burns, John (Glasgow UK)
Strathclyde University - Bioengineering

Coauthors
Spence WD, Solomonidis SE

Abstract
The Endolite Echelon foot is designed to passively realign during walking in order to adapt to the terrain underfoot. This investigation aims to quantitatively assess the effect of passive realignment on the prosthetic socket interface pressures and gait.

Introduction
When a person walks up or down a slope there are gradient dependant adaptations in joint angles at the ankle, knee and hip which occur to aid in clearance and placement of the leading foot [1, 2]. However, a lower limb amputee is at a disadvantage as their prosthesis will generally be aligned for walking on level ground and while modern feet are flexible and can conform to uneven surfaces it will always try to return to that alignment. The Echelon foot (Endolite) is designed to address this issue. It is capable of dorsiflexion and plantarflexion under the control of two adjustable and independent hydraulic dampers. These permit passive realignment of the foot on uneven surfaces with the goal of improving stability and reducing loading at the socket on such terrain. The purpose of this investigation is to quantify the effect this design has on trans-tibial amputee gait and prosthetic socket interface pressures during walking on level ground, inclines and stairs.

Methods
Unilateral trans-tibial amputees will be recruited via a local amputee support service. Subjects will be a minimum of 1 year post amputation, and free of any residual limb, musculoskeletal or neurological pathologies that may affect their gait. An instrumented prosthesis will be manufactured for each subject with mounting points for pressure transducers. An eight camera Vicon Motion capture system and four Kistler force-platforms will be used, with passive markers on the pelvis and lower limbs, to obtain kinetic and kinematic data. The system will also be used to collect data from pressure transducers attached flush with the inside surface of the prosthetic socket. Data will be collected for walking on level ground, a 7 degree incline and stairs. In order to assess the effect of the hydraulic unit each task will be performed using the Echelon foot and repeated with an Esprit foot.

Results
Preliminary results of an analysis of lower limb joint angles, moments and prosthetic socket pressures will be presented.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3422-597]

Hydraulic Properties of 6-Bar Prosthetic Knee Joint, NK-6 Symphony

Author
Okuda, Masahiko (Kobe JP)
NABTESCO Corporation - Welfare products department

Coauthors
Yoshiaki NAKAYA,Taishiro MISAO

Abstract
Forced swing measurements showed hydraulic properties during knee flexion of a newly developed 6-bar prosthetic knee joint, which were compared with those of conventional knee joints. The results suggested that the developed knee joint could reduce an amputee's burden and enhance a cadence response.

Introduction
Using hydraulic cylinder for swing phase control can bring compact design of a polycentric knee joint. However, amputees generally express that hydraulic knees give them a larger burden than pneumatic knees. The reason can be that hydraulic resistance increases dramatically at an early stage of knee flexion in the late stance phase or a push-off period, and then the resistance force transmits to their stumps. To solve this problem, several efforts have been done the way multiple throttle valves set up on the hydraulic cylinder. However it produced unnatural properties rather than the pneumatic cylinder did. Consequently, we tried to reduce the hydraulic resistance at the push-off period by applying nonlinearity of force-moment conversion of a polycentric linkage, in order to obtain ideal properties similar to those of pneumatic knees. The purpose of this thesis is to show hydraulic properties of the developed 6-bar prosthetic knee joint, NK-6 symphony.

Methods
Measurements were carried out by a swing machine, in which motor rotation was transferred to forced swing of the knee joint by a link mechanism. The knee joint was settled on the machine through a pylon load cell, which measured 6 components composed of force and moment that transferred to a holding part of the knee. In these measurements, we used only the moment on a sagittal plane (My). The developed 6-bar prosthetic knee joint, NK-6 symphony (Nabtesco corporation, Japan) was measured. A throttle vale for flexion resistance was opened by 100 degrees from fully closed position. Three different swing frequencies, 1.0Hz, 1.4Hz and 1.8Hz were chosen. For comparison, 3R60 and Total knee were measured by the same method. Each valve was set to the position suited to normal speed waling.

Results
Figure 1 shows a result of NK-6 at 1.4 Hz, which describes a relationship between knee bending angle and moment (My). My is normalized by the maximum value. The initial My of NK-6 at flexion angles of 0 to 25 degrees is small, less than 30% of the maximum value, and then exponentially increases at 25 to 45 degrees. After that, it reaches maximum at 55 degrees, and falls down at 60 degrees. When the hydraulic cylinder was removed, My was almost constant, ~0.3, during the knee flexion, which might indicate rotational resistance (Mb) of axes on the linkages. At the other frequencies, the results had the same tendency. The maximum values increased as the increase of the frequency. The maximum value

at 1.8Hz was 1.4 times as great as that at 1Hz. Fig.2 shows a result of 3R60pro at 1.4 Hz. The initial My goes up and reaches the maximum at 25 degrees, and then gradually decreases (enhancement of the resistance after toe-off period can not be found). Fig.3 shows a result of Total knee. The My remains constant at flexion angles of 0 to 40 degrees, and then it jumps up at approximately 40 degrees (the enhancement can not be said to be ideal because of its discontinuity).

Conclusion

The moment values, subtracted Mb from My, are due to hydraulic resistance of the knee joint. It is considered that the hydraulic resistance at the push-off period (knee flexion angles of 0 to 25 degrees) can put a burden on amputee’s stumps, and the enhancement of the hydraulic resistance after the toe-off period (knee flexion angles of 40 to 60 degrees) can lead to a cadence response. Therefore, it can be concluded that the developed 6-bar hydraulic knee, NK-6 symphony, possesses idealized hydraulic properties, which enables amputees to enjoy less fatigue and more varying speed walking compared to the conventional knees.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3408-583]

Application of the Lower Limb Prostheses for Long Stumps in Japanese Life Style

Author
Asami, Toyoko (Saga JP) | Application of the lower limb prostheses for long stumps in Japa
Saga University Hospital - Rehabilitation Center

Coauthors
Naoya Yamanouchi1, Makoto Eriguchi,
Nanae Akiyama, Kanako Kodama ,Akihiko Asami,
Yoichi Arizono

Abstract
In Japan, we have the life style without shoes in door. This time, we devised about the lower limb prostheses for long stumps. In result, the present prostheses for 2 cases were useful.

Introduction
It is important to make the lower limb prostheses for lower limb amputees in consideration of patient's needs about the factor such as not only function but the appearance or wearing. We experienced 2 cases wearing the lower limb prostheses we devised .The present lower limb prostheses were useful for them.

Methods
[Cases 1] He was an elderly man, with a left Syme disarticulation amputation that occurred following gas gangrene of his foot in 1994.He has had his current prosthesis, a Syme prosthesis. And, he has walked without a Syme prosthesis in door. Recently, he has had to wear the Syme prosthesis because he had weight pain due to stump's atrophy. But, it was not easy to put on / off the Syme prosthesis when he went to toilet every midnight. So, we devised a lower leg prosthesis to put on / off easily for him. To provide structural support and a comfortable fit, the formed socket with posterior open was made to have adequate thickness and strength.
[Cases 2] She was an elderly woman, with a right Lisfranc disarticulation, a left Chopart disarticulation and all fingers amputations that occurred following angitis in 2008. As she had disabilities to pinch, we devised bilateral lower leg prostheses to put on / off easily for her. These had the formed socket with posterior open.

Results
In case 1, it was easy to put on / off the present lower limb prosthesis when he went to toilet every midnight (Fig. 1-1,1-2).
In case 2, the lower leg prostheses were high quarter shoes type. It was easy to put on / off the present lower limb prostheses though she had disabilities to pinch or grasp .It is always necessary to her , now (Fig. 2-1,2-2,2-3).

Conclusion
In this study, we devised about the lower limb prostheses for long stumps. In result, the present prostheses improved the ADL in 2 cases.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3305-480]

Socket Materials and Perspiration: Development of the Superabsorbent Polymer Socket Interface

Author
Takashi, Nakamura (tokorozawa JP) | Ph.D
National rehabilitation center - Research institute

Coauthors
Toyama, S.

Abstract
The purpose of this research is improvement of the socket discomfort for perspiration.
We developed the superabsorbent polymer socket interface by employing the electrospinning technology.
Use of the developed interface decreased the moisture percentage of the skin of the stump.

Introduction
Perspiration in the prosthetic socket is one of the serious problems to be solved. In summer season most of Japanese Amputees feel discomfort about their wet stumps in their sockets. Previously we reported the effect of the socket material for perspiration and the superabsorbent polymer holds enormous potential as the socket interface [1]. In this paper we report the development of the superabsorbent polymer socket interface and its distinctive material property for perspiration in the socket.

Methods
Material: The superabsorbent polymer socket interface was prepared by employing the electrospinning technology [2]. This method sprays polymer solution from the nozzle by applying high voltage on the tip of the nozzle (Fig. 1), and produces a membrane composed of submicron-diameter fibers (Fig 2). In our case we used a polymer solution that contained both a water-adsorbing polymer and a supporting polymer. The obtained material was a nonwoven stretch fabric and was converted into stump socks.
Subject: eight male unilateral transtibial amputees
Experiment: Each amputee wearing the lower limb prosthesis (PTB socket with/without the developed interface) was subjected to 15 min walking. The values of the moisture percentage of the skin were compared before and after the walking.

Results
The result is shown in Figure 3.
Use of the developed superabsorbent polymer socket interface decreased the moisture percentage of the skin of the stump. This level was lower than the moisture percentage of the sound leg after walking. In addition the interface was not affect the socket fitting because of the thin fabric (ca.0.1mm in thickness)

Conclusion
We developed the superabsorbent polymer socket interface by employing the electrospinning technology. The developed interface improves the skin condition of the stump in the socket and might make it possible for amputees to overcome some of the discomforts associated with wearing prostheses. Another benefit is use in the same way as stump socks. The interface might be applied to various types of the prosthetic socket.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3303-478]

Sinridhorn National Medical Rehabilitation Centre (SNMRC) Guideline for Prosthetic Knee Test in Thailand

Author
Suvapan, Daranee (Nonthaburi TH) | Dr
Sirindhorn National Medical Rehabilitation Center - Physical Medical and Rehabilitation

Coauthors
Sorachaimetha P,Junsaard T,Sittakornkovit D,Onmanee P

Abstract
Summary
This report describes SNMRC guideline for prosthetic knee tests in Thailand, aims to assess mechanical properties required in ISO 10328:2006 and function of new designed prosthetic knee by observation, optoelectronic motion analysis system and questionnaires to promote development of prosth

Introduction
Nowadays prosthetic service in Thailand is constantly growing as the government and society become more aware of amputees' potential capabilities. The appropriate prostheses are provided for individuals to maximize their functional capabilities, hence improve their quality of life. The prosthetic provision is currently inadequate due to the limited budget and expensive imported components. This urges the development of the prosthetic devices in Thailand.
Sirindhorn National Medical Rehabilitation Centre (SNMRC), a leader in provision of prostheses, has high potential to facilitate the development of prosthetic devices, in particular a prosthetic knee joint. SNMRC intentionally serves as a prosthetic testing centre for mechanical and clinical evaluation of developing prosthetic knee joints
This report describes development process of the guideline to test the prosthetic knee utilized in SNMRC for safe in use and the development of the prosthetic knees.

Methods
There are 5 main steps1 as following:
2.1 Proposal step The proposal is submitted for vote by SNMRC prosthetic research committee to carry out the framework and form the working team.
2.2 Preparatory step This involves literature review and discussion among the working team members, and external specialists. The visit to Blatchford & Sons -design and mechanical testing centre- is arranged.
2.3 Enquiring step The submitted draft is discussed by the SNMRC prosthetic research committee. The consensus should be reached on the appropriate tests described.
2.4 Approval step The final draft is circulated among the SNMRC prosthetic committee for the final vote on the publication as the SNMRC guideline. If two third majority of the committee are in favor without any objections, this draft will be approved as SNMRC guideline for prosthetic knee test. Otherwise, this draft will be revised.
2.5. Publication step The approved draft will be published as the SNMRC guideline for prosthetic knee test

Results
The SNMRC guideline for prosthetic knee test consists of 5 main stages:

3.1 Design of the new prosthetic knee. The designers must state the user's indications clearly.
3.2 Manufacture of prosthetic knee prototypes. The minimum of 4 prosthetic knee prototypes should be submitted for next stage.
3.3 Initial mechanical tests. The specimens are subjected to static proof test and cyclic test stated in ISO 10328:2006 before functional evaluation ensuring safe in use2,3. The specimens are required to complete 600,000 cycles without significant deformation. Otherwise the specimens must be modified i.e. return to the design stage.
3.4 Clinical test. The function of the prosthetic knee is assessed by 3 methods: clinical observation4, questionnaires5 and optoelectronic motion analysis system6.
3.5 Claim for compliance with ISO 10328:2006 .The centre are capable of running principal structural tests and separate test on knee lock.If the designed prosthetic knees pass these tests, they are sent to the testing centre abroad for compliance with the international standard before this prosthetic knee model could be prescribed for SNMRC customers.
The equipment utilised in SNMRC is the servo-pneumatic benchtop testing machine for the principal structural tests and separate test on knee lock and the optoelectronic motion analysis for functional evaluation.These are supported by Structural Adjustment Loan (SAL) to promote human resources in Thailand.

Conclusion
The principals of guideline development process are literature review and consensus from internal and external prosthetic specialists and users i.e. trans-femoral amputees.
This guideline is utilized to facilitate development of prosthetic knee in Thailand by establish safety of use through the assessment of the conformity of prosthetic knee with the strength requirements and obtain information on functionality leading to prescription and promote further research.
Currently there is co-research on the development of a polycentric four-bar linkage knee joint prosthesis and endoskeleton prosthetic component without foot component between SNMRC and the other organizations. This guideline will be reviewed and revised after the completion of this project. Afterward it will be revised every 3 years for updated information and advance technology available.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3298-473]

A Case Study Review of the Progression and Trends of Selected Settings Programmed into the Power Knee™

Author
Beachler, Mark (Washington, DC US)
Walter Reed Army Medical Center - Orthotics and Prosthetics

Coauthors
Beachler, M.D., Wolf, E.J., Miller, J.A.

Abstract
This study examines the progressions and trends of selected settings programmed into the Power Knee™ of seven male Service Members with a transfemoral amputation. The objective is to increase our understanding of how to optimize the programming of the knee in order to enhance the subject's gait.

Introduction
The relationship between the transfemoral amputee and how they ambulate is relevant to optimal prosthesis design (1). This is more evident with microprocessor controlled knee units which require programming adjustments. Unlike conventional prosthetic knee devices which rely on the user's own power for movement, the Power Knee™ (PK, Ossur®, Reychavick, Iceland) provides active knee flexion and extension. This active motion may help unilateral transfemoral amputees improve their mobility, reduce elevated energy expenditure during gait (2), and reduce compensatory loads on the non-amputated limb (sound side). This case study includes 7 subjects that participated in a larger clinical investigation of the PK at Walter Reed Army Medical Center. In this study we examined the progression and trends of selected settings programmed into the PK of these individuals. The goal of this study is to improve the gait pattern of patients by optimizing the setting programmed into the PK.

Methods
This prospective study included seven male Service Members between the ages of 21 and 35 years who sustained unilateral transfemoral amputations secondary to trauma. Subjects were independent high activity community ambulators who were prescribed with a total surface bearing, ischial containment suction socket, a PK, and a LP Variflex™ (Ossur®, Reychavick, Iceland) foot. Alignment was set to manufacturer's recommendations. Initial power knee settings were set to "advanced level 3" and corresponding default settings were used. Initial PK fitting and training consisted of 3 days with level ground walking, sitting, walking on inclines/declines and ascending/descending stairs. An additional six weeks of training was provided by a physical therapist and prosthetist, both specialized in PK training. Throughout the training changes to the PK settings were conducted to optimize the function of the PK for an improved gait pattern. All setting changes were dated, recorded, and stored.

Results
Figure 1 shows the percentage value (a value of 1 represents 100%) for Stance Flexion Support (SFS) in descending stair mode for each individual program setting change made. A higher percentage value indicates an increase in SFS.
The SFS percentage value settings in descending stair mode are shown trending upwards with subjects 1-5 as training on the PK progressed. Subject 6 overall value trends decreased and subject 7 overall

value trends remained the same. The settings for SFS while descending ramps in subjects 2, 4, 5, and, 7 increased in overall value while subjects 1, 3, and, 6 remained the same.
During ascending stairs the setting values in subjects 1, 2, 4, and, 5 increased for the Stance Extension Support (SES), while values in subjects 3, 6, and, 7 were unchanged overall. The SES in subjects 2, 4, 5, 6, and, 7, while ascending ramps increased in value and subjects 1 and 3 remained the same overall.
The first and third values of subject 6 in the SFS while descending stairs and SES while ascending stairs were in the off mode. These values were eliminated from the trend calculations.

Conclusion

The general upward trend in the SFS while descending stairs and SES while ascending ramps may suggest that the subject's confidence in the PK increased with experience. Subjects had a tendency to use less assistance (i.e. handrail support) while descending stairs and ascending ramps as experience using the PK increased. This in turn, increased both the weight load through the PK and the required support settings. While ascending stairs and descending ramps the trend was not so clear. There were four subjects with an increase in SFS and SES and 3 that remained unchanged overall. Subject 6 had a tendency to use the handrail more often secondary to a same side transradial amputation. The subject's handrail use resulted in offloading the PK as indicated by a decreased SFS value while descending stairs.Continued investigation of the PK settings and trends would help to gain a better understanding of how best to optimize the programming of the knee and enhance the subject's gait.

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Image: Dave Beachler fig 1_None.JPG (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3169-360]

Prosthetic Rehabilitation of Patient with Easy Mentally Retardation

Author
Stojanovic, Slavica (Belgrade RS) | Mrs.
Specialized Hospital for Rehabilitation and Orthopedic Prosthetics - medical section

Coauthors
Vitaz M, Blagojevic T, Teofilovski M, Vidakovic-Maksimovic B

Abstract
Mentally retarded patients with amputation on different levels requires specific treatment.
Key words: amputation, prosthetic rehabilitation, mental retardation.

Introduction
Rehabilitation program has to be created according the mental potentials of mentally retarded patient. Patient´s family has to be included in treatment. That is the only way to achieve a reintegration of patient.

Methods
A male patient, at the age of 19, was hospitalized in our institution after the amputation of left leg on transfemoral level, caused by traffic accident. In his biography was that he had finished only four classes of elementary school. At the admission, there were: postoperative oedema, operative incisia with crusts on amputated side and cicatrix after trauma of right leg. Communication with patient was difficult because of his mental retardation and hearing deficit.
An integratitive prosthetic rehabilitation was performed according to patient´s functional and mental capabilities(IQ52).All members of prosthetic rehabilitation team were included in program.patient was independent in simple ADL. In contacts with people he behaved addictively and weak-willed. Patient had unstable gait with crutches, lack of GMS. Elements of PNF were performed.

Results
GMS was improved, as coordination in gait training. After a team evaluation a transfemoral prosthesis was made in our hospital. In ADL patient was more independent, he achieved better functionality.

Conclusion
Prosthetic rehabilitation was performed to achieve the reintegration of patient and the important factor of success includes patient´s family.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3471-646]

Effects of Prostheses Knee Joints Flexion-extension Resistance Degrees on Pelvic Tilts in Three Planes During Unilateral Above Knee Amputees Walking

Author
Malekmohammadi, Sedegeh (Tehran IR)
Iran Medical Sciences University

Coauthors
Malekmohammadi,Sedegeh

Abstract
Recently,there are some above knee unilateral amputees who have eccountered with pelvic tilt abnormalities and secondery problems after using prosthesis.
Since prosthetic knee joint has basic role in prosthetic gait pattern,to find solution, it was decided that flexion-extension resistance of knee joint is changed and its effects on pelvic tilt on both sides(sound and prosthetic sides)in three planes was studied through VICON motion analyzersystem during amputee walking.

Introduction
Above knee amputees have to use prosthesis in order to resume optimal level of independence.To ensure that this is possible,prosthesis components and alignment are important factors.Knee joint is one of the basic components which influences gait pattern that results in pelvic shifting during walking.Pelvic connects lower limbs to the trunk.Every changes in the position of pelvic will be transfered to the both directions and vice versa ;besides,pelvic must be adapted with two types of walking(ie,sound and prosthetic sides)simultaneously.Pelvic angle in three planes,affects body segments during either standing or walking as well as balance,stability,base of support and erect posture which over time will will lead tofurther problems.
There are many above knee amputees who have encountered with this problem after prosthesis using ;thus,choice of prosthesis knee joint is essential in ensuring that amputee has a biomechanical efficient gait.

Methods
50 unilateral above knee amputees selected randomly with following conditions:
without any other physical/mental problems or disorders,they had neither joint nor muscle problems before and after amputation, theywere amputated after full maturity,their residual limbs were normal,all of samples were men(as the shape of pelvis),the length of stumps were medium,all of the sockets and feet were quadrilateral and SACH with suction suspension.
landmarks were ASIS and PSIS on both sides.Through VICON motion analyzer system during three stages pelvic tilts were evaluated.
He was asked to walk with his prosthesis on a predetermind testing route then in the second stage knee joint flexion-extension
resistance increased up to 20 percent and in the third stage up to 30 percent.He was tested several times in each stage and the medium was considered.Prior to second and third stages he had to continue his walking

till get used to new alignment.Samples rested between trials and did not use torque absorber,shock-absorbing

Results

some of the results are as follows:
-Increasing of flexion-extension resistance of polycentric knee joints did not affect on pelvic tilt symmetry in both sides(sound side and prosthetic side)during short -term walking but forward shifting was more in sound side in comparison with prosthtic side in horizontal plane during long-term walking.
-Increasing of flexion-extension resistanceof single axis knee joints resulted in asymmetry of pelvic tilt in both sides during either short-term or long-term walking.
There was forward shifting on sound side and upward shifting on prosthetic side.Increasing of walking velocity without increasing of resistance led to same result.
-Phantom pain resulted in asymmetry of pelvic shifting on both sides in three planes in all conditions.
-Increased resistance of locked knee joints did not change pelvic tilts during high/low speed walking in both sides.
-Increased resistance of pneumatic knee joints resulted in more stability during high level activities but swing phase was done with delay meanwhile there was no asymmetry of pelvic in both sides.
-Increased resistance of hydraulic knee joints stopped walking.
-Increased resistance of hybrid knee joints(polycentric+pneumatic)resulted in asymmetry of pelvic tilts on both sides but about(polycentric+hydraulic)knee joints walking stopped.

Conclusion

Increased resistance of polycentric knee joints tends to closing of ICOR(Instataneous center of rotation)to weight bearing line.ICOR will be in front of weight bearing line during flexion.Stump muscles have to exert more force to the anterior wall of the socket to flex knee joint for moment arm is shortened.During walking muscles get tired very soon and can not exert enough force which results in pelvic tilt on horizontal plane in sound side and on frontal plane in prosthetic side.
After unloading,amputee can flex single axis knee joint.If resistance is increased,amputee will not exert more force to flex knee joint for stability decreases and may fall down.Prosthesis is moved forward without bending knee joint which tends topelvic shifting asymmetry on both sides.Since single axis is desined for low speed walking,increased velocity without increased resistance tends to same result.
Phantom pain pain annoys badly so that amputee walks in different manners to relieve this pain which results in pelvic tilts as

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2977-175]

New Motor Design for Motorized Prostheses: External-Rotor Motors

Author
Sensinger, Jonathon (None US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Coauthors
Wickramarathna, LN

Abstract
This study analyzed benchmarks and simulation performance of exterior-rotor and interior-rotor motors performing typical prosthetic elbow and hand tasks. Exterior-rotor motors were found to be stronger and more efficient than conventional interior-rotor motors used in existing prostheses.

Introduction
Many commercial motorized prostheses have switched from brushed exterior-rotor motors to brushless interior-rotor motors to achieve improved power. A third type of motor may provide even better performance: brushless exterior-rotor motors. These inexpensive motors are used in mass-produced appliances such as computer hard-drives, and hobbyists have recently started using them to create RC-airplanes that are more powerful. These motors produce more force, but they are also more sluggish during acceleration due to their larger inertia. This study compared analytic models of interior-rotor and exterior-rotor motors to see which design is better suited for application in prostheses.

Methods
Three motor geometries were examined with equal area profiles: pancake (P1 = 40 mm outer diameter, 10 mm length), square (P2 = 20 mm outer diameter and length), and skinny (P3 = 16mm outer diameter, 25 mm length). Motor parameters were generated from an analytic model [1], including torque constant Kt, winding resistance R, and rotor inertia J. Benchmark parameters were calculated including motor constant (proportional to how much force the motor can generate), efficiency, and speed ratio (a benchmark that is useful for prosthetic applications [2, 3]).
Motor windings and gear ratio were then tuned and optimized for a series of elbow and hand task models that incorporated realistic forces, speeds and accelerations. The battery energy required to perform these motions over the course of one day was recorded and compared between interior-rotor and exterior-rotor models.

Results
Exterior-rotor (ER) motors had 90-160% improvements in stall torque and 6-35% improvements in efficiency compared with interior-rotor (IR) motors. However, interior-rotor motors had 76-90% decreases in speed ratio compared with interior-rotor motors. All three exterior-rotor motors were able to complete both the hand and elbow tasks. The skinny interior-rotor motor, however, was unable to complete the set of hand tasks. Exterior-rotor motor models always consumed less energy than interior-rotor motors, allowing them to use a smaller battery and still last the entire day. These results are shown in Table 1. Exterior-rotor motors also weigh 1/3 the weight of comparable interior-rotor motors [1, 4], resulting in further weight savings.

Conclusion
Exterior-rotor motor models provided increased force and efficiency and decreased battery requirements compared with interior-rotor motors. They appear to be better suited for application in prostheses. Few companies specialize in production of exterior-rotor motors geared for use in prostheses, although several companies are willing to produce custom-wound motors [4]. Exterior-rotor motors should be considered for use in future designs, especially for joints like elbows, knees, and ankles, which require substantial forces.

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Image: Exterior_rotor_table_175.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3454-629]

Analysis of Plantar Pressure and Balance of Transfemoral Amputees Compared with Non Amputee Subjects, Using Their Shoes

Author
Mendes, Emilia (Arcozelo PT)
CRPG - REATEC

Coauthors
Spence W D (1), Correia MV (2), Soares D(3), Castro M(4), Sebastião AE (5)

Abstract
Pressure and balance of transfemoral amputees' was compared with non amputee subjects. 9 amputees and 19 controls walked over 8m walkway w/a pressure and a force plate placed in the middle. Results showed significant differences on COF distance, #X, #y, Max/MIN AP, Min ML, stance time and impulse.

Introduction
Lower limb amputation affects daily living, as most of our daily tasks involve standing and moving around the environment. Lower limb amputation as a permanent disabling condition leads to a permanent loss in locomotion and mobility. Posture, a key component of all perception action system, serves to maintain bodily orientation and can
be considered as a primary support for the exploration of the environment serving as a mechanical support for action. (1) Prosthetic fitting and rehabilitation contributes to restore the ability of standing and walking in such conditions. In amputees, weight distribution over the feet on standing and walking is altered, and balance and equilibrium are affected. Prostheses can provide good static support, but asymmetry can be observed, frequently, during dynamic locomotion. (2) The knowledge
on balance and pressure distribution on amputees and comparison with non amputated subjects may be very helpful on prosthetic fitting and rehabilitation.

Methods
9 transfemoral amputees, selected from the population attending CRPG and 18 healthy/active subjects, recruited from FADEUP, the 9 amputees 53 years old (± 16, 23), physically active- SF36 physical function 62, 78 (± 24, 89) and 18 non amputees 67 years old (± 8, 56), physically active - SF36 physical function 82, 33 (± 18, 01) walked on a 8m
walkway, passing over a pressure plate RSScan ® and a force plate Kistler® wearing their own shoes at a self selected speed. After adaptation, each subject walked six times, at least three randomly selected, for a three times collection of right and left foot. Kinetic data were recorded with Simi Motion System® (1000 Hz). Fx, Fy and Fz peaks and time, duration of stance and resultant impulse were analyzed using MATLAB®. The pressure and balance data were recorded and analyzed using software package Gait Scientific 3D® and Balance®. Statistics with Minitab software package version 14.0. Due to the normality of the data, parametric tests were used.

Results

The subjects where physically active and reported no relevant concern with their health as confirmed by SF36 Scales of Physical Function, General Health and Vitality (Table 1). Amputees had used prosthesis for at least 2 years and reported to be well adapted to the
prosthesis currently in use. Total COF traveled way, delta x and delta y were analyzed for the amputee and non amputee group. Results are displayed on Table 2 and graphs Graph 1, 2 and 3 attached. There is significant difference on the total distance traveled by the COF over the base of support longer on the amputee group, as well as the difference of dislocation in x and y direction. Pressure, force, stance time and impulse the results are summarized on Table 3, 4, 5,6,7,8 and 9 attached. For these variables, amputated side and sound side from the amputee group were analyzed. Each subject walked 6 times on the walkway and at least 3 times for the left side and at least 3 times for the right side was recorded. In total, for each variable, a total of 29 measurements for each side were used. Statistical significance with a strong test result was registered for Max AP force, Min AP force, Min ML Force and Min ML Force Time, time and impulse differences.

Conclusion

Prosthesis are usually aligned for a specific shoe and the end result is always a combination of both components. For that reason we have assessed all the variables with the subjects wearing their shoes. Prosthetic knee and ankle components mimic, to a certain level, the normal human ankle and knee. The mechanical behaviour of the
prosthetic feet and ankle is important during stance phase as it must allow for a correct transition of forces and force application point, when not verified changes in gait can be observed. In this study we have encountered significant differences in COF total travelled
way, delta x and delta y between a group of amputees and non amputees. When compared, the amputated side and sound side show significant differences in Max AP Force, Min AP Force, Min ML Force and Time Min ML Force as well as in stance and impulse. Amputees must cope with less flexible ankle and feet and may have to enlarge
their support basis and their sound side support.

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Image: ISPO2010_Abstract Emilia Mendes_629.JPG (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3285-460]

Balance Recovery after a Simulated Fall in Lower Limb Amputees

Author
Curtze, Carolin (None NL)
University Medical Center Groningen - Center for Rehabilitation

Coauthors
Hof AL, Otten E, Postema K

Abstract
In this research project we focus on the diverse motor strategies of amputee patients facing a complex motor task or challenging environment. We aim at identifying those major biomechanical parameters that contribute to successful balance recovery and control.

Introduction
Learning to walk with a prosthesis is a strenuous and time-consuming process. After amputation, a complex reorganization of postural [1, 2] and movement control [3] is required. The challenge faced by the patient is a drastic change in the multi-joint dynamics of the human body as a result of limb removal. To gain insights into the reorganization of the motor control strategies, the motor behavior of amputees was tested in a series of complex balance and walking tasks. Here we present data from one of the diverse tasks, the fall simulation.

Methods
A group of 18 transtibial amputees were included in the study. The subjects were suddenly released from a fixed forward-inclined position of 10° [4]. The subjects were instructed to restore balance by stepping after the forward fall was initiated. No instructions were given with which limb (prosthetic or sound limb) they should initiate the recovery (allowing us to determine leading limb preference). After three trials they were requested to initiate the recovery by stepping with the other, non-preferred limb first.

Results
We found that 53% of the transtibial amputees had a sound limb leading preference, while the remaining 47% preferred to use their prosthetic limb as leading when recovering from the simulated fall.
Furthermore, we performed a detailed three-dimensional motion analysis of the simulated fall using a VICON motion capture system. Detailed results on the spatio-temporal differences (e.g. step length and timing) in stepping strategy will be presented at the conference.

Conclusion
Despite the asymmetry in their locomotor system, amputees do not alter their limb preference to recover after a forward fall.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3249-430]

Optimization of Lower Limb Transfemoral Amputee Gait through Smart Release of Stance Phase

Author
Zahedi, Saeed (Hampshire RG22 LU GB) | Prof
Blatchford Products Ltd. - R&D

Coauthors
Andy Sykes; Steve Lang; David Moser; Juan Ochoa; Joe McCarthy

Abstract
This study will present current issues facing transfemoral amputees and the limitation of prosthetic knee controls. The outcome of a solution through development of smart control device is presented. The key principle is to closely match the knee control function to individual amputees needs.

Introduction
It is now widely accepted that electronic control of the stance phase in the gait cycle can significantly improve lower limb stability across a multitude of terrains. However this improved stability can be at the expense of a more restricted and less energy efficient gait, causing asymmetry, due to delayed release of stance. To acheive symmetry, the knee control function must match to individual amputees in any specific condition. This is addressed by using smart programming techniques to optimize the critical point of stance support release in the gait cycle. In this way, the goal of achieving symmetry, both in magnitude and duration of loading of sound and prosthetic side is achieved. Quantification of biomechanics of walking in conjunction with intelligent gait monitoring algorithms could determine the stance support selection and release points that would give unimpeded initiation of flexion which leads to timely limb extension without compromising stability and safety.

Methods
A wireless goniometry system is used to measure joint angles of both limbs over a prolong period in all terrains. Subjects who are mainly K3 amputees of mean age under 50 years old, with medium stump length were asked to wear the device following a fixed route so that measurements for all cadences and terrains can be made. Gait symmetry index for comparison are computed. 6 amputees using different microprocessor knee control were examined in details. The data collected are compared with that of normal population as well as transtibial amputees and non microprocessor knee control such as progressive stabilising knee or weight activated knee used for stabilisation of stance control on transfemoral amputees. Detail outcome of the study and statistically significant differences will be presented.It was hypothesized that the biomechanics of walking in conjunction with continuous intelligent gait monitoring algorithms could determine the stance support selection and optimum release points.

Results
A hydraulic stance, pneumatic swing control device was developed that employed automatic stance selection and release determination by monitoring actual gait characteristics during walking. Initially 13 devices were fitted to amputees for periods in excess of 1 month. Key amputee reaction was enhanced proprioception. Further analysis highlighted that this optimal release point varied with walking mode. Greater degree of symmetry of sound limb stance duration and prosthetic side stance is noted as direct

consequence of smart release. Phasing and stride symmetry as well as improvement in balance loading were measured using in the laboratory gait analysis to determine kinetic parameters such as sound side and prosthetic side loading are measured. This was in order to validate the kinematic and temporal parameters from symmetry measurements. Results were:
1 By optimizing the point of release of a stance supporting resistance to flexion a more energy efficient and natural gait can be achieved without compromising stability or safety.
2 The optimal point of stance support release varies according to the mode of walking.
3 Self-selection of the stance release point achieved by intelligently monitoring the gait cycle during walking can enhance proprioception.
4 Greater degree of gait symmetry achieved during walking down the ramp, stairs descent with smart release control.
5 Walking slowly for transfemoral amputees was noted to be more symmetrical with optimized stance control.

Conclusion

Stability, comfort, increase in function are primary goals of ideal knee control. For most amputees, balancing stability and voluntary control, provides advantages of stability during ambulation on level, slopes, stairs and uneven ground, yet enabling energy efficient locomotion. A pre condition to achieving such objective, is correct geometry and self alignment at ankle joint to provide correct body posture and load condition. The Smart Release Knee enables this balance between these opposing need to be maintained, thus enabling natural release of stance control from high yield rate, resulting in equal loading of lower limbs and high degree of symmetry. Combined with self alignment capability, for the first time a device can provide enhanced stability and comfort as well as increased function.

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Image: srk gait pattern_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3147-345]

Prosthetic Sockets Stabilized by Longitudinal Compressed Areas with Relief Openings in Between

Author
Williams III, T. Walley (Holliston, Massachusetts US)
Liberating Technologies, Inc - Product Development

Coauthors
Williams TW, Alley RD

Abstract
A plaster wrap produces a cylindrical socket. Bone is centered in tissue which must move before pushing the socket wall. In a compression stabilized (CS) socket, 4 longitudinal areas compress tissue between the socket wall and the bone to reduce lost motion as the bone moves toward the wall.

Introduction
The force versus motion graph produced by pushing an area of tissue toward the bone has three different slopes. There is a point on the second slope where little further motion is possible but pressure has not reached a dangerous or uncomfortable level. This amount of compression will restrain motion of the bone toward the socket wall, and this observation explains why a compression stabilized (CS) socket works for three types of amputation. Typically this new design uses four longitudinal depressions with open areas in between. The open areas are important. They receive the displaced tissue so that the depressed areas lie close the bone. The thinking that has lead to the CS design has a long history that can be accessed by studying the references.

Methods
The production of a transhumeral CS socket is typical. Four long, narrow forms are pushed against the flesh of the upper arm to find the best locations for the compression areas. Plaster is loosely wrapped around the limb, and then two technicians push the wood forms inward in the pre-selected areas. Additional plaster wrap is added to form anterior and posterior anti-rotation wings. This cast is used to make a check socket with openings where the plaster bulged out between the forms. Most often, the final socket is a carbon composite frame with a thin liner surrounding the limb.

Results
The new socket technique has been taught to many prosthetists, and R.D. Alley has fit a small number of transhumeral patients, over 70 transfemorals, and a even larger number of transradials. Most of the transfemoral patients have presented with an existing previously-made unstable socket. The improvement in balance, comfort and gait is dramatic. With a CS socket the proximal brim can be reduced to make sitting more comfortable while improving stability when standing and walking. Before and after videos of several transfemoral patients will show the improvement and the structure of the new sockets.

Conclusion
Sufficient patients have been fitted with CS sockets to show that they work better than conventional sockets for most patients. As more prosthetists learn to apply this new technique, it will be possible to do a multi-center study to quantify the improvements that amputees experience. The important conclusions

of this study are: 1. Compression only gives stability if there are relief areas in between to receive the displaced tissue. 2. Three and preferably four longitudinal compressions are needed for stability. 3. Too much compression must be avoided. Blood volume perfusion must not exceed 85 mmHg.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2976-174]

Voluntary Opening – Closing Terminal Device Design

Author
Sensinger, Jonathon (None US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Abstract
A new voluntary opening-closing terminal device is described that combines a simple mechanism with a compact size. Analysis of the design and an initial prototype has shown that although the concept has promise, there are still substantial hurdles to overcome before clinical implementation.

Introduction
The majority of body-powered terminal devices (TDs) are naturally closed, and voluntarily open (VO) when pulled by a Bowden cable. A few TDs are naturally open, and voluntarily close (VC) when pulled by a Bowden cable [1, 2]. Several studies have attempted to design a TD that combines the benefits of both of these designs. LeBlanc et al. has designed a TD that opens during the initial stage of cable excursion, and then closes [3, 4], which may be termed a voluntary open – close (VOC) TD. ADA Technologies, Inc. has designed a TD that switches between VO and VC modes [5]. Although it currently weighs too much to be clinically acceptable, such an approach shows much promise. The Open Prosthesis Project has suggested a simple VOC design [6], but its tong-opening to tong-length ratio is clinically unacceptable. This study sought to create a simple, lightweight VOC mechanism that was clinically acceptable.

Methods
Mechanical design constraints, including geometry and strength considerations, were obtained from the literature [7]. A staggered-rotation lever was designed to provide VOC motion in a compact package. This design allowed the tong-opening to cable-excursion gear ratio (GR) to be carefully controlled. Kinetic and kinematic equations were iteratively optimized to reduce forces and provide a clinically acceptable size and GR. An initial prototype was constructed to assess design feasibility.
VOC designs open and close using approximately the same excursion as a conventional TD. As a result, their average GR must be twice the GR of a conventional TD. This GR may be altered, however, as long as the average GR remains constant. The staggered-rotation lever parameters were adjusted to provide a high GR during the opening phase and a lower GR during the closing phase.

Results
The VOC TD design was 14.2 cm long and had a tong opening of 8.0 cm. These geometric parameters are equivalent to the TRS VC TD [1]. The device opened quickly, with a maximum GR of 17:1 at the beginning, and exerted a constant GR of 3:1 during closing. The final design is illustrated in Figure 1.
The design was assessed by several clinicians, who felt that the large GR at the beginning would be too responsive for accurate grasping of objects, and that the resulting pinch-force would be too small to hold light-weight objects. Future designs could modify this opening GR and introduce a nonlinear spring to reduce the forces felt by the user while maintaining larger grip forces. These design choices will be simulated to obtain user feedback before commitment is made to a second model.

Conclusion
Voluntary opening-closing (VOC) terminal devices remain a promising, but elusive sector of TD development. Although they may provide benefits of VO TDs (such as holding small objects in the relaxed

state) and VC TDs (such as exerting large grip forces to hold heavy objects), their necessity of having twice the average GR of conventional designs makes them difficult to engineer in a clinically acceptable manner. Future research will attempt to solve these problems. The VO/VC design of ADA [5] remains a compelling alternative.

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Image: VOC figure_None.TIF (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3135-333]

Development of a Test Device for Lower Limb Prostheses (Gait Simulator) and First Results

Author
Wulff, Wulf (Berlin DE) | Dipl. Ing.
Technische Universität Berlin - Fachgebiet Medizintechnik

Coauthors
Kraft M

Abstract
Patient mobility and technical development of prosthetic components are closely connected. This gait simulator will establish the performance potential and the safety reserves of cost-intensive components. Simulation of a five-year history of walking can thus be achieved in six weeks of testing.

Introduction
Being able to walk as an amputee with prostheses without having to think carefully about each individual step poses tremendous challenges for technology. In addition to the functional needs, the requirements regarding the mechanical structure are of great significance owing to the diverse loads. At present, the effects of the loads can only be estimated on the basis of analogies to the applied subjects of service strength [3]. Definite load sequences can have effects that both shorten and extend the service life. Our investigations clearly demonstrate this performance. In this way, the standards inspection as per ISO DIS 10328 [2] for a complete mechanical knee joint with Condition I, P6+20% was passed with 3.5 million cycles, although a test with graded loads could also be performed with many more cycles. It therefore became apparent that load situations can be associated both with reserves as well as, in the converse argument, with risks.

Methods
For an exact and reproducible examination of the effects of the loads in exoprosthetic lower limb prostheses, a hydraulically-operated gait simulator is being developed in the department of medical technology of the Berlin Technical University. The structure of the gait simulator is oriented to the loads which are applied to the lower limb prosthesis during its use. The hip is represented by the hip module, the ground by the foot module. The hip module consists of the three drives coupled according to the series for motion involving extension/ flexion, adduction/ abduction and inversion/ eversion. The foot module consists of the two drives coupled according to the series for the vertical and horizontal motion of an instrumented foot plate. The gait data [1] previously recorded with a measuring pylon is coupled via the drives in the prosthesis with real-time control. The gait cycle to be initiated can be processed and compiled in advance using planning software.

Results
The current state of development comprises the technical realization of the test bench and implementation of the control software STEP© as well as the interface to the real-time control system. Every drive system is equipped both with position as well as force or momentum sensors, thereby enabling a hybrid force-position control. The real-time control together with the rapid actuator mechanism consisting of servo-parts and low-friction cylinders therefore enables monitoring of the time-critical sections, “place foot down" and

“lift foot up“. All tests can be planned via the graphical user interface and can also be configured and monitored location-independently via an Ethernet interface. Closely associated with the control, a safety system is also installed, which continuously monitors the location, force and speed limits while controlling the working space. An integral hydraulic unit has been developed and tested for a secure energy supply. The energy-efficient functioning is a special feature of this unit. A frequency converter allows automatic adjustment to the average gait-specific energy requirements. In addition, a special storage configuration serves for secure realization of rapid load changes. The unit also has an interface for the safety system, which enables the hydraulic pressure to be released from the test bench in critical fault cases.

Conclusion

Ever more effective functional and structural elements enable increasing mobility of the patients, but also require strict safety standards which are reflected in high requirements in regard to material and production and hence in the costs. The test bench provides the option of reducing the load history from 5 years to about 6 weeks test bench operation. It should be examined whether a gait data pool can be created which is, for example, available for selection. The gait data would therefore be accessible as an important source for the development of future designs in respect to the functional and structural properties. The test results could typically serve a damage-tolerant design in the form of recommendations. Furthermore, specific inspection intervals, data on the component exchange or options for estimation of the refurbishing capacity and reusability can be derived from the insights.

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Image: Gangsimulator_Collage_rev15end_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3286-461]

Variability of Prosthetic Walking: Effects of Asymmetry

Author
Curtze, Carolin (None NL)
University Medical Center Groningen - Center for Rehabilitation

Coauthors
Otten E, Hof AL, Postema K

Abstract
We discuss how the inherent asymmetry of the locomotor system in lower limb amputees affects the variability and symmetry of roll-over shapes of transtibial and transfemoral amputees during steady-state walking.

Introduction
While, as a rule, normal unimpaired walking is reasonably symmetric, walking with a prosthetic limb is characterized by a marked asymmetry of limb movements. In lower limb amputees the locomotor system is inherently asymmetric in its construction, which results in multiple adjustments in gait pattern; e.g., on the level of temporal dynamics the stance phase on the sound limb is prolonged, while on the spatial level the step width is increased to make walking with a prosthesis more stable [1]. In addition to these spatio-temporal adjustments, changes in interlimb coordination [2] as well as alterations in joint kinetics have been reported [3,4]. Here we use a method that allows capturing the overall motion of the ankle–foot system in so-called effective roll-over shapes, that form the basis of the rocker-based inverted pendulum model of walking [5,6].

Methods
We evaluated the walking pattern of six lower limb amputees (three transtibial and three transfemoral amputees), and three matched able-bodied controls. The variability and symmetry of prosthetic walking was analyzed in terms of roll-over characteristics (i.e., roll-over shape and radius of curvature) and temporal factors (i.e., stride time, stance time, and double support time).

Results
We found that the level of amputation added to the asymmetry of walking; the transtibial amputees had a quite symmetric gait pattern, with respect to temporal factors as well as the roll-over characteristics, while the gait in the transfemoral amputees was more asymmetric (Figure 1). However ,the level of amputation did not lead to an increase in intralimb variability.

Conclusion
By determining the individual roll-over shapes of amputees with different levels of amputation, we gain intriguing new insight into the different individual adjustments occurring during prosthetic walking.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3128-326]

Prosthetic Fitting after Amputation in the Hip Area with an Individual Full Contact Silicone Socket Combined with a Two-Part Frame of Carbonfiber Mate

Author
Gawron, Olaf (Heidelberg DE)
Pohlig Orthopädie-Technik, Niederlassung Heidelberg - Prothetik untere Extremität

Coauthors
Schäfer M, Baumeister T, Rehg M

Introduction
The most important part of a prosthesis is the prosthetic socket, which connects the patient with technology. For the design of the pelvic socket, besides the load transfer the possibilities of controlling and fixing the prosthesis are of particular importance. Except for the classical pelvic socket systems the authors have up to now tried to increase the wearing comfort for the patients by reducing the socket surface.

Methods
In view of modern materials and working techniques we have to ask ourselves if there are no other ways of optimizing the prosthetic fitting. As for patients with an amputation in the hip area the possibilities of prosthetic control are rather restricted a socket fitting with a surface as large as possible could be more appropriate. But can we then preserve the necessary mobility of the trunk? There is also the problem of an optimization of the wearing comfort. It would be desirable to design the adhesion of the prosthesis, which has been effected up to now by a contoured enclosure of the iliac crest, by extensively applying modern materials with adhesive qualities on the full surface. Through this procedure the possibilities of controlling the prosthesis could also be improved.

Results
The lecture describes new experiences of a fitting with extensive silicone stump embeddings, which can be opened and closed by a zip. In the manufacturing process high-temperature cross-linking silicones with partially integrated reinforcement nets are used. The full-surface embedding of sensitive pressure zones and bony areas is effected through the integration of low-shore room-temperature cross-linking silicones. A technical procedure was developed which combines both types of silicone in a homogenous surface.
The connection with the functional joint components of the prosthesis is achieved through pelvic baskets which are as small as possible and manufactured in a carbon-composite-technology. The pelvic frame is divided in two parts and are closed and fastened through a dorsal closing mechanism.

Conclusion
The circular enclosure of the silicone embedding provides a good stability for the soft tissues in the trunc area. The soft parts of the tissue are stabilized in a more compact way and the possibilities of controlling the prosthesis are improved as compared to traditional socket systems.
As the adhesion of the prosthesis need not exclusively be effected by a contoured enclosure of the iliac crest, but to a large extent through the adhesion between the patient´s skin and the silicone, the lift of the prosthesis during swing phase is reduced. All in all we obtain a prosthetic fitting with functional advantages and at the same time an improved wearing comfort.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3006-204]

Speed Ratio: An Ideal Benchmark for Prosthesis Motors

Author
Sensinger, Jonathon (None US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Abstract
The limited range of motion in prostheses requires novel benchmarks to optimize motor design. Speed ratio is mathematically shown to capture the required characteristics. Simulations show that it is a better predictor of motor success than conventional benchmarks.

Introduction
Motors can either produce high forces or fast speeds, but they cannot simultaneously provide high forces and high speeds. Selection of prosthesis motors is fairly unique from other motor applications: due to the limited range of motion, prosthesis motors must generate relatively high forces, high speeds, and high accelerations all at the same time. Conventional motor benchmarks such as motor constant (proportional to motor force) and rated power may therefore be inappropriate in choosing a motor for prosthesis applications.
This study looked for a mathematical derivation of an ideal benchmark for application in a prosthesis. It then tested this benchmark against conventional benchmarks to gauge their predictive power.

Methods
The mathematical derivation incorporated the required force, speed, and acceleration of a given point within a trajectory into the available force-speed envelope of the motor. Parameters were then manipulated to group motor parameters on one side of the equation and task parameters on the other side of the equation [1].
Movement of the prosthesis was modeled as a minimum jerk trajectory, which accurately models movement of human joints [2]. 37 Emoteq high-torque motors were used as models. Their windings and gear ratios were optimized to find the tuning that required the least amount of energy across a set of tasks. Voltage was varied for a task to cause approximately 50% of the motors to fail. The ability of the benchmarks to predict this success / failure was then analyzed using a receiver-operator characteristic (ROC) curve. The area under the curve (AUC) was measured for each benchmark.

Results
The motor-dependent features were successfully isolated from the task-dependent features of a force-speed-acceleration profile. The resulting motor-dependent features directly corresponded to an existing motor parameter: the speed ratio, equal to the reciprocal of the mechanical time constant [1]. Although rarely noticed, this benchmark is frequently provided by motor manufacturers, and mathematically captures the complete force, speed and acceleration requirements of a point within a movement profile.
Speed ratio was a better predictor of motor success than conventional benchmarks, providing an AUC of 77%. These predictive values are shown in Figure 1.

Conclusion
Speed Ratio is a benchmark parameter that mathematically captures the force, speed, and acceleration requirements inherent in motion of a prosthesis. Simulations showed that it is a better predictor of motor success than conventional benchmarks. Designers of prostheses should choose motors with larger speed

ratio values, rather than relying on motor constant or rated power when choosing a motor. Doing so will allow them to choose the minimum-weight motor that will succeed in dynamic tasks common in prostheses.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3013-211]

Quality of Life in Children with Uni-lateral Lower Limb Prosthesis, a Quantitative Study in Cambodia and Norway

Author
Nilsen, Rune (NO) | CPO
SMO - Prosthetics

Coauthors
Øygard T, Aasen G and Jensen JS

Abstract
The study shed light on quality of life and prosthetic user satisfaction between children in Norway and Cambodia. We have used 2 questionnaires and the results give a clear indication of higher QoL within Norwegian children. Cambodian children score higher on user satisfaction with the prosthesis.

Introduction
Main objective is to improve the knowledge and services provided to children with lower limb amputations in Cambodia and Norway. The project will focus on children's met, or unmet, needs and experience of using prosthesis. The Project aims to improve the quality of life for children with a uni-lateral lower limb amputation, increase the level of knowledge on the subject of fulfilling a child's needs and detect if cultural differences have an impact regarding the need of a prosthesis. Client-centered and holistic assessments are strived towards, and there is an increasing awareness of Quality of Life as one of the outcome measures. As of today there are no studies or surveys conducted regarding quality of life and children with lower limb prosthetics. Children are not likely to know of and ensure they get the best available treatment, thus this study seeks to find out if children are offered what they are in need of.

Methods
This is a quantitative study using two questionnaires. The selected sample is all children in Norway who meet the inclusion criteria. The questionnaires used are PedsQL and 'Follow-up evaluation of clinical services. The results from PedsQL describe the child's physical, emotional, social and school functioning. It consists of 23 statements. Follow-up evaluation of clinical services is part of Orthotics and Prosthetics Users' Survey, conducted by Heinemann et al. This instrument measures quality of life and satisfaction with the orthopaedic device and the services. It consists of 11 statements concerning comfort; looks; use; and expenses of the prosthesis. The last two questions are qualitative questions related to play and physical activity. The results have been analyzed according to prevailing scoring instructions. The results evaluate the situation in each country, and can indicate whether there are cultural differences. A pilot of 10 non-disabled children was conducted.

Results
PedsQL contains 23 statements in 4 dimensions, physical functioning, emotional functioning, social functioning, and school functioning. The total score can be divided into psychosocial health summary score and physical health summary score. High score is an indication of good QoL. Max score is 100.
Nationality Psychosocial health summary score Physical health summary score Total score
Norwegian 78,6 84,4 80,6
Cambodian 54,7 62,6 57,4

OPUS results. Max score is 100.
Nationality Score
Norwegian 62,4
Cambodian 68,8
Norwegian children have a higher score on health related quality of life and children in Cambodia have a higher score on satisfaction with their appliance.
From the preliminary results it can seem that the prosthetic services are adequate in both countries. All children in the study are living an active lifestyle, and not inhibited by the prosthesis.
83% of the Norwegian children and 73 % of the Cambodian children answered a physical activity as their favorite play activity. Football is the physical activity most often mentioned in both countries. Next, the children mention play with siblings and friends, this is mentioned equally in both countries. The results indicate equal activity interests in both groups, regardless of country.
From the preliminary results it can seem that the prosthetic services are adequate in both countries, however Cambodian children score lower on quality of life.
A comparison with the group in pilot study will be conducted in 09/2009.

Conclusion

The most significant differences between the two countries are lower QoL in Cambodia. This might not be related to the prosthetic services, more to the social and welfare structures of the country. The prosthetic services are up most adequate in Cambodia, however, the country lacks in including the disabled into society and this is indicated in the results of the study. Children in low-income countries are expected to score lower on QoL surveys than children of high-income countries, and the results in this study indicate no different.
The user satisfaction was higher in Cambodian children, which indicate good prosthetic services. The Norwegian children reported high QoL and lower user satisfaction. This indicates that Norwegian children do not question the availability of prosthetic services, and rather take the services for granted.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3049-247]

Sweat Management in Prosthetic Sockets

Author
McCarthy, Joseph (Basingstoke UK)
Blatchford - Research&Development

Coauthors
Zaheedi S, Ross J, Ward A, Ritchie L,

Abstract
Sweat at the stump socket interface is known as being an issue with modern impervious liners, especially in hotter climates or when activity above the norm is undertaken. The Author reports here findings from several experimental investigations to remove sweat from the stump socket interface.

Introduction
Sweat at the stump socket interface is widely reported as being an issue with modern impervious liners. This moisture results in reduced control, potential increased risk of tissue breakdown as well as being an ideal breeding ground for pathogens.
This presentation will reveal some experiments carried out over recent years to improve sweat management at the stump socket interface and discuss the results.
These issues are more profound in hotter climates and when higher levels of activity are undertaken.
Specific problems caused are

Methods
Three experimental methods were used:
a-An impervious liner was perforated allowing transmission of vacuum directly to the residuum. An active vacuum was then applied to facilitate fluid being drawn from the surface of the residuum.
b- A sock was worn distally on a residuum under a standard liner; the liner was then punctured to allow transmission of vacuum again to draw away fluid using both active and standard suspension sleeve.
c- A liner was manufactured with fabric internally and a one way valve distally both with and without pin suspension on transfemoral amputees
The trial protocol was developed and tested on amputees (K3-K4) who were specifically prone to these problems.

Results
Overal the feedback from trial participants showed improvement in maintening a drier stump-socket interface. Specific evidence showed the following:
-improved stump liner contact.
-improved suspension
-improved proprioception
-a new method of suspension.

Conclusion
We conclude from these findings that it is possible to achieve a drier stump socket interface than most wearers currently enjoy.
Several methods of sweat transmisssion are possible

Suspension and proprioception are percieved to be improved when active vacuum is transmitted directly to the residuum.
Future trials and tests are required for validation of these preliminary results in order to lead towards optimisation of new sweat management technologies

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3093-291]

Experience Fitting Partial Hand Prostheses Using Prodigits

Author
Uellendahl, Jack (Scottsdale US) | CPO
Hanger Prosthetics and Orthotics, Inc. - Prosthetics

Coauthors
Uellendahl, EN

Abstract
This presentation will suggest criteria for appropriate selection of ProDigits. Individual cases will be presented to demonstrate the functional potential of powered finger fittings for this challenging patient population.

Introduction
Partial hand amputation is the most common upper limb amputation level in the United States. Traditionally partial hand amputations have been treated with cosmetic devices, opposition posts, or not treated at all. Partial hand amputations have been challenging to fit with externally powered devices due to the limited space available for prosthetic mechanisms. With the introduction of individually powered fingers, ProDigits by Touch Bionics, exciting possibilities for fitting externally powered finger prostheses are now feasible.

Methods
The author has gained experience designing and fitting prostheses using ProDigits for persons with a variety of hand configurations. To date more than 20 such prostheses have been provided. This presentation will review the prosthesis design, control strategies and component selection.

Results
All of the patients fitted have been successful in learning to operate the prosthesis. Control has been achieved using either myoelectric signals or force sensitive resistors. Myoelectric control has been either single site with alternate direction control strategy or a two site first –over strategy depending on available muscles signals. When the thumb is absent several options have been employed to replace this function. When there is enough space a powered thumb has been provided and this is the preferred method. With limited space the powered thumb is not possible and either a passively positioned friction thumb or a passive locking two position thumb has been provided. The friction thumb also offers rotation where the locking thumb does not. The locking thumb is better suited to activities where higher loads are experienced.

Conclusion
The introduction of ProDigit powered fingers has expanded the fitting options for certain levels of partial hand amputees. Powered fingers allow a greater variety of gripping options than was previously available for these patients. The current ProDigits offer the same finger performace as the TouchBionics iLimb hand. Future powered fingers should minimize the build height in order expand application to a greater number of partial hand amputees as well as continue to improve the grip strength and speed of the finger movement.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3219-401]

Use of High Consistency Rubber (HCR) Silicones for Upper Limb Prostheses

Author
Uellendahl, Jack (Scottsdale US) | CPO
Hanger Prosthetics and Orthotics, Inc. - Prosthetics

Coauthors
Uellendahl EN

Abstract
The use of HCR silicones has been shown to be advantageous for use in upper extremity prosthetics. These materials offer new ways to fabricate both the socket interface as well as some of the structural components. Users report improvement in comfort and suspension of their prosthesis.

Introduction
Traditional upper limb prosthesis construction utilizes plastics for both the interface material and structural components. With the advent of HCR silicones it is possible to design and fabricate silicone interfaces and complete prostheses in new ways that take advantage of the unique attributes of this material and means of manufacture. Material thickness, stiffness, and elasticity can be selectively controlled. It is possible to incorporate hardware such as electrode mounts, screw attachments, zippers, battery compartments and wrist mounts into the silicone during fabrication.

Methods
HCR silicones are manufactured using a high pressure two-roll mill. These materials are clay like in their forming state. The stiffness of these materials using the Shore A durometer scale is generally between 15 and 70. These different stiffness materials can be precisely positioned to control regions of stiffness as desired. The material can be blended to modify the durometer and other physical properties, has a high tear strength and produces no volatile by-products.

Results
Construction methods have been developed for production of prostheses utilizing all silicone construction as well as hybrid construction where silicone as well as traditional plastics have been employed. The elasticity of the material allows for donning of bulbous limbs, such as wrist disarticulations, as well as retention of joint range of motion even when the joint is crossed by the silicone socket for partial hand prostheses where the wrist is included in the socket design. For transhumeral prostheses the socket has been designed using the concepts of the Sauter “half and half” socket where the silicone socket incorporates a shoulder saddle providing excellent suspension while retaining good shoulder range of motion. (1)

Conclusion
The use of HCR silicones has been shown to be advantageous for use in upper extremity prosthetics. These materials offer new ways to fabricate both the socket interface as well as some of the structural components. Material thickness, stiffness, and elasticity can be selectively controlled. The introduction of

this new material has opened new ways to design and fit upper limb prostheses that can improve patient comfort as well as prosthesis suspension.

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Image: PH-silicone-socket_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3189-376]

Silicone Liner Compression Therapy to Reduce Residual Limb Edema among Adults Following Trans-tibial Amputation: a Randomized Controlled Pilot Study

Author
Clements, RJ (Toronto CA)
Sunnybrook Hospital - Prosthetics

Coauthors
Torres-Moreno R, Salbach NM, Mahy B, Nasturzio L, Murnaghan JJ

Abstract
Preliminary effect of silicone liners on reducing post-operative edema among amputees was evaluated. Subjects who used silicone liners experienced greater volume reduction than those using compression socks. Expediting volume reduction could decrease fitting time, hospital stay and associated costs.

Introduction
A principal challenge of amputee rehabilitation is the management of post-operative edema. As the level of edema decreases, prosthetists must repeatedly fit amputees with sockets to accommodate new limb volumes. Once the volume stabilises, the amputee is fitted with a definitive socket. Wait times for volume stabilisation using traditional compression methods, such as dressings, tensor bandages and compression socks1, average from 1202 to 1503 days. A more rapid volume reduction would expedite the fitting of the definitive socket, gait rehabilitation, and hospital discharge4. Silicone liners may be more effective than traditional compression methods in reducing edema as they provide graduated pressure from the distal to proximal end due to a tapered thickness and distal matrix design. Thus, our objective was to evaluate the effectiveness of using a silicone liner compared to a traditional compression sock in reducing residual limb edema among adults following trans-tibial amputation.

Methods
We conducted a randomized controlled pilot study targeting adults with a maximum of 18 days post-amputation who had sufficient hand dexterity to roll-on a liner and were able to communicate in English. Residual limb volume from the mid-patellar tendon to distal end was measured at baseline, then weekly for one month and biweekly for three months (11 evaluations in total) using the water displacement method3. After the baseline evaluation, subjects were randomly assigned to the silicone liner (experimental) group or compression sock (control) group. Subjects in the experimental group were fitted with a roll-on silicone liner and followed a wearing protocol for four months. When the liner was not applied, a compression sock or the prosthesis was worn. Subjects in the control group wore a compression sock as per standard practice. Both groups were fitted with a patellar tendon-bearing preparatory prosthesis. Otherwise, all subjects received routine rehabilitation services.

Results
Seventy people were assessed for eligibility between May 2007 and February 2009. Of these, nine people met the eligibility criteria and five people consented to participate. One participant died due to underlying health conditions leaving two people in the experimental group and two in the control group (Table 1). Data collection was completed for each of the four subjects. Linear regression was used to fit a line based on the

"least squares" method to the volume measurements for each subject. The regression equation takes the form of y=ax+b where the regression coefficient “a” indicates the magnitude and direction of the slope of the line. The regression coefficient is interpreted as the average change in residual limb volume between consecutive evaluations. The linear regression coefficients (cm3/evaluation) based on the 11 evaluations per subject were -21.7 and -16.0 for the silicone group and 1.4 and -1.3 for the compression sock group. The percentage of change in residual limb volume from baseline to post-intervention (four months) was also computed. Subjects in the silicone liner group experienced a reduction in residual limb volume from baseline to four months of 37.4 % and 18.9 %. In the compression sock group, one subject lost 3.8 % in limb volume while the other subject experienced an increase in volume of 2.5 %. No adverse events occurred from using the silicone liner.

Conclusion

Study findings suggest that the silicone liner may be superior to the compression sock method in reducing residual limb edema following trans-tibial amputation in adults. Although residual limb volume decreased to a much greater extent among subjects in the experimental group than among subjects in the control group, these results should be interpreted with caution given the small sample size and imbalance in potential prognostic factors (e.g., time-post amputation, BMI, length of the residual limb, lower extremity function) between groups. For example, Subject 1 in the silicone liner group was 7 days post-amputation compared to Subject 4 in the control group who was 18 days post-amputation at study entry. Thus, Subject 4 may have experienced a reduction in edema in the residual limb prior to study participation. Overall, a larger study should be undertaken to confirm our findings.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2946-144]

Motivations and Barriers to Participation in Exercise & Sport: a Review of the Literature

Author
Deans, Sarah (Glasgow UK)
University of Strathclyde - National Centre for Prosthetics and Orthotics

Coauthors
Mutrie N, Sexton S.
University of Strathclyde

Abstract
The aim of this work was to conduct a structured review of the international literature on motivations and barriers to participation in exercise and sport within the prosthesis user population.

Introduction
The importance of making accessibility and involvement in sport to those athletically inclined has become apparent. Preparation for the 2012 Paralympic Games in London and the 2014 Commonwealth Games in Glasgow highlights a need to champion sport for people with lower limb deficiency and empower those who might never have participated to become involved (Gold & Gold, 2007) Each individual has the right to fulfil their exercise potential. The White Paper on Sport (2007) by the Commission of European Communities stated that “Sport has a greater influence than any social movement as a tool for health enhancing physical activity”.
Importantly, the UK population with limb deficiency is predominantly elderly and has a sedentary lifestyle (Davies and Datta, 2003). There has been an increase in opportunities for users to participate in sports due to better prosthetic components. However, the number of sports prostheses users remain relatively low.

Methods
The objective was to investigate the motivations and barriers to participation in physical activity and sports in a group of people with lower limb deficiency. A review was carried out by examining literature from a key electronic databases. Articles were limited to those written in, or translated into English, and which focused on established users of lower limb prostheses. In future, the review will underpin ongoing doctoral research into how exercise and sport participation can be increased for our patients and how exercise concepts and knowledge can be enhanced in the undergraduate curriculum and professional communities. The work examines the motivations and barriers to exercise within the normal population, and how these issues might be compounded within the prostheses user population. The work also examines the type of psychological benefit the user can derive from physical activity and how patients can be encouraged to implement a healthy lifestyle change.

Results
The results will detail the number of articles identified, those which meet the inclusion criteria and those full text articles obtained.

Conclusion

In conclusion and because of its dynamic nature, increasing physical activity in all populations is challenging. The challenges of lower limb loss can seem insurmountable when compounded by an alteration in body image. Factors such as self-efficacy, social support, and perceived health benefits are all mutable and show potential for an increase in the chance of individual behaviour change in people with lower limb amputation. Integrating an achievable, realistic exercise regime into hospital based rehabilitation and importantly continuing this into community based sports initiatives for people with limb loss would capitalise on the clear relationship between physical activity and improved health and well-being.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3003-201]

Mechanical Performance of Voluntary Closing Hand and Hook Prostheses

Author
Smit, Gerwin (Delft NL) | MSc
Delft University of Technology - Biomechanical Engineering

Coauthors
Plettenburg, DH

Abstract
Five commercially available voluntary closing terminal devices were mechanically tested, three hands and two hooks. Hands require more mechanical work than hooks. The TRS hook can be operated without getting fatigue. For the other devices the time over which the force can be maintained is limited.

Introduction
About 20 to 40% of the patients abandon their upper-limb prosthesis after some time [1]. Patients are often not satisfied with their prosthesis because it does not fulfil their basic demands, which can be summarized by the words: cosmetics, comfort and control [2]. The Delft Institute of Prosthetics and Orthotics (DIPO) has started a research program on the development of an improved voluntary-closing (VC) body-powered (BP) hand prosthesis. This prosthesis should require significant lower physical control effort than commercially available VC BP prostheses. Currently only little data is available on BP prostheses. LeBlanc et al. performed mechanical tests on child-size voluntary-opening (VO) and VC devices [3]. Corin et al. tested adult-size VO devices [4]. In this study currently available VC devices for adults were analyzed on mechanical performance properties.

Methods
To quantify and compare the performance of the tested prostheses [Hosmer APRL VC hand, Hosmer Soft VC Male hand, Otto Bock 8K24, Hosmer APRL VC hook, TRS Grip 2SS], the following parameters were measured or calculated:
-Mass
-Maximum opening width
-Excursion range of the activation cable for closing
-Work needed for closing the device
-Hysteresis (dissipated energy) of one cycle (closing and reopening)
-Work needed for closing the device and pinch 15 N
-Activation force needed to generate a pinch force of 15 N
-Generated pinch force at an activation force increasing from 0 to 100 N
-Force drop induced by the locking mechanism
A custom-build test bench was used to measure the tensile force and the displacement of the activation cable of the prosthesis. The bench was manually operated. The prostheses were controlled at a low speed (fingertip speed about 3 mm/s), to reduce viscous behaviour. The pinch force applied by the prosthesis was measured using a custom-build pinch force sensor.

Results

Closing test

The calculated amount of work needed for closing the prosthesis is shown in the figure. Also the calculated hysteresis (dissipated energy) of one cycle of closing and reopening is shown in this figure.

Pinching test

To pinch with a 15 N force, the following activation forces were required:

61 N, APRL hand (without cosmetic glove)
62 N, APRL hook
131 N, Soft hand (frame+inner glove)
78 N, Otto Bock hand (frame)
90 N, Otto Bock hand (frame+inner glove)
98 N, Otto Bock hand (frame+inner glove+cosmetic glove)
33 N, TRS hook

Locking mechanism

The locking mechanisms showed a drop in pinch force after being activated. The magnitude varied from 50 to 90% of the initial pinch force (approximately 15 N). No results were obtained from the TRS hook, as it is not provided with an automatic locking mechanism. The following values were measured:

7.3 N, APRL hand (without cosmetic glove)
10.4 N, APRL hook
13.9 N, Soft hand (frame+inner glove)
6.7 N, Otto Bock hand (frame)
5.9 N, Otto Bock hand (frame+inner glove)
6.5 N, Otto Bock hand (frame+inner glove+cosmetic glove)

During unlocking of the Otto Bock hand, the hand opens a little and the pinch force drops to (almost) zero, before the cable is released.

Conclusion

Concluding remarks

The maximum force that can be generated using a shoulder harness is 280±24 N, according to Taylor [5]. All measured maximum forces in the pinch test are within this range. The maximum force that can be exerted over a longer time without muscle fatigue, the critical force, is about 18% of the maximum muscle force [6]. Only the activation force of the TRS hook is within this critical force. For the other devices there is a trade-off between applied force and the time over which this force can be maintained. Therefore the usability of the Hosmer Soft hand will be limited. Activation forces should be within the critical force range, to enable continuous activation without muscle fatigue.

The inner glove accounts for 30% of the total mass of the Otto Bock hand and adds significant hysteresis. It is recommended to decrease the mass and hysteresis of the inner glove, or abandon its use.

To enable a secure grip, the locking mechanisms should either be improved or abandoned.

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Image: Work-hysteresis_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3127-325]

HYSCOM Knee, a Prosthetic Knee Joint with Stance and Swing Control System Utilizing Compact MR Fluid Brake

Author
Hikichi, Yuichi (yamagata JP)
M-SUPPORT.INC., - general affairs

Coauthors
Nakano M, Tsujita T

Abstract
HYSCOM knee joint with stance and swing motion control system utilizing a developed compact MR fluid brake has been developed, and the details of the knee design and control system and the field walking test results on some individual TF amputees are reported.

Introduction
The author reported on a developed HYSCOM knee joint at the 12th ISPO Congress in Vancouver in 2007. The knee allowed TF amputees to select the three modes of Lock, Yielding and Free by the optional motion of leg utilizing a simple hydraulic cylinder and solenoid valves. So, the field walking tests showed that the HYSCOM knee allowed TF amputees to ascend and descend stairs and to go up and down a slope with a reciprocating gait. However, since this knee joint was not able to harmonize with some demands of amputees in some situations due to the simple control strategy, it was concluded that a more sophisticated and precise control system was required for the knee joint.
In this research, a developed compact MR fluid brake, some sensors and computer control system has been installed to the HYSCOM knee instead of the hydraulic cylinder and solenoid valves, in order to improve the control performance.

Methods
A compact MR rotary brake of multi-disks type using magnetorheological(MR) fluid, which can be changed their rheological properties in a reversible manner by applying magnetic field, has been designed and developed to satisfy patient’s demands using a magnetic field analysis. The new knee joint utilizing the developed MR fluid brake has several sensors; the first one is put above the knee axis which detects A-P movements, the second senses knee angular, and the third one is put on the lowest part of the joint and measures the vertical loads. These data are taken in to a laptop computer through a cable and calculated according to a control strategy. And then, adequate voltages are given to the MR fluid brake to harmonize with individual situations.

Results
The developed MR brake performed enough braking torque to adjust the resistances for individual situations. Although the HYSCOM MR knee system has been tested in the labor and not on the field, it enabled TF amputees to ascend and descend stairs and go up and down a slope very smoothly with a reciprocating gait. It was even better than the previous model. Also this MR knee system enabled us very easily to change the program and to let adjust precisely the resistances for individual situations.

Conclusion

This trial evaluation has proved the MR fluid brake + laptop computer system has enhanced the adjustability and helped to optimize patients walking on stairs. It is also found that it is very important to select a proper protocol for collecting all the data and calculating the knee control resistance values to optimize patients walking. It means that now we have a possibility to construct a good program that makes progress in patients ADL especially in tough situations such as on stairs, ramps or with obstacles.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3453-628]

Baropodometric Analisys of Amputees Gait: a Preliminary Study

Author
Castro, Marcelo (Porto PT)
University of Oporto - Biomechanics department, Sports School,

Coauthors
Soares DP, Mendes EA, Sebastião RA, Machado LJR

Abstract
The purpose of this study is to present the patterns of shoe pressure parameters in amputees gait. Five subjects walked three times with each leg over a pressure plate. Results showed differences between both legs and among feet zones.

Introduction
Amputations represent high impact in fuctional capabilities and quality of life of the individuals. Many studies have been performed with the purpose of understanding such alterations and investigate different ways to reduce the impact of them (Archer et al 2006; Bailey & MacWhannell, 1997; Buckley, 1999; Buckley et al, 1997; Hafner et al, 2002; Han et al, 2003; Hill et al., 1997; Meatherall et al., 2005).
Among these studies, the gait, due to the necessity of this skill for daily life activities has been widely investigated, even though, the studies using baropodometry are rare.
The analysis of plantar pressure can be useful also to the comprehension of the pattern of pressure distribution as to implement terapeuthic approaches to improve amputees quality of life.
The purpose of this study is to present the patterns of plantar pressure parameters in amputees gait.

Methods
5 subjects with transfemural amputation (mean age 67 years old ± 8, 56) and SF36 physical function 82, 33 ± 18, 01) were asked to walk on a 8 m walkway, passing over a footscan® pressure plate at a self selected speed. After a short adaptation, each subject walked three times stepping with the right foot and three times with the left foot.
The baropodometric data were recorded using the Footscan 7 Gait 2nd generation software, in a frequency of 300Hz. The foot was divided in six zones, where two were placed in the fore foot (Z1 under the antero medial zone of the foot and Z2 under the the antero lateral zone of the foot) two in the midfoot (Z3 medial zone of midfoot Z4 lateral zone of midfoot) and two in the rearfoot (Z5 under the medial zone and Z6 under the lateral zone).
The values of zone peaks and impulse were collected using MATLAB routines specifically developed. The data were compared between the amputated leg (AL) and the sound leg (SL). Data analysys: SPSS 17.0

Results
The results showed that there are significant differences between the peak pressure in zones Z1 and Z3 and in total pressure when comparing AL and SL. This difference in Z1 can be due to the fact that many amputees don’t support the forefoot in stance phase and have no capacity for propulsion, and in Z3 because the prosthesis doesn´t allow to transfer the weight properly from the calcaneous to forefoot passing through the medial region.

When comparing different zones in the same foot, there are significant differences in AL, in many comparisons, differently from SL, as showed in table 1. These differences can evidence the abnormal pressure distribution in the prosthetic foot.

Conclusion

According to the results, there are significant differences between the amputated leg and the sound leg. These results are in agreement with the literature and, even though they are preliminary, show that the methodology is useful to analise amputees gait and can be used to improve rehabilitation protocols to apply in the amputees.

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Image: pressure_None.jpg (see online)

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Poster Session: Prosthetics
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Poster [3322-497]

Evaluating the Mechanical Behaviour of two Ossoeintegrated Transfemoral Implant Systems when Loaded in Bending using 3D Digital Image Correlation

Author
Mechefske, Chris K (Kingston CA) | PhD, P.Eng
Queens University - Department of Mechanical and Materials Engineering

Coauthors
Thompson ML, Branemark R, Backman DS, Mechfeske CK

Abstract
Two osseointegrated transfemoral implant systems have been investigated to evaluate the implications of raising the tightening torque beyond the current manufacturers specified tightening torque of 12Nm. Results suggest increased torque may increase assembly strength and response to loading.

Introduction
Osseointegrated transfemoral implants provide prosthetic solutions to some individuals that cannot be accommodated by socket-based devices. The current system employs a hex based connection between implant and abutment with a retention bolt tightened to achieve proper clamping of the three parts. A new design proposes a Morse taper connection with the bolt. This design has been successful in improving the strength and loading response in oral implants of a similar construction [1, 2]. Preliminary work comparing the transfemoral components suggests both assemblies may achieve increased strength when tightened beyond the manufacturers specified tightening torque (12Nm) [3]. This study evaluates the mechanical response during loading to investigate the implications of tightening to the current tightening torque (12Nm) as well as an increased specification (25Nm). The systems are loaded in bending, using loads representative of those observed during activities of daily living [4].

Methods
Three dimensional digital image correlation was used to measure and evaluate the strain concentrations that developed following tightening torque, and after adding bending loads to the implant assemblies. Twelve bolts were coupled with implant/abutment components (six bolts using a hex connection, and six using the Morse Taper connection). Each design type was then divided into two groups, three samples tightened to 12Nm, and three samples tightened to 25Nm. The increased tightening torque was determined with the 75% ultimate torsional strength criterion [5] using the minimum observed torque to failure result measured during an earlier study [3]. External loads were applied to the assembly in a cantilever orientation to observe its response to bending. Calibrated weights were added in 20lb increments from 40-120lbs. Following loading, loosening torque was recorded for each sample. All results were evaluated visually, as the limited sample size did not provide strong statistical power.

Results
Digital image correlation provided a means to measure deformation over the entire field of view to identify critical locations within a part when the assembly was subjected to a series of loading conditions. The complex geometry of the test specimens presented some calibration and evaluation challenges. Vertical strains, measured as #yy, were effectively a measure of the poisons effect. Due to the noise floor of the

optical setup, it was difficult to measure these small strains accurately. For this reason, the longitudinal strains, #xx, were used for the comparative evaluation. Figure 1 presents the #xx strain measurements during the highest loading condition, 120lb applied load. This is the condition that produced the most active response to loading for all of the four test groups. The left column shows the response using the current, manufacturers stipulated tightening torque of 12 Nm, the right being the response when applying an increased tightening torque of 25 Nm. The top row shows the behaviour of the hex-based samples, the bottom row being the behaviour of the Morse taper samples. These images illustrate that increased tightening torque substantially decreases the tensile strain concentrations and increases the compressive strains experienced by the samples. It was also seen that increased torque decreased the peak strain magnitude and increased torque retention.

Conclusion

The experimental results provide evidence that both the hex-based and Morse taper assemblies exhibit improved performance when tightened to a level beyond the current specified tightening torque of 12 Nm. Increased tightening torque increased the preload force within the assembly by raising the compression between bolted components. This led to increased torque retention, decreased peak tensile strain values and a more gradual, primarily compressive distribution of strains throughout the assembly. These results were achieved by evaluating the behaviour and material response in the presence of a tightening torque established as approximately 75% of the ultimate tensile strength of the material. Additional testing must be performed to increase the statistical power of the ultimate strength criterion for these assemblies.

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Image: Thompson-ISPO Abstract- Evaluating the Mechanical Behaviour of two OTI_None.png (see online)

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Poster Session: Prosthetics
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Poster [3443-618]

The Influence of Shoes on the Properties of Prosthetic Feet

Author
Hochenleuthner, Norbert (Wien AT) | DI
FIOT - Biomechanik

Coauthors
Kiene B, Hoecker K, Rohringer M, Sturm D

Abstract
Shoes limit the deformation possibility of prosthetic feet in the heel area which influences their properties depending on the style of construction of the prosthetic foot. Prosthetic feet with a cushioned heel are more influenced by shoes than carbon prosthetic feet which deform inside a cosmesis.

Introduction
The influence of a shoe on the properties of a prosthetic foot is only seldomly taken into consideration. Studies prove, that shoes highly influence properties and usage of prosthetic feet in different aspects. Besides changes in gait pattern during stance and swing phase (Schmalz et al., 2000, Van Jaarsfeld et al., 1990a and Donn et al,. 1989), shoes also change the stiffness of prosthetic feet (Van Jaarsfeld, 1990b). For dynamic energy return prosthetic feet, which store energy at heel strike and return it at toe off, shoes cause an energy loss (Klute et al. 2004, Van Jaarsfeld 1990b).
This energy loss can make some of the expensive high tech prosthetic feet less advantageous and questions their recommendation.

Methods
To determine the properties of the prosthetic feet as well as the prosthetic foot ñ shoe combinations dynamic tests were made. For this study five different prosthetic foot types and five different shoe types were tested in all possible combinations.
Therefore the prosthetic foot is dropped on an incline in a way that the ground reaction force impulse equates the heel strike of a person with 80kg bodyweight. With a heel contact step angle of 15# and a toe off step angle of 20# the test equals the ISO 10328.
The tests are done barefoot as well as with shoes; each test is repeated five times to ensure reproducibility. The measurement results are evaluated according to their dampened oscillation, wherewith the mechanical properties of the prosthetic feet as well as the prosthetic foot ñ shoe combinations can be calculated.

Results
The barefoot measured spring stiffness of the multiaxis carbon foot (79N/mm) is the highest of all tested feet. Followed by the jointless carbon foot (67N/mm) the single axis foot (58N/mm) and the dynamic foot (49N/mm). The lowest value had the SACH foot (30N/mm).
Inside a shoe the multiaxis, the dynamic and the SACH foot show an increase of spring stiffness.
Compared to the barefoot measurements the jointless carbon foot shows a decrease in spring stiffness with the running and the leather shoe. The multiaxis carbon foot shows a decrease in stiffness during all measurements with shoes.
Barefoot the dampening coefficient of the dynamic foot (96Ns/m) is the highest. Followed by the multiaxis foot (86Ns/m) and the multiaxis carbon foot (81Ns/m). The lowest values come from the jointless carbon foot (17Ns/m).

For the dampening coefficient in combination with shoes the multiaxis carbon foot has the highest increase compared to the barefoot measurements (77Ns/m with the mountain boot). The SACH foot and the jointless carbon foot also show an increased dampening. The jointless carbonfoot has beside the tests with the womenís shoe always the lowest dampening coefficient of all prosthetic feet. The SACH foot in combination with the running shoe provides the highest dampening of all tested prosthetic feet.
The multiaxis foot, the multiaxis carbon foot and the jointless carbon foot compared to the SACH foot and the dynamic foot show only a low increase of the dampening coefficients.

Conclusion

As expected carbon prosthetic feet show the highest spring stiffness and the lowest dampening values.
The spring stiffness of the SACH-foot and in the heel area similar-constructed prosthetic feet depends on the deformation of the heel. The deformation possibility is not limited while walking barefoot. Inside a shoe this deformation possibility is limited which highly influences the spring stiffness. With carbon prosthetic feet the deformation takes place inside and this hardly deforms the cosmesis. Therefore a shoe doesnít limit the deformation possibility of a carbon prosthetic foot.
This leads to the fact that spring stiffness of carbon prosthetic feet hardly depends on the surrounding shoe. The properties of SACH-feet however are highly influenced by the stiffness of the heel area of the shoe.
The dampening behaviour is contrary. Shoes influence the dampening coefficient of the already heavy dampened SACH foot less than they do by hardly dampened carbon feet.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3213-395]

A Clinical-routine Gait Analysis Protocol to Monitor the Transition between Mechanical Knees and the C-leg

Author
Raggi, Michele (Vigorso di Budrio IT) | B.Sc.
INAIL Centro Protesi - Motion Analysis Laboratory

Coauthors
Cutti AG, Govoni G, Gherardi L, Amoresano A, Davalli A, Sacchetti R

Abstract
Who can really benefit from a C-leg is a question still debated. A simple gait analysis protocol to be used in the clinical routine was defined to study the variations induced by the C-leg on the gait of amputees coming from mechanical knees. A pilot study proved the applicability of the protocol.

Introduction
The Otto-Bock (D) C-leg is routinely provided to the patients of our prosthetic centre. Every year, about 70 new C-leg are fitted, thus raising the number of our clients using it to 450 since 1998. Compared to mechanical knees, the C-leg has been appreciated over years by our amputees and CPOs for its reliability, safety during stance, for the possibility to easily cope with stairs and inclines descending, and easily change the walking speed. Our clinical practice, however, also put in evidence that not all users are actually able to fully exploit the C-leg possibilities. On one side it is thus important to understand who can really benefit from its use. On the other, quantitative data should be available to guide in the best fitting of, and gait training with, the C-leg. For these aims, we defined a protocol to routinely measure selected gait features of amputees switching from a mechanical knee to the C-leg, i.e. the 100% of our new C-leg users.

Methods
In deciding which gait features to collect, we considered the following constraints: 1) the test must be possible outside the gait-lab, e.g. where the training is done; 2) the gait cycles collected should be as much as possible, to be really representative of the amputee's walking ability; 3) the gait features should be expressions of frequent comorbidities of transfemoral amputees; 4) the test must be completed within 30 minutes; 5) aside from the self-selected normal walking speed (SSWS), also the self-selected slow (SSSS) must be tested, as it is challenging for amputees. Qualitative information must be also collected, i.e.:1) state of the prosthesis before the test; 2) general and stump conditions; 3) pathologies at the sound side, including the use of foot orthoses; 4) falls and fear of falling; 5) back pain; 6) pain at the controlateral knee; 7) felling during walking with the mechanical and C-leg regarding stability, symmetry and fatigue.

Results
When amputees visit the INAIL Centre for been fitted with the C-leg, they are firstly assessed with the current prosthesis featuring a mechanical knee, provided it is still usable. In the first part of the test the qualitative information are collected by a practitioner. Then, the following gait features are measured through a pair of insoles-based pressure measurement system (Novel Pedar-X, D), while the amputee walks along a 70m corridor at SSWS and SSSS: 1) stance-time symmetry, i.e. the ratio between the time spent on the sound and affected side [1]; 2) stance, step and stride variability [2]; 3) the shape and repeatability of the vertical ground reaction force (VGRF) for each foot; 4) the pressures inside the shoes

and the trajectory of the centre of pressures (CoPs). These features were chosen as they have been related: stance-time symmetry to back-pain, knee pain and falling [3-4]; the stance and stride variability to mobility disability and falls [2,5]; shape of the VGRF to the proper use of the rockers [6]; pressure and trajectory of the CoP to foot pathologies [6]. The test is then repeated at the end of the training with the C-leg, and then after 1 year of use.
An example of application of the protocol is reported in Fig. 1, for a left-side amputee, 55 year-old, after being trained with the C-leg for 3 weeks. In Fig. 1 information are solely provided for the stance time symmetry and difference between foot-pressure when using the C-leg and mechanical knee.

Conclusion

The pilot studies performed so far on 5 new C-leg uses are showing that the protocol can be introduced in the clinical routine of the INAIL Centre. By the end of 2009 about 10 new users will be fitted and tested. The pilot study also showed that the information provided by the protocol can be clinically relevant. For instance, the amputee whose data are reported in Fig. 1 did not show an improved stance time symmetry or variability with the C-leg (with a Variflex LP) compared to the mechanical knee (Mercury S'N'S with a 1C40). By looking at the difference in foot pressure, a higher push-off is received by the amputee by the Variflex, which is followed by a higher peak in loading response on the sound side. This can be probably the cause of the unchanged asymmetry/variability. The adaptability of the amputee to the change in foot will be monitored in time, and thus the overall performances with the C-leg.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3321-496]

The i-LIMB Hand and DMC Plus Hand Compared

Author
van der Niet, Olga (Groningen NL)
University Medical Centre Groningen - Department of Rehabilitation

Coauthors
Reinders-Messeling HA, Bongers RM, Bouwsema H, van der Sluis CK.

Abstract
The i-LIMB,a multi articulated prosthetic hand is compared to the DMC plus hand in a test procedure executed by a 45-year old man, to determine the added functionality of the device. We found no clear functional advantage and concluded that the patients´needs should determine the type of prosthesis.

Introduction
The human hand is extremely complex. When a missing hand needs to be replaced it is important that the device mimics the hands´complexity so that the user keeps the same level of dexterity. Currently, the majority of upper extremity prostheses have only a single movable joint: the hand can open and close. Recently, the i-LIMB, a myoelectric hand with multi-articulated fingers and thumb and independently powered digits was brought onto the market(Touch Bionics. The i-LIMB hand has a range of grip patterns and the ability to fold around items as it grasps them. The current study aims to determine wether this new device has additional functionality above the one degree of freedom DMC plus terminal device (Otto Bock). Establishing additional functionality is of high importance becaus a new devic such as the i-LIMB is axxiciated with high costs. This causes health insurance companies to be reluctant to compensate for this newly available prosthetic hand.

Methods
The patient perfomed tests that covered all functional levels as described in the framework of the ICF, with the DMC hand an four weeks later with the i-LIMB hand. Grip and pinch strength were measured with the hand dynamometer and pinch meter. Prehensile patterns were assessed by the Southampton Hand Assessment Procedure (SHAP). The Assessment of Capacity for Myoelectric Control (ACMC) gauged myoelectric control. Satisfaction with the prosthesis and its influence on daily activities were measured by the Trinity Amputation and Prosthesis Experience Scales (TAPES). The functional status of the Orthotics and Prosthetics Users´Survey (OPUS) assessed the use of the prosthesis. The CAPP-PSI (Child Amputee Prosthetic Project-Prosthesis Satisfaction Inventory) examined prosthesis satisfaction. Visual Analogue Scale (VAS)scores determined the patient´s subjective opinion on strength, look, sound, precision- and power grip and the solidness of the prostheses.

Results
Grip strenght in teh i-LIMB hand was low compared to the DMC plus hand. Teh power gip in position 4 of the dynamometer was 4.9 kgs versus 9.8 kgs respectively. The pinch grip was 1.5 kgs for the i-LIMB versus 12.3 kgs for the DMC plus hand. The SHAP index offunction score was 52 for the i-LIMB and _ $ for teh DMC plus hand. The Capacity for Myoelectric Control was above average for both devices: 2.6 logits for the i-LIMB and 2.47 logits for the DMC plus. The TAPES showed that the patient seemed to be more satisfied with his i-LIMB hand: 40 versus 35. The performance of daily activities was almost equal for the two prosthetic hands: the OPUS functional status was 29 for the i-LIMB hand and 30 for the DMC

plus hand. Satisfaction with the prosthesis, measured with the CAPP-PSI seemd to be higher for the i-LIMB hand in comparison with the DMC plus hand: 35 versus 26, respectively. VAS-scores showed tht the i-LIMB hand was valued for its reliabilty in holding objects and the DMC plus hand was valued for its strength and solidness. The look and sound of the prostheses wer not judged as important.

Conclusion

This case report is the first to compare the multi-joint myoelectric i-LIMB hand to the widely used single joint DMC plus hand. The functional scores of the i-LIMB hand seemed to be equal or even lower than those of the DMC plus hand, which is interesting given the novel technical improvements of the i-LIMB. The lower SHAP scores are explained by the extra time needed to manage the thumb and to position the hand due to the rigid wrist. Moerover, the limited power made execution of heavy tasks impossible. Other explanations for the moderate results of the i-LIMB hand were inexperience of the patient and limited training with the device. The higher satisfaction with the i-LIMB seems to be based predominantly on the reliability of the i-LIMB when holding objects. We conclude that, dependent on the users´ needs, patients should opt for an i-LIMB hand or a more conventional DMC plus hand. Moreover, innovations of prosthetic hands should take the limitaions of the i-LIMB hand into account.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3416-591]

Investigating the Effects of the Mechanical Properties of Trans-tibial Prostheses on User Performance: A Preliminary Study

Author
Major, Matthew (Salford GB)
University of Salford - Centre for Rehabilitation and Human Performance Research

Coauthors
Twiste M, Kenney L, and Howard D

Abstract
The relationship between the mechanical behaviour of a trans-tibial prosthesis and user performance is still not well understood. This study involved a controlled investigation of the effects of varying prosthetic mechanical properties on user performance using a purpose-built adjustable prosthesis.

Introduction
As the design of trans-tibial prostheses has continued to advance, this has led to a wide range of alternative commercially available modular components. Each component's mechanical function will have a direct influence on the performance of both the prosthesis and, consequently, the user. The effects of various trans-tibial components on user performance have been thoroughly investigated [1]. Studies have also been conducted which characterise the mechanical properties of prosthetic components to reveal their specific mechanical behaviour during gait [2]. However, there appears to be little quantitative evidence supporting manufacturers' claims that particular foot designs provide the user with a biomechanical or physiological advantage compared to alternative designs. The objective of this study was to design and test a controlled method of investigating the influence of trans-tibial prosthesis stiffness properties on the biomechanical and physiological performance of the amputee.

Methods
A purpose-built prosthesis was designed with adjustable ankle-joint stiffness characteristics (Figure 1), to allow for a comprehensive investigation of the effects of prosthetic stiffness properties on gait without the use of commercial products. The mechanical behaviour of the prosthesis was quantified using the "roll-over shape" model [3]. Gait kinematics, oxygen consumption, and heart rate of 5 subjects were measured. Additionally, the in-vivo roll-over shape and gait kinetics were measured with a custom prosthesis that utilised a 3-axis load cell installed between the pylon and socket. These parameters were observed during use of four combinations of dorsiflexion (DF) and plantar flexion (PF) stiffness of the foot, and under the following scenarios: self-selected and fast walking on a level surface, 5% grade incline and 5% grade decline. Parameter differences were statistically analysed using ANOVA with Bonferroni adjustment for multiple comparisons (significance set at $p<=0.05$).

Results
Despite noticeable differences in the average metabolic efficiency (ml O2/kg/m) between each foot setup for a particular walking condition, these differences were not statistically significant ($p<0.738$ for all scenarios). However, the combination of lowest PF and DF stiffness produced the lowest metabolic cost for all walking conditions, averaging 25% lower metabolic efficiency (ME) than the highest PF and DF stiffness combination for decline walking. Across all foot setups, there are statistically significant differences in ME

between each walking condition, apart from decline versus fast walking. Incline walking produced a 53% increase in ME compared to decline walking. Apart from walking on the level, vertical ground reaction force profiles did not conform to the standard two-peak form. Fast walking (150% of self-selected speed) generally produced the highest peak vertical ground reaction forces during gait (average of 1.1xbody weight). The foot setup of high PF and low DF stiffness consistently produced the highest peak vertical ground reaction force in each walking scenario (e.g., 8% increase compared to low PF and high DF for decline walking). Subjective ratings of each foot setup (stability, comfort, and exertion) indicated that certain foot setups are more preferred for particular walking scenarios. Overall, the majority of subjects rated foot setups with low PF stiffness as the most stable across all walking conditions, and high PF stiffness as the least stable.

Conclusion

This paper discusses the relationship between the mechanical function of a trans-tibial prosthesis and the performance of the amputee. The novelty of this approach is that the methodology provides for a systematic exploration which is decoupled from the constraints imposed by the use of commercial products. Differences in metabolic efficiency and subjective ratings were found between foot setups within a specific walking condition. This implies that certain prosthetic mechanical properties might be better suited for particular walking conditions in order to produce a more optimal gait. Irrespective of foot setup, incline walking had the highest metabolic cost. Irrespective of walking condition, lower average metabolic cost was observed with low PF and low DF than with high PF and high DF. The results from this study will provide insight into appropriate prosthetic prescription of modular components and assist in establishing improved design guidelines for future prostheses.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3170-362]

Polycentric Hip and Microprocessor-controlled Knee Improves Gait of a Patient with a Hemipelvectomy

Author
Kaufman, Kenton (Rochester US) | Dr.
Mayo Clinic - Department of Orthopedic Surgery

Coauthors
Gozola MA

Abstract
The gait of a patient with a hemipelvectomy was compared when using differing prosthetic components. The gait was improved when a microprocessor-controlled knee was used in conjunction with a polycentric hip.

Introduction
A hemipelvectomy is a rare surgery and represents only about 0.4% of lower limb amputations. The ability to walk is closely related to the level of amputation. Prosthetic use in this group of patients is limited. As a result, there are few prosthetic components that are available to serve this group of patients. The purpose of this study was to evaluate the importance of 3D polycentric hydraulic motion for patient function.

Methods
This is a cross-over study of a patient (male, age 43) who required a hemipelvectomy for a pelvic carcinoma. The patient was initially fit with a polycentric stance control and hydraulic swing control knee (Otto Bock 3R60) and a unicentric hip joint (Otto Bock 7E7). The patient was subsequently fit with a microprocessor-controlled knee (Otto Bock C-Leg), torsional adapter (Otto Bock 2R81), and a hydraulic stance and swing control polycentric hip (Otto Bock Helix3D). The patient had both prosthetic configurations for greater than 10 months before testing and was fully adapted. Objective gait measurements were collected with a computerized video motion analysis system utilizing ten infrared cameras. Simultaneously, ground reaction forces were collected from four force plates. The 3D marker coordinates and forceplate data were input to a commercial software program to calculate lower extremity joint kinematics and kinetics.

Results
The patient reported improved ease of walking and a significant reduction in falls from approximately two per month with the initial configuration to two falls over a 10 month period with the second configuration. The patient was also able to eliminate the need for gait aids when his prosthetic components were changed. There were notable improvements in gait with the advances in prosthetic technology. Overall, gait velocity improved by 67% as a result of increased stride length (32%) and increased cadence (28%). Single support time also improved (38%). Hip extension during early stance was more controlled and continued over a longer portion of the gait cycle until full extension was achieved (see figure). Hip flexion started at the beginning of the swing phase and continued throughout swing phase in synchrony with knee flexion and then extension, rather in the terminal swing. The knee exhibited a shock absorbing pattern during loading response, achieved greater swing phase flexion and had a timing of swing phase flexion which was closer

to normal (see figure). Rotational motion was increased at the pelvis, hip and knee. These kinematics changes resulted in a normal knee kinetic pattern and improved ankle dorsiflexion moments.

Conclusion

Functional outcomes of patients with a hemipelvectomy are generally limited (1). The use of microprocessor-controlled knees has been shown to decrease energy expenditure (2). Improved gait mechanics achieved with prosthetic improvements for this patient resulted in increased comfort and easiness of ambulation. These improvements increased the patient activity level which result in improved quality of life. A reduction in falls was of particular importance due to increased susceptibility for this amputee population. Future research should focus on quantifying activities of daily living functional improvements, lower spine biomechanics, low back pain, improvement in body image, and socialization in a larger sample size.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3455-630]

Early Experiences with the Otto Bock Axon-Bus Prostheses System with Michaelangelo

Author
Conyers, Dan (Redondo Beach US)
Advanced Arm Dynamics - None

Coauthors
Conyers D

Abstract
This presentation will focus on the early keib phase fitting experiences with the Otto Bock Axon Bus Prostheses System with Michaelangelo.

Introduction
The Axon Bus Prostheses System with Michaelangelo is a new compliant hand developed by Otto Bock.

Methods
Various international patients have been utilizing the hand in the keib phase fitting.

Results
The Axon Bus Prostheses System with Michaelangelo has various grip patterns and functional hand positions.

Conclusion
The Otto Bock Axon Bus Prostheses System with Michaelangelo is a revolutionary hand system. This system is the latest advancement in compliant hands that offers more anatomical articulation while still maintaining the aesthetics of the human hand.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3367-542]

Prosthesis Fitting for a Complicated BK Amputee: a Case Study

Author
Kafili Larimi, Mohammad (IR) | CPO
JMERC - Biomedical Department

Coauthors
Shojaei,Hadi
Yavari,Amir
Allami,Mostafa

Abstract
We have a patient here with some acute problem and we tried to fit a suitable prosthesis for him In this progress. We consulted each other a lot and we successes to fine some solution for improving sitting and walking in the patient.

Introduction
Prosthesists sometimes encounter amputees which at first glance, various problems in various body organs, show fitting of prosthesis and making mobility for them impossible. However these things are very complicated hard and time consuming, but in the event of success it is result will be very satisfactory usually fitting of prosthesis for these people is out of principals of references and attaining favorable result needs enough knowledge and patience. Amputee should want to regenerated mobility .This survey is a case study and has studied experiences of successful fitting of prosthesis for one of these amputees.

Methods
The patient is 66 years old ,left below knee amputation, range of knee flexion 65-80 ,excessive medial rotation of femur ,neuroma at the end of stump ,muscle atrophy above knee with cardiovascular and respiratory problems , right lower limb of patient had also fracture in femur and 4 cm shortness .The patient walked very hard with previous prosthesis and with abduction gait a part of patella at left leg was removed .

Results
After evaluation of the patient in a team of 3 prosthesists , physical medicine expert , orthopedic surgeon and cardiologist , a prosthesis with femoral shell and external knee joint prescribed. Socket was PTS and foot was SACH and part of weight was took with femoral shell which attached to ankle a pair of joint at two sides of socket .Static balance attained by fabricating repeated alignment and during repeated experimented walking ,dynamic alignment also attained .

Conclusion
After 15 sessions exercise and changing of patient alignment he could walk with a better gait than previous prosthesis. Using of knee free joints caused flex of knee prosthesis got possible and usual sitting at a car and other chairs become possible for patient .

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3368-543]

Comparison of Sealin Silicon Sockets with Common Sockets in Mobility and Fitting of Prosthesis for Above Knee Amputees

Author
Gharibpanah, Shahram (IR) | CPO
JMERC - Biomedical Department

Coauthors
Rouhani,Mohammad Reza
Allami,Mostafa
Masoumi,Mehdi

Abstract
Selection of socket has important role in fitting above knee prosthesis. This study shows comparison of Sealin silicon sockets with common sockets in mobility and fitting of prosthesis in above knee amputees. We found some useless and useful points of Sealin sockets.

Introduction
Selection of socket has important role in fitting above knee prosthesis. Most of researchers emphasize on principal role of socket in above knee prosthesis. It means that a prosthesis with advanced and expensive segments but improper socket usually has not appropriate efficiency for amputee over against fitting of appropriate socket and create favorable mobility even with cheap segments for amputee. This study shows comparison of Sealin silicon socket with common socket in mobility and fitting of prosthesis in above knee amputees.

Methods
In this study for 7 above knee amputees that had experience of using common prosthesis for the first time a prosthesis with Sealin socket was given to them , after one month usage of prosthesis with Sealin socket a questionnaire was completed face to face. In questionnaire some questions about comparison of suspension, rang of using prosthesis, perspiration, facility of donning and control of knee joint were proposed.

Results
6 of 7 amputee remarked that suspension of their prosthesis improved with Sealin system, according to remark of 3 of them their mobility got better with Sealin system and according to remark of 4 of them their mobility was not changed.3 amputees remarked that donning was more comfortable and 4 said that was harder, 4 of them remarked that their control on knee joint was improved and 3 said that it was not changed. Also by using Sealin socket, rolling of adduction muscles of 2 amputees got better and tenderness at one of them and skin mobility at 6 amputees improved.

Conclusion
In fitting of prosthesis, individual characteristics, environmental condition, role of life and activity level should be considered. 3 of amputees which had remarked that their perspiration increased with Sealin socket lived in humid environment .3 of them which had remarked that donning of prosthesis got better,their previous was suction socket and against 4 of them which said donning got worse for them their previous

prosthesis was a kind of belt socket .4 amputee which had remarked that their control increased on knee joint had a belt socket in previous prosthesis .

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3332-507]

Paperboard Technology: an Application Example in Upper Limb Prosthetics

Author
Plettenburg, Dick (Delft NL) | Dr. Ir.
Delft University of Technology - BioMechanical Engineering

Coauthors
Ivan van der Veld

Abstract
Mass and costs are decisive factors in the use of hook prostheses. Paperboard is considered a reliable, lightweight, and low cost construction material. To demonstrate the feasibility of using paperboard materials in prosthetics an adult size body-powered hook prosthesis has been made.

Introduction
Despite all the efforts to improve over the existing types of prostheses the majority of the prostheses ends up not being used [1, 2]. Among the decisive factors to choose for and wear a prosthetic device are the cost and the mass [3]. As paperboard material is considered a reliable, low mass, and low cost construction material [4], a research project was started to demonstrate the feasibility of the use of paperboard material in prostheses. The main objectives were to show sufficient load carrying capabilities of paperboard constructions, and to show a reduction on the cost and the mass.

Methods
The material properties of paperboard material were derived from the literature. Together with the general and basic requirements for prostheses [5] a list of demands for the new paperboard design was formulated. A prototype prehensor was designed and build, and subsequently tested with different load cases, typically for prosthesis use. In the design process finite element analysis was used to study the maximum stresses in the different load cases. Moreover, the mass was determined using an ordinary scale, and the cost of the materials used were added to the estimated costs for the production and assembly.

Results
The material properties of paperboard differ considerably depending on the fiber type, fiber density, and the chemical/mechanical treatment, and on the different principal directions of the material. Besides, paper is sensitive for moisture, temperature, creep, twist and curl. As the main objective of the study is on the structural properties, these properties were not considered, especially not as several measures can be taken to deal with possible negative effects as a result of these properties.
From the list of demands, the load cases were defined according to the three principal directions: pull force # 350 N; push force # 250 N; lateral load # 250 N; and posterior load # 250 N.
In the design of the prototype the anisotropy of the material was accounted for. A prototype was constructed, and build, Figure 1. It is a voluntary opening hook-type prehensor, operated by pulling a cable. The prehensor offers passive wrist rotation with discrete pronation/supination positions set 12º apart. The prototype is build from 1 mm thick paperboard, where necessary in different layers bonded together for increased strength.

The tests for the different load cases showed the prehensor construction can carry loads exceeding the demands: pull force = 450 N; push force = 450 N; lateral load = 490 N; posterior load = 275 N. The overall mass was measured at 145 g.
The cost of the materials used is only € 1. The production and assembly costs are estimated not to exceed € 4.

Conclusion
The prototype shows the feasibility of the use of paperboard material in prosthetics. The load carrying properties can be made sufficient for the forces acting on prostheses.
Overall costs are very low at approximally € 5. The overall mass of the prototype is slightly less compared to existing hook prostheses. It is believed a further reduction of the mass is very well possible through an optimization procedure. Paperboard technology seems promising for applications within the prosthetic field.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3390-565]

Relationship between Stump Hygiene and Skin Diseases in War-related Bilateral Lower Limb Amputees

Author
Masoumi, Mehdi (Tehran IR) | Relationship between stump hygiene and skin diseases in war-rela
Janbazan Medical and Engineering Research Center (JMERC) - Prosthetics

Coauthors
Masoumi M, Morteza N, Soroush M, Mousavi B, Allami M, Amirani O

Abstract
The purpose of this study was to determine the relationship between stump hygiene and stump skin diseases in war-related bilateral lower limb amputees.

Introduction
Residual limb skin is prone to breakdown as a consequence of snug socket fit and stresses caused by prosthetic use. Besides, Stump hygiene is believed to attenuate stump skin problems to some extent. These issues become further challenging once they are dealt with in bilateral amputations.

Methods
This study was a cross sectional study and a part of a national survey regarding the assessment of health needs of war-related bilateral lower limb amputees, accomplished in 2006 in Iran . 576 war affected bilateral lower limb amputees were invited to participate in this national project, of those, 334 agreed to participate. A questionnaire and an assessment form were designed and used to collect data about prosthesis, stump hygiene and skin assessments. Descriptive statistics were developed, and statistical analyses were performed using chi-square test.

Results
I82 subjects had at least one skin problem. The most common skin problems were respectively contact dermatitis (n=126), callus (n=85), folliculitis (n=46). Skin problems in stump were significantly higher in subjects whose level of amputation was bilateral below knee. Prevalence of stump skin complications was significantly lower in those who washed their stump more times per day and week (p=0.035). However, no statistically significant relationship was found between socket hygiene and skin diseases. Amputees with higher education level had better stump hygiene; moreover marital status had no effect on stump skin complications.

Conclusion
As the result of this study showed, about half of the subject had a sort of skin problem in their stumps which was related to the amputees attitude toward their stump hygiene. This finding draws attention to the need for more residual and prosthesis hygiene education for amputees, especially for those with lower educational level.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3326-501]

Effectiveness of Using Upper Prosthesis for Activity Daily Living in Bilateral Upper Limb Amputees

Author
Hosseini, Parisa (IR) | CPO
JMERC - Biomedical Department

Coauthors
Masoomi , Mehdi
Allami , Mostafa
Balouch kayvan , Behrad

Abstract
The upper limb is as a device for communicating and having influence on environment Prevalence of bilateral upper limb amputation is lower than unilateral study shows effect of using upper limb. Decreasing pain ,healing , protection of stump sensation , increasing psychical adaption with amputation

Introduction
This part of body is as a device for communicating and having influence on environment.
Prevalence of bilateral upper limb amputation is lower than unilateral and generally than lower limb amputation this study shows effectiveness of using upper limb prosthesis for ADL in bilateral upper limb amputees

Methods
For evaluation a questionnaire was prepared and capabilities of amputee with and without prosthesis for ADL was compared . FIM index was used for comparison in this cross-section study following a complete physical examination questionnaire were completed of a small electric shock aroused by application of a prosthesis contact with a bed or on palpation of the stump was recorded as neuroma because of no objective biological markers self report is considered the most accurate pain assessment further information and nerve condition after injury and also medical records due to patient recall bias were unreliable and not available.

Results
Because mail reason of these people`s amputation was mine exploding they get other problems like burning ,blindness , quiver in some parts of their body and …
From 103 amputees ,73 of them (70.9%)got right hand prosthesis and 69 of them got left hand prosthesis
Based on chart findings of management and control of prosthesis ,amputees without prosthesis act more independently that it shows consistency with amputation more fine activities more dependency like button . dependency of amputee increase in doing gross activities chart of personal cleanliness also shows that amputees without prosthesis have more freedom
Of course level of amputation and stump length has influence on it
Chart of house keeping activity shows that in fine activities freedom and independency of amputees decreases again it means getting prosthesis doesn’t have an effective role in this field.

Conclusion

Far arable appearance and low weight durability , comfortableness ,being functional and … of the prosthesis are all important for amputees

A long length stump is better for a functional prosthesis is spite of not acceptation but we should not forget important role of rehabilitation and getting prosthesis immediately after amputation .in fact first month after amputation in considered as golden time of rehabilitation .advantages of this include

Decreasing pain , healing , improving of rehabilitation decreasing of hospitalization time , protection of residual limb sensation , and increasing psychical adaption with amputation.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3070-268]

Development of a Knee Joint to Allow Trans-femoral Prosthesis Users to Ascend and Descend Stairs and Oxygen Uptake Evaluation Using this Knee Joint

Author
Ninomiya, Makoto (Nagasaki-city JP) | Development of a Knee Joint to Allow Trans-femoral Prosthesis Us
Nagasaki Kanae Co.,Ltd. - president

Coauthors
Katsuya M , Manabu G

Abstract
We have developed the NAL-Knee (Natural Automatic Lock Knee) for use in trans-femoral prostheses, enabling users to ascend and descend stairs. Our oxygen uptake evaluation proved that the NAL-Knee offers merits for not only descending stairs, but also ascending stairs.

Introduction
In order for a trans-femoral amputee to smoothly move up and down stairs wearing a trans-femoral prosthesis, there needs to be control of the hydraulic cylinder in the knee joint. In other words, the knee must stop bending at arbitrary angles when ascending stairs, and carry out a yielding function when descending. At the ISPO 2007 World Congress we reported on our development of a knee joint with a “bouncer” system that provides these functions, and today we would like to report on improvements that have been made, as well as on the oxygen uptake evaluation we have made since that time.

Methods
A new link (bouncer) was established under the knee joint, which can move when the load is on the heel or toe, thus closing the yielding or locking valve within the hydraulic cylinder, respectively. This is called “NAL-Knee”. There are two methods employed by prosthesis users when climbing stairs. The first is to climb one step at a time, extending the prosthesis knee as before. The second method is to use a reciprocal gait. Furthermore, there are two methods that can be employed when ascending stairs with a reciprocal gait, specifically: A) ascend while the knee is extended and B) stop the angle of the knee hydraulically at the desired angle. Also, the two methods employed when descending stairs are to climb down one step at a time like before and to use a reciprocal gait. We considered the degree of ease for trans-femoral amputees to climb up and down stairs using these methods. This was accomplished by measuring oxygen consumption for each method, using a portable gas analyzer.

Results
Each step had a height of 16cm and a depth of 25cm. Measurements were made with the subjects ascending and descending 50 steps (continuously). A break of 10 minutes was provided between each measurement. Subjects were asked to walk as fast as they could. The subjects were two trans-femoral amputees, a 31 year old woman, and 44 year old man, who usually use an Intelligent knee.
Compared to the conventional method of descending one step at a time, the NAL-Knee was better for descending stairs in terms of both oxygen uptake and speed. In other words, we proved that the yielding function is effective. However, compared to the conventional method of ascending one step at a time, the

NAL-Knee was inferior in terms of both time required and oxygen uptake. One possible reason for this result is that the male subject was equipped with the NAL-knee for the first time and was still not proficient in its use. However, in the case of a trans-femoral amputee with good athletic ability, ascending stairs could be accomplished faster and easier when using NAL-Knee as compared to the conventional step-by-step method.
When only focusing on a reciprocal gait, it turned out that ascending stairs using a NAL-Knee more comfortably compared to ascending by a reciprocal gait with a conventional knee joint using the extension muscles of a hip joint. Furthermore, we believe that once the trans-femoral amputee becomes more accustomed to the NAL-Knee, the functions can be used more effectively.

Conclusion
We have established a knee with a bouncer system called the NAL-Knee. Experiments showed that trans-femoral amputees could comfortably ascend stairs with a reciprocal gait by stopping knee flexion at arbitrary angles. When descending, the amputee will step down feeling the resistance for flexing the knee. Since a power source is not required, maintenance is minimal and therefore, less expensive. NAL-Knee is only a knee joint product, so there is no need to exchange either the socket or foot sections.
Oxygen uptake tests proved the merit of the NAL-Knee in going up and down of stairs. The NAL-Knee clearly excelled in terms of both speed and efficiency for descending stairs, but for ascending stairs there was the problem of individual differences and the need for practice. However, when focusing only on reciprocal gait, it turned out that ascending stairs with a reciprocal gait and using the NAL-Knee is more efficient then ascending with a reciprocal gait using muscles.

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2001 ISPO Voluntary Control of Mechanical Knee Joint Using Socket Pressure Sensor of Trans-femoral Prosthesis
2004 ISPO Development of a Knee Joint for a Trans-Femoral Prosthesis that Can Ascend and Descend Slopes and Stairs
2007 ISPO Development of Knee Joints to Allow Trans-femoral Prosthesis Users to Ascend and Descend Stairs

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2902-100]

Fitting of a Multifunction Hand-wrist System at the Transradial Level

Author
Miller, Laura (Chicago US) | Dr.
Rehabilitation Institute of Chicago - Neural Engineering Center for Artificial Limbs

Coauthors
Kuiken TA, Li G, and Schultz AE

Abstract
Pattern recognition involves “learning” the nature of the muscle contraction patterns for a specific user. This control can be applied to a multifunction hand-wrist system to allow easier access to each of the different movements, without requiring a separate switching like co-contraction.

Introduction
Pattern recognition (PR) has been described in the literature as a way to control a large number of arm movements.(1) It has also been used to control advanced components with higher levels of amputation with individuals who have had targeted reinnervation.(2) We have shown that it can also be used for transradial (TR) level amputees, without targeted reinnervation, to control a physical device: a multifunction hand-wrist system with 7 hand & wrist movements.
Initial PR testing has been done with 5 TR amputees using a virtual reality system with 10 wrist & hand movements, comparing the residual limb to the intact arm.(3) Performance metrics included motion selection time, motion completion time, and motion completion (“success”) rate.
Four different TR amputees have been fit with a prosthesis that allows them to control a prototype multifunction hand-wrist system: movements include wrist pronation/supination, wrist flexion/extension, and two hand grasps: three-jaw chuck and key grip.

Methods
For PR, the individuals first have to “train” the system. In order to train the system, the user is prompted to perform each of the movements, or classes. During this time the electrode data is collected. The computer then processes the data, looking at various features, including the number of zero crossing, the length of the signal, the mean value and other characteristics. It uses the data from all electrodes for each of the different movements to create a classifier. Once the classifier is created, the controller can look at short windows of new EMG and predict the movement.
Four individuals have been fit with sockets that integrate 6 electrodes. The system is currently controlled by a desktop computer wirelessly through a Bluetooth connection. Electrode signals are sent wirelessly to the computer, the computer then determines the correct classification and then returns motor command signals. A battery is mounted on the prosthesis to provide the power.

Results
Five individuals were tested for the ability to control ten movement classes (wrist flexion/extension, wrist pronation/supination, hand open, and five grips: chuck, key, tool, power, and fine pinch) using either the residual limb or intact limb. Initial testing and training was performed using a virtual reality system, simulating a device. Overall, the residual limb did not perform as well as the intact limb. Testing on residual

arm musculature produced significantly lower classification accuracies than testing on intact arms ($p<0.02$). The average accuracy over all five subjects was 79 +/- 11% for the residual limb and 94 +/- 3% for the intact arm. Similar results were found for motion select times, motion completion rates and motion completion times.
With fewer hand grasps to control, functional performance was improved. Outcome measures of the four individuals using the multifunction hand-wrist system will be presented. Video of the hand and wrist in being used during some of these of outcome measures and also during functional activity of daily living tasks will also be shown.

Conclusion
Although we have shown that it is possible to control a two degree-of-freedom hand and two degree-of-freedom wrist with pattern recognition, there are still many factors that need to be resolved before this can be a viable home system. For example, it is still not clear if users will need to train the system over time to maintain control. Additionally, a system that detects when an electrode looses contact with the skin may provide more reliable control. Also, six electrodes can be difficult to integrate into a transradial system. It may be possible to reduce the number of electrodes to make prosthesis fitting easier.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3393-568]

Comparison of Prosthetic Use and Walking in Different Levels of War-related Bilateral Lower Limb Amputees

Author
Mortaza, Niyousha (Tehran IR)
Janbazan Medical and Engineering Research Center (JMERC) - Prosthetics

Coauthors
Morteza N, Masoumi M, Soroush M, Mousavi B, Allami M, Yavari A

Abstract
The objective of this study was to compare prosthetic use and amount of walking with prosthesis in bilateral below knee amputees (BK-BK), bilateral above knee and below knee amputees (AK-BK), and bilateral above knee amputees (AK-AK).

Introduction
Bilateral lower limb amputees have difference needs and challenges in comparison with unilateral lower limb amputees. Besides, for this group of patients use of prostheses is an indispensable part of their rehabilitation and mobility. One of the important points in this arena is that to what extent dose presence of a physiological knee joint can affect the role of prostheses in the mobility of bilateral lower limb amputees.

Methods
This study was a cross sectional study and a part of a national survey regarding the assessment of health needs of war affected bilateral lower limb amputees, accomplished in 2006 in Iran . 576 war affected bilateral lower limb amputees were invited to participate in this national project, of those, 334 agreed to participate. A questionnaire were designed and used to collect data about prosthesis use and walking duration and distance. Five certified prosthetists were trained to do the assessments and to fill out the questionnaires during six days. Descriptive statistics were developed, and statistical analyses were performed using chi-square test and ANOVA.

Results
Out of 334 participants 320 (98%) were men and 8 (2 %) were women with the mean age of 43±6.34 years, and mean time since their amputation was 25 years . 93 patients were AK-AK, 136 were BK-BK , and 102 were AK-BK . 66 subjects did not use prosthesis at all, out of which 22 could not receive a prosthesis mainly because of their too short residual limbs, and the main reason that the rest of them gave for prosthesis disuse was their undesirable prostheses. Moreover, 138 amputees did not wear their prostheses at home. Prosthetic use among BK-BK amputees were significantly higher than AK-AK and AK-BK amputees ($p<0.05$).
227 patients walked with their prostheses 7 days a week. Among three groups of amputees 170 patients (66.9%) walked 1-3 hours per day. 102 patients could walk 50-100 meters without any interruption. Comparing walking duration and distance per day and week between three groups of amputees (AK-AK, BK-BK, AK-BK) did not show any statistically significant difference.

Conclusion

Finding of this study showed higher prosthetics use among bilateral above-the-knee and below-the-knee amputees than double above-the-knee amputees, and again double below-the-knee amputees showed the highest rate of prosthetic use of all. However, Comparisons of walking distance and duration per day and week showed no difference between three groups of prosthesis user amputees. This could possibly be the result of the differences that subjects had regarding their living environment, vocational demands, psychological status, and motivational issues. This finding showed that presence of a knee joint is not the only effective in using prostheses for walking among double lower limb amputees. Finally, further investigations are necessary to find out the effect of the aforementioned factors on the amount of walking and activities of different double lower limb amputees.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2964-162]

Range of Acceleration as an Indicator of Stability for Transtibial Prosthesis Users

Author
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Coauthors
Kendell C, Lemaire ED, Kofman J

Abstract
Range of acceleration has been used to assess stability. To test this measure with transtibial prosthesis users, accelerometer data were collected across various walking conditions. Range of acceleration was not appropriate for prosthetic stability analysis.

Introduction
Previous studies have used accelerometers to assess stability during walking by employing complex signal processing methodologies (i.e. non-linear time series analysis, harmonic ratios) [1,2,3]. Range of acceleration of a limb may be a suitable parameter for clinical settings since it is easy to measure, requires minimal processing, and is easy to interpret. For example, a larger range of medial-lateral acceleration could be related to greater medial-lateral sway during gait (i.e., larger acceleration needed to move the body back over the base of support before the next step). Since kinematic variability is associated with decreased stability [4,5,6], an increased range of acceleration would correspond to a decrease in stability. The aim of this study was to determine whether 3D range of acceleration could be used to assess dynamic stability over a range of walking conditions.

Methods
Subjects consisted of 12 individuals with unilateral, transtibial amputations who were community ambulators. Tri-axial accelerometers (Xsens, Enschede, Netherlands) were affixed to the lumbar spine using double-sided tape (x-axis = vertical; y-axis = medial/lateral; z-axis = anterior/posterior). Subjects walked over six different conditions; level ground, uneven ground, upramp, downramp, upstairs, and downstairs. Two trials were collected for each of upstairs and downstairs, and five trials were collected for all other conditions. The absolute acceleration range was calculated for multiple strides for each trial (3 for each of upramp and downramp, and 5 for all other conditions). For each subject and condition, the average absolute acceleration range was calculated over the total number of strides (# trials x # strides extracted). A one-way analysis of variance was used to determine whether the range of acceleration along each axis differed between conditions.

Results
Condition had a significant effect on acceleration for the x-axis ($F(5,50)= 10.025$, $p<0.05$), y-axis ($F(5,60) = 18.037$, $p<0.05$), and z-axis ($F(5,60) = p<0.05$). For the x-axis, and z-axis, acceleration for downstairs was significantly greater than all other conditions. For the y-axis, acceleration for downstairs was greater than all other conditions and acceleration for upstairs was significantly greater than uneven ground. In addition, standard deviations were consistently higher for the x-axis, indicating high variability in the vertical projection of the body center of mass. During stair descent, individuals with transtibial amputations tended

to place the middle of their prosthetic foot over the edge of the step to facilitate knee flexion and roll-over. This method of "minimally-controlled" rollover may have contributed to an increased walking rate and to increased acceleration along all three axes.

Conclusion

With the exception of downstairs, range of acceleration was not useful in highlighting stability differences between walking conditions. Level ground walking was not significantly different from any condition other than downstairs, although level ground is likely the most stable walking condition. Range of acceleration was not sensitive to differences between walking conditions and did not provide sufficient information to draw conclusions about dynamic stability, highlighting the need for a multi-factorial approach to examining dynamic stability.

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Image: Figure 1-Range of Acceleration by Condition_None.emf (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg240353/cg34942

Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3251-432]

The Role of a Shock Absorbing Pylon in Absorbing Force in Running

Author
Strike, Siobhan (London UK) | Dr
Roehampton University - Human and Life Sciences

Coauthors
Wickett, O

Abstract
We aimed to determine if a shock absorbing pylon (SAP) influenced the loading rate, knee angles and knee power absorption during the loading phase in running compared to a rigid pylon. The SAP reduced the loading rate, but did not influence the knee flexion angle or the knee joint absorption power.

Introduction
Transtibial amputees have a compromised capacity to attenuate the impact forces of gait. To address this deficiency, shock absorbing pylons (SAP) have been developed. Research in walking has indicated that these devices have little effect on the biomechanics of gait1,2 and no effect on oxygen consumption at self-selected speeds, though less energy was expended at higher walking speeds3. Running poses a greater shock-absorbing problem for amputees as weight transfer is more rapid and the magnitude of the forces is larger. In walking and running, amputees have been shown to maintain the prosthetic limb in an upright position to ensure stability at the knee4,5. There is a reduced shock absorbing capacity at the limb and to protect it there is reduced loading7,8. There is little research assessing the efficacy of the SAP in running. We aimed to determine if the SAP reduced the loading rate in prosthetic stance and if the knee angle and power absorption in the loading phase were altered.

Methods
5 male unilateral trans-tibial amputees participated. They were young, active and at least 1 year post-operative. They were independent walkers and able to jog, free of other muscular-skeletal injuries, disease or limitations. They wore Elite VT feet and a Tele-Torsion [TT] Pylon, (Endolite, UK). Two prosthetic limb conditions were analysed: TT Pylon active (SAP) and inactive (Rigid). Data were collected using a Kistler force platform synchronized with a 9-camera Vicon motion analysis system. 34 reflective markers were attached to create a full body model. The amputee was given a week to adjust to their altered pylon.
The participants warmed up for ten minutes then ran down a 20m runway at a controlled velocity of 4 ms-1, which was monitored using two infrared beam sensors.
The loading rate was defined by maximum vertical force divided by time taken to max. Maximum knee flexion angle and the peak knee absorption power (standard inverse dynamics) were determined in the loading phase.

Results
The loading rate was reduced using the SAP for the group as a whole and for each individual but one. For AMP4, the loading rate was marginally higher for the SAP condition. For the group as a whole, there was no difference in the knee joint angle. Two amputees had a more extended knee joint angle in the SAP condition and for AMP1 the knee was on average 15o more extended with the SAP. The knee angles

of our amputees were similar to those reported previously for AB runners8 and slightly greater than the knee angles reported for TT amputees running at a slower pace5. There was little difference in the knee absorption power between the SAP and the rigid condition. For 3 of the amputees the power was reduced on the SAP limb, for one it was very similar and for two it was greater for the SAP. McMahon et al9 have shown that running with exaggerated knee flexion causes the runner to attenuate more shock between the shank and the head, while running with an extended knee results in a ‘stiff’ runner and so less shock is attenuated. Here, the amputees maintained similar knee flexion angles. The increased compliance of the SAP did not alter the magnitude of the knee flexion in loading. This contradicts the findings in controlled speed walking when the amputees using the SAP increased their knee flexion2. Knee absorption power was not affected by the SAP, and along with the knee flexion angles indicate that the knee did not alter its shock absorption capacity as a result of the SAP.

Conclusion

We aimed to determine if the use of a SAP altered the loading rate and knee mechanics in the loading phase of the prosthetic limb in running. The results indicate that using the SAP reduced the loading rate for these amputees running at this speed. As the knee kinematics and kinetics were not altered, it is likely that the reduced loading rate was as a result of the presence of the SAP. The reduced loading rate is seen as useful for amputees, to reduce the loading on the residual limb which may reduce the likelihood of amputees experiencing both the shock related injuries that are common in runners and residual limb discomfort.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3083-281]

Prosthetic Systems for Lower Extremities - Interdependencies between Prosthetic Components & Alignment

Author
Pusch, Martin (Duderstadt DE) | Dipl.-Ing.
Otto Bock HealthCare GmbH - Strategic Technology Management

Abstract
Prosthetic feet and knees are designed for a specific functionality. Three characteristic foot-knee combinations are analyzed in relation to their different functionalities. The influence of the foot to the knee in TT prostheses is demonstrated.

Introduction
For prosthetic components, amputee indications for effective component application are written in the instruction manual. Also included is a table of prosthetic foot-knee combinations which will result in the best function of the knee by proper selection of the foot.
Those recommendations are based on the principle functionalities of the individual components. These principle prosthetic functionalities can be applied to general biomechanical questions such that amputee indications can drive the selection of appropriate component combinations. A typical example of the component selection question which will be considered in this talk is: For which indications should knee stabilization be driven by the foot versus when should a foot which supports the center of gravity of the amputee dynamically be combined with a knee joint stabilized by the knee design itself? Knee joints are operating in one plane only, so only that plane (close to sagittal plane) is analyzed in this paper.

Methods
Relevant functional aspects of prosthetic feet are measured on a simulator (servohydraulic test machine), which loads and moves the foot such that functional characteristics can be objectively described and compared (roll over shape, roll over length Hansen 2002). Knee geometries and their relevant functional criterions are combined with this foot data. Amputee actions which demonstrate either a positive or negative use of the designed functionality are discussed.

Results
It can be shown, that component selection must consider the foot and knee in combination and not just as individual components.. The system’s function has to be designed to meet the needs of the individual amputee. The alignment of the components in the prosthesis must also consider the functional interdependency of both the foot and knee as well as considering the amputee’s conditions. Proper consideration of these parameters results in a positive result for the amputee in terms of both stability and dynamic functions.

Conclusion
As modern components become more functional, they can be better matched with the appropriate amputee user., but the alignment and fitting of the components to the user also becomes more critical in order to achieve the optimal function. This applies equally to both trial and definitive fittings for which the same care has to be taken with regards to both selection and alignment. Time and money invested for different trial fittings therefore is well invested.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3048-246]

The Effect of Residual Limb Length on Biomechanical and Metabolic Gait Parameters in Transfemoral Amputees

Author
Schmalz, Thomas (Göttingen DE) | Dr.
Otto Bock HealthCare GmbH - Research

Coauthors
Bellmann M, Brau J, Blumentritt S

Abstract
TF amputees with short residual limbs (<30%) demonstrate reduced motor function performance which leads to a modified gait pattern. This can be clearly characterised by biomechanical parameters. With short residual limbs, metabolic energy consumption increases as the residual limb length decreases.

Introduction
In general, it is understood that transfemoral residual limbs with a length less than 30% of the contralateral femoral segment lead to physiological muscle imbalances and modified leverage [1]. This makes fitting them with a prosthesis more challenging compared to medium or long residual limbs. In spite of this undisputed difficulty, information about the effects of short transfemoral residual limbs on biomechanical parameters is scarce [2,3]. Therefore, this presentation discusses the general effects of short transfemoral residual limbs on biomechanical and metabolic gait parameters based on a complex study approach. The results offer valuable information for use in fitting practice, for example, the selection of a suitable prosthetic knee joint for the fitting of a short transfemoral residual limb can be based on objective criteria.

Methods
A total of 10 TF amputees with a residual limb length <30% of the length of the contralateral femoral segment (mean length 20% – “Short Stump Group” (SSG): 41±11y, 180±13cm, 84±22kg) and 8 TF amputees with medium to long residual limbs (mean length 53% – “Long Stump Group” (LSG): 37±11y, 187±7cm, 75±14kg) were included in the study. All amputees were using the C-Leg prosthetic knee joint (Otto Bock, D). The biomechanical parameters were recorded using an optoelectronic system (VICONPEAK, UK) in combination with two force plates (KISTLER, SUI) at three speeds (self selected, lower speed, and higher speed) while walking on a level surface. Metabolic energy consumption parameters were measured during a treadmill test which was also conducted at three speeds (self selected, speed reduced by 20%, and speed increased by 20%). Distinguishable average peaks of the biomechanical and metabolic parameters were examined for significant differences between the SSG and the LSG with the U-Test.

Results
In comparison with the LSG, the walking speed of the SSG was significantly reduced by approximately 13% at all three speeds. The femoral segment of the SSG on the prosthetic side was extended by approximately 6° more during the entire stance phase compared to the LSG regardless of speed. In comparison with the LSG, the external moment acting on the hip joint on the prosthetic side during the first half of the stance phase was significantly reduced by approximately 50% at all three speeds for the SSG. The maximum knee extension moment for the SSG was increased by 18 to 30% compared to the LSG; here only the

difference at medium speed was significant. No differences were noted between the two groups regarding the ankle moment acting on the prosthetic foot. A regression analysis including all individual values of both groups indicated that both the femoral segment angle on the prosthetic side and the corresponding hip moment basically depend on the residual limb length. Compared with the LSG, the mean O2 cost was significantly elevated by approximately 22% at all three speeds for the SSG. The detailed examination of the correlation between the O2 cost and residual limb length showed that energy consumption increases as the residual limb length decreases for residual limb lengths <30% of the length of the contralateral segment. By contrast, energy consumption is largely independent of residual limb length for medium to long residual limbs.

Conclusion

The results show that the anatomical/physiological particularities of short transfemoral residual limbs require a modified gait pattern and in particular more extended positioning of the residual limb segment. The reduced hip moments of the SSG constitute proof of reduced residual limb performance. Rising energy consumption for residual limb lengths <30% of the contralateral segment length clearly indicates increased compensation activities required for these residual limb conditions. Furthermore, the knee and ankle joint parameters on the prosthetic side show that for short residual limbs all conditions for the proper functioning of the C-Leg prosthetic knee joint are met [4]. This means that indication of this knee joint is independent of residual limb length.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3258-439]

Design and Testing of a Two-degree of Freedom Active Wrist Prosthesis

Author
Yakimovich, Terris (Wien AT) | M.A.Sc.
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Kumar N,Vujanic D, Eder M, van Vliet JW

Abstract
A new wrist prosthesis providing active flexion/extension and pronation/supination for transradial amputees is under development. Preliminary trials have elicited positive user feedback and suggest reduced compensatory motions in some activities.

Introduction
Recent advancements in prosthetic hands have highlighted the need for a powered wrist prosthesis that will effectively exploit the functional and anthropomorphic capabilities of these new end effectors. Including flexion/extension (FE) with pronation/supination (PS) on a wrist prosthesis has been shown to foster more physiological body motion patterns (Bertels et al. 2009). While most activities of daily living (ADLs) are accomplished through fluid positioning of the wrist using FE and PS (Palmer et al. 1985), the majority of prosthetic wrists can only be adjusted manually to a limited number of fixed positions (Kestner, 2006). Existing powered prosthetic wrists only provide active PS without active FE. A two-degree of freedom wrist prosthesis is therefore being developed for transradial amputees to deliver active wrist PS and FE.

Methods
The prosthetic wrist is comprised of a proximal PS drive unit connected to a distal FE drive unit. Both drive units share a common linear architecture with electrical slip-ring contacts, motor electronics, DC motor, and gear train acting as distinct modules. Electric power and digital communication are supplied remotely to the wrist prosthesis via an electrical bus that also accommodates other modules on the upper limb prosthesis. A custom 12-volt brushless DC-motor is used to drive the gear trains in each drive unit. The PS unit gear train combines a friction-based planetary gearset and cycloidal gearset, while the FE unit employs a compact Wolfrom-type planetary gearset due to stricter envelope constraints.
As part of a National Institutes of Health funded project at the Rehabilitation Institute of Chicago, a transradial amputee was fitted with a prosthesis incorporating a prototype of the wrist and the 2-degree of freedom Otto Bock Electrohand Light™.

Results
The user expressed a positive impression of the wrist prosthesis and was particularly impressed by the wrist's speed and response rate. Fewer compensatory elbow, shoulder and torso motions were observed when performing such tasks as picking up a coin from a table, and inserting shaped blocks into complimentary-shaped holes.

Conclusion

Preliminary field trials have elicited positive user feedback and suggest reduced compensatory motions in some activities. Adequate training and practice could help the user capitalize on the anthropomorphic capabilities of the prosthesis. Future efforts will include performance evaluation, optimizing the size and weight of the prosthesis and refining gear quality to increase device efficiency and minimize noise.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3331-506]

The Rehabilitation of a Chinese Hemicorporectomy Amputee After Pelvic Trauma

Author
Yang, Ping (Beijing CN)
China Rehabilitation Research Center - prosthetics and orthotics

Coauthors
Cao xj,Tian G

Abstract
The rehabilitation of a hemicorporectomy amputee needs multidisciplinary team work.

Introduction
Few patients can survive after severe crushing pelvic traumas which is an indication of hemicorporectomy (HCP, also called translumbar amputation). Also, few literatures discuss the rehabilitation of such a patient. This article aimed to describe the rehabilitation procedure of a Chinese HCP amputee.

Methods
Case study method was used. A 46-year-old male patient came to our hospital 3 years after accidental emergency amputation from pelvis. Orthopaedist, physiotherapists, psychologists, prosthetists, engineers and social workers made up a rehabilitation team.

Results
It took over 5 months for the patient to attain most of activities of daily living independent. A self-suspending socket independent of wheelchair was made for him. Walking was also realized with a reciprocating gait prosthesis.

Conclusion
Results suggest that rehabilitation is essential for HCP amputees to improve independence and return to the society.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3288-463]

Self-energizing Microprocessor-based Above-knee Prostheses

Author
Andrysek, Jan (Toronto CA) | Dr.
Bloorview Kids Rehab - Research Institute

Coauthors
Steinnagel B, Andrysek J, Liang T, Christensen J.

Abstract
This work relates to the development and pilot clinical testing of a microprocessor-based swing-phase control mechanism with electrical power generation. This work demonstrates that effective swing-phase control can be achieved along with charging of on-board batteries.

Introduction
Microprocessor knee joints that adapt to changing gait and environmental conditions are becoming an integral part of today's prosthetic rehabilitation services. While their clinical benefits are increasingly evident [1-4], one of their main caveats is the limited working time associated with a finite battery life. Conventionally, prosthetic knee joints use dampers (usually hydraulic) to slow and control the motion of the lower limb; typically these dampers dissipate energy. As part of this work, we are investigating the use of an electromechanical system that is capable of providing adaptable swing-phase damping, and instead of dissipating energy as is conventionally done, converting mechanical energy into electrical energy to be used by the onboard microprocessor and electronics. Initial clinical testing to measure the magnitude of electrical power generation and the effectiveness of the adaptive swing-phase control damper was performed using a prototype system.

Methods
Three young individuals with above-knee amputations were recruited for this study. A prototype system was developed comprising of a direct current (DC) motor for damping, a position sensor and a torque sensor to measure knee angles and torques, respectively (see figure). Walking trials were performed for four damping conditions including no damping (ND), maximum damping (MD), maximum charging (MC) and adaptive damping (AD), and two gait speeds (self-selected and fast walking). Gait performance was assessed via selected temporal, kinematic and kinetic parameters, and where applicable compared to the intact limb which was instrumented with an electrogoniometer, and/or to the subjects' conventional knee joints. Data were also acquired to measure electrical power generation (charging current and voltage).

Results
As indicated by higher cadences, on average the subjects walked fastest with the AD setting. Specifically, at the self selected walking speed, mean cadence (± one standard deviation shown) for the AD setting was higher (1.52±0.04 steps/s) when compared to the other settings (1.40±0.07 to 1.51±0.03 steps/s) and with the conventional knee joint (1.50±0.05 steps/s). At the fast walking speed, mean cadence for the AD setting was also higher (1.67±0.02 steps/s) when compared to the other three settings (1.56±0.04 to 1.66±0.08 steps/s) and comparable with the participants' conventional knee joint (1.73±0.02 steps/s). In terms of the kinematics, the ND condition resulted in excessively high prosthetic side heel-rise shown by peak knee flexion angles and the symmetry index which was calculated based on peak knee flexion angles from the prosthetic and intact limbs. The ND condition produced greatest asymmetries of up to 27.4±7.3%

on average across both walking speeds. As expected, the AD setting resulted in lowest asymmetry with an average symmetry index across both walking speeds of -5.4±9.0%. For electrical power generation, mean mechanical power absorption at the knee ranged from 1.18±0.35W for the ND condition to 10.11±1.57W for the MD condition. For the MG setting, on average 2.07±0.19W and 3.04±0.11W of electrical power was generated for the two walking speeds. The AD setting produced slightly less than half the power of the MG setting.

Conclusion

A self-energizing microprocessor-based damping system holds practical applicability in the advancement of lower limb prosthetics. In this study, it was demonstrated that a prototype system is capable of providing effective swing-phase control, in terms of increased walking speeds and kinematic symmetry, and concurrently generating substantial levels of electricity to power on-board electronics. Additional work is needed to develop an entirely closed-loop swing-phase control system and algorithms, and power saving features to decrease electrical power consumption when the individual is not active. In this way, a system that does not need external power may be feasible.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3300-475]

Myoelectric Prosthetic Application for a Non-amputee

Author
Heim, Winfried (Toronto CA)
Sunnybrook Health Sciences Centre - SCIL

Coauthors
Hager H, Russell P

Abstract
A non-amputee who had suffered Cerebral Palsy was fitted with a myoelectric prosthesis to sustain his current functionality. He experienced overuse of his contralateral side and presumed that a prosthesis could potentially provide some functionality that would in turn offload his ailing sound side.

Introduction
This case describes the treatment of an individual who suffered Cerebral Palsy at birth and sustained a hemi paralysis in his left underdeveloped arm with a shortened forearm and a non-functional hand with ulna deviation. The concept that a prosthetic solution could assist in coping with the inevitable effect of aging and allow him to retain the integrity of their sound limb was applied in this case. Generally myoelectric prostheses are fitted to individuals who have lost remnants of their limbs. Some non-amputees may anticipate that due to the overuse of their sound limb other ailments such as arthritis and back pain due to muscle imbalance may materialize that will reduce their functionality gradually as they age. In those cases, the premise is that a prosthetic device could help gain functionality for the affected arm that has been non-functional for decades in order to sustain and prolong functionality on the contralateral side.

Methods
A myoelectric prosthesis was built for the patient's affected side using a bracing suspension system on his affected forearm that encapsulates his flail hand. Two muscle sites were identified - one being in the thumb web and a secondary site in the medial aspect of the palm. Predictable control was achieved from the primary thumb web muscle site and a sympathetic control on the secondary muscle site using his opposite arm movement to trigger a muscle action. An I-Limb hand was the terminal device of choice, offering single site function and operation by the primary muscle site while the secondary site activates the chosen electric wrist rotator. The hand and rotator are situated in the hand palm area. A brace style interface that rests on the forearm, providing self suspension and rotational stability without moving past the elbow was utilized.

Results
Upper limb prosthetic devices are generally considered for patients who are missing a limb or part of a limb. Individuals with limbs intact and one non-functional limb as a result of a disorder such as Cerebral Palsy are not considered prosthetic candidates unless they have suffered a congenital anomaly. The patient chose the I-Limb hand because of his vocation where he is involved with public figures. It was important to him to be able to shake hands and carry a briefcase, tasks that he was unable to do without the prosthesis. The unique suspension method used enabled the user to carry objects in his hand without losing control and suspension. After practicing controlling the hand over several weeks, the patient was able to manage various tasks without major problems. Some muscle control functions required mastery due to the Cerebral palsy condition that affected his control factors. The patient was satisfied with the function of the hand

and acknowledged that prior to the fitting of the prosthetic device, he was unable to utilize his flail arm productively.

Conclusion

A prosthesis was fitted to accommodate the existing hand and its pathological deviations. The individual had come through clinic requesting a myoelectric controlled prosthesis for the affected side to help offload his sound side that is slowly showing signs of overuse. Numerous challenges needed to be addressed such as availability of myoelectric sites, control capability and suspension design to accommodate donning and doffing challenges. The finished prosthesis provided key functions that met the client's expectation, which included grasping objects, carrying his briefcase and shopping bags, shacking hands (something he was never able to do) as well as providing an esthetically acceptable appearance. Providing a myoelectric control prosthesis for this patient's non-amputated flail arm enabled him to regain some functionality on his affected side, as well as potentially slowing down the gradual deterioration of the sound side that is diagnosed with arthritic conditions.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3291-466]

EMG Feature Selection for Simultaneous Proportional Control of Multifunctional Upper-limb Prostheses

Author
Fougner, Anders (Trondheim NO)
Norwegian University of Science and Technology - Department of Engineering Cybernetics

Coauthors
Stavdahl Ø, Kyberd PJ

Abstract
A selection of EMG signal features has been evaluated for simultaneous proportional control of upper-limb prostheses. They were tested individually and in combination, as an input to a linear mapping function. The performance has been evaluated in a pilot experiment for ten healthy subjects.

Introduction
Boostani and Moradi (2003) evaluated a selection of forearm electromyography (EMG) signal features for control of upper-limb prostheses. However, similar to most current research, they focused on ‘crisp classification’ with ON/OFF-style state selection output.
We have reviewed these EMG signal features for simultaneous proportional control of multiple degrees of freedom. This involves a continuous mapping from a vector of EMG features, or a combination of these, to a vector of prosthesis states to be controlled, e.g. torque, velocity or position setpoints.
The overall hypothesis is that the user will more easily adapt to a simple and smooth control function, thus achieving improved utilization of the prosthesis.

Methods
Our pilot study included ten healthy subjects. Eight surface electrodes were applied to the proximal forearm, and signals were recorded during different movements involving several joints of the arm and hand. Simultaneously, pro-supination, radioulnar deviation and finger and wrist flexion/extension were recorded using motion tracking equipment. Three recordings were taken for each subject, for training, validation and testing of the mapping function. The test set was recorded on another day.
We used a simple linear mapping function which was trained using the pseudoinverse for minimizing the mean square error.
15 different EMG features were calculated, and we used all 1940 possible combinations of these when we allowed up to 4 features to be employed together as input to the mapping function.

Results
The root-mean square error (RMSE) in % of range of motion (ROM) for the estimated angles lies in the range 20-25% for finger flexion/extension, 14-22% for wrist flexion/extension, 16-24% for pro/supination and 30-66% for radioulnar deviation (mean value for ten subjects). In all cases, a combination of four features performs better than single features.
The best combination for finger flexion/extension is average amplitude change, autoregressive coefficients, cepstrum coefficients and energy loss of wavelet packet coefficients with 20.51% error (only average amplitude value/AAV: 20.83%). For wrist flexion/extension: Energy of wavelet packet coefficients, wilson amplitude, wavelength and zero crossings with 14.64% error (only AAV: 17.39%). For pro/supination:

Average amplitude value, autoregressive coefficients, number of turns and wavelength with 16.45% error (only AAV: 18.52%). For radioulnar deviation: Histogram, myopulse percentage rate, number of turns and wilson amplitude with 30.6% error (only AAV: 34.67%).
For an example plot of estimated versus measured angle, see Fig. 1. Although the example plot gives an RMS error of 37.40% of ROM, the estimate follows the fluctuations of the measured angle. We believe that the RMS error should be replaced by another measure of performance, for example correlation coefficient. Of course, then it can also be used in the training algorithm.

Conclusion

Most widely used for prosthesis control (Muzumdar, 2004) is a rectified and low-pass filtered EMG signal as a single feature. This pilot study shows that signal features can be combined to give better results for simultaneous proportional control.
The features can be improved, and the technique for combining them can be optimized for the subject and the prosthesis state we try to estimate.

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Image:

RMSE_LT_ab_v3_ar_wamp_wave_zc_lf_measured_angles_smoothed15_rud_20091005_120956_EDIT_None.p
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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3179-366]

The Use of Outcome Measures in the Evaluation of the Echelon Hydraulic Ankle

Author
Ross, John (London GB)
Blatchford

Coauthors
Mr Alan McDougall

Abstract
Using outcome measures from patient satisfaction questionaires and the long term activity monitor (LAM) we measured the actual differences in usage and satisfaction for 10 amputees trialing the Echelon (with a Hydraulic ankle) and a similar foot with fixed ankle.

Introduction
Bolwey Close Rehabilitation Centre looks after the rehabilitation of 1500 lower limb amputees. 10 amputees where chosen from this population to trial the Echelon foot to evaluate if the foot had an effect on the patients satisfaction with their prosthetic rehabilitation. 5 unilateral transtibial and 5 unilateral transfemoral amputees agreed to take part, and each was asked to complete a questionaaire, the Prosthetic Evaluation Questionnaire (PEQ). The PEQ was chosen as it relates regular activities of daily living questioning the amputee on thier prosthesis over a 4 week period, which is the authors preffered minimum trial period. The PEQ is also a internationally known and validated questionaire.
Additionally each amputee was also fitted with a Long Term Activity Monitor (LAM2) to record their usage. Following our Presentation at Ortho-Reha in 2007, the manufacturers launched an improvement to the LAM to introduce cadence as one of the measured outcomes to improve its usage.

Methods
Each amputee was fitted at random with an Esprit foot or the later Echelon Foot. The Esprit foot is a dynamic foot with independant heel and toe that was already a commonly used foot at Bowley Close Rehabilitation Centre. The Esprit fitted with a patient adjstable ankle (Brio) had been the basis for an earleir presentation (Ross 2007) measuring their role in socket comfort. The Echelon foot is a later product with a hydraulic yielding ankle, which constantly adjusts to body weight, which the manufacturers state improves socket comfort and patient stability on unevben terrain.
Each patient would have four weeks to aclimitise them selves with both feet before completeing the questionaire during wich their mobility would be recorded by the LAM as previously presented(Ross 2007). The results of the avtivity monitor and patient evaluation questionaire would then be used to evaluate the overall satisfaction of the prosthesis and monitor any increase or decrease in either usage or satisfac

Results
all 10 amputees completed the trial and completed the questionaire, additionally they all wore the LAM for the same period allowing us to record their mobility against predicted outcomes from earlier studies which had been presented.
Results from the questionaire with the Echelon showed that all 10 amputees claimed greater socket comfort from their prosthesis overall against that with the Esprit, as well as greater stability and comfort over a range

of obstacles. 9 amputees felt better able to complete daily activities while one showed little difference. Only two amputees where aware of the increased weight of the prosthesis, yet these also felt the the increased weight was more than offset by the increased satisfaction of their limb. All 10 users showed overall from the questionaire greater satisfaction with their prosthesis and all wished to remain using the prosthesis.
From the activity monitor it was shown that all three amputees met the criteria in number of steps per day to be classified as K3 amputees from our earlier study (Ross 2007). No amputee increased thier usage from using the Echelon sufficiently to increase to the expected usage of a K4 amputee, yet all showed either an increased step count or preferred cadence.

Conclusion
The Echelon with its hydraulic ankle offers a clear advantage to the amputee in both socket comfort and their ability to perform standard activities of daily living.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3102-300]

Literature Review on Sub-Atmospheric Suspension for Prosthetic Sockets

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Abstract
The objective of this presentation is to review the literature on sub-atmospheric suspension systems for prosthetic sockets with the focus on quantitative evidence for lower limb applications.

Introduction
Sub-atmospheric refers to the creation of an environment in which pressure falls to below that observed at sea level (ie below atmospheric pressure or <1atm or <100kPa).1 The terms suction & vacuum are synonyms for sub-atmospheric pressure. On an absolute pressure scale, zero is a condition where no air molecules exist (ie pure vacuum), while on a relative pressure scale zero equals 1 atmospheric pressure (1atm or 100kPa or 750mmHg). Suction suspension for prosthetic sockets first gained widespread use for transfemoral amputees in the 1930s, but it was not used as widely with transtibial amputees (TTA) until the 1980s.2 Vacuum-assisted suspension was introduced in the 1990s.3 Suspension is an important component of the fit & function of a prosthetic socket as it is believed to affect comfort, proprioception, performance of activities, & limb health. However, the evidence for use of sub-atmospheric suspension, in particular vacuum-assisted suspension, has not been previously reviewed.

Methods
A search of Pubmed was conducted in August 2009 using the search term “artificial limbs AND (suction or vacuum).” This identified 60 articles. Review of the abstracts resulted in exclusion of 48 articles. A search of Recal Legacy was also conducted in August 2009 using the search terms “vacuum,” “suction socket” and “limb volume.” A total of 320 articles were identified of which 262 were excluded based on review of article descriptions. Of the remaining 60 articles another 44 were excluded because they were duplicates of articles found in the Pubmed search or the journals were not available. Based on these searches, 28 articles were included in the review (7 on suction suspension, 8 on complications of suction suspension, 3 on vacuum-assisted suspension, and 10 on residual limb volume). Additionally 3 articles were identified based on a review of the references cited in the included articles (2 on vacuum-assisted suspension and 1 on suction suspension).

Results
Five experimental studies of suction suspension 4-8 & eight case reports of skin complications with use of suction sockets were reviewed.9-16 X-ray analysis of skeletal displacement in 22 TTA suggest better contact between residual limb & prosthesis in a PTB socket with suction compared to strap suspension, with significantly less displacement in the suction socket attributed to less tissue movement.4 Studies of socket pressure with sleeve5,8 & pin suspension8 demonstrate that negative pressures are present during swing.5,8 Both positive and negative pressures during swing were greater with pin suspension, which also reportedly caused proximal constriction of the residual limb during swing.8
Three experimental studies by the same authors were reviewed comparing residual limb volume17,18 & pressure19 in traumatic TTA using total surface bearing sockets with/without vacuum.19 Pressures were

significantly lower in stance & significantly higher in swing with vacuum.19 Authors suggested this was the mechanism by which vacuum helped maintain limb volume. They also found a significant increase in limb volume after 30 mins of walking with vacuum, with significantly less pistoning of the tibia & liner, & significantly greater stance phase & step length symmetry.17 When comparing neutral, under- & over-sized sockets with vacuum, average limb volumes were significantly larger after 18 mins of walking than the volume available in all sockets, yet no subjects reported discomfort/pain.

Conclusion

Only a few experimental studies of suction or vacuum suspension for prosthetic sockets have been reported, limiting the evidence available regarding use. Studies of vacuum suspension are limited to traumatic TTA and use post-doffing residual limb volume measurements that may be inaccurate.20,21 Vacuum-assisted closure (VAC) uses negative pressure to remove fluid from open wounds through a sealed dressing and tubing to a container.22 Evidence on whether fluid-based or mechanical properties have greater influence on efficacy of VAC favor the latter.23 It is suggested that tensile stresses applied to the skin stimulate cell proliferation, while compressive forces lead to tissue resorption.24 While direct association is not possible between negative pressure use in wound therapy and prosthetic suspension, current thinking about the role of tissue deformation in wound healing may help to explain the oft reported effects on residual limb health using suction and vacuum sockets.25

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3311-486]

Prosthetic Suspension Using a Hypobaric Liner

Author
Lilja, Magnus (Jonkoping SE) | Dr.
Össur Nordic AB - Sales and Marketing

Abstract
Pistoning tests were performed in a clinical environment, on a new type of silicone liner trying to identify fit and suspension of the prosthesis using the new liner.

Introduction
Suspension is a key factor in prosthetic socket fit. Vertical suspension determines the fit of the prosthesis and links closely to the safety and function of the user. Several studies have been reported on suspension and tibial movements inside prosthetic sockets (Lilja et al. 1993, Narita et al. 1997, Karlsson and Lucas 2007). However, these studies have been performed in a laboratory environment with high technological equipments. Studies on suspension in a clinical set up are rare. Introducing new prosthetic components should initiates clinical studies on the function of the new components. A new type of transtibial liner has been introduced to the prosthetic profession. The liner differs from earlier liners through its way of suspension using five seals. The aim of the study was to, in a clinical environment, identify the amount of stump pistoning during full weight bearing and non weight bearing in the prosthetic socket using two different liners with different suspension methods.

Methods
30 transtibial amputees, 31 amputation limbs, were fitted with the liner. Three of the amputees were female. Cause of amputation was infection in two, vascular in three and trauma in 26 of the cases. Date since amputation ranged from 0-44 years. The amputees activity level were 2 users in level 2, 25 in level 3 and 4 users in level 4. The amputees were fitted by certified prosthetists and the prosthetic fit was measured through the amount of socket pistoning, comparing the old prosthesis with the new prosthesis using the new liner. All user were using different liners before entering the study. Markers were applied anteriorly to the prosthetic socket and to the liner for detection of pistoning, measured with a measuring tape during full weight bearing on the prosthesis and during non weight bearing. The difference in distance was defined as pistoning of the stump inside the socket.

Results
The pistoning were reduced in all cases fitted with the new liner. The mean displacement with the users old prosthetic socket and liner were 0,7 cm R(0,2-1,7) and the displacement with the new liner/socket were 0,3 cm R(0,1-0,7). The average decreased displacement was 0,4 cm or 56%.

Conclusion
The results show a clear difference in suspension between the old liner and the new liner. The improved suspension might be transferred to improved fitting and improved gait for the amputees. In other studies on displacement in prosthetic sockets X-ray has been used therefore this study can’t be compared to those (Lilja et al. 1993, Narita et al. 1997, Karlsson and Lucas 2007). The use of a standard measurement tape and markers put on socket and liner is of course a very simplified and low accurate way of evaluating displacement, however it gives a clear indication of the prosthetic fit in a clinical environment and is very easy to use for the clinicians. Using simple methods to evaluate new products entering the prosthetic

market is crucial for both prosthetists and amputees. These evaluations have to be performed in a clinical environment simulating the normal use of the prosthesis. Present study is one example of this kind of evaluation.

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Image: Tabel on suspension_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3371-546]

Unprofessional Intervention of Prosthesis User for Increasing Balance

Author
Shokouhandeh, Morteza (IR) | MD
JMERC - Biomedical Department

Coauthors
Mostafa,Allami
Masoumi,Mehdi
Hosseini,Parisa

Abstract
During several years various prostheses are fitted for me all of them had similar condition in imbalanced. The imbalance was remarkable which hardened walking often when I was standing my body got shaking intensively .Adding some pads and make some changes in foot by myself made me comfortable.

Introduction
I am a bilateral lower limb amputee. During several years, various prostheses are fitted for me all of them had similar condition in imbalanced, so I had to increase back arch unnatural and mandatory to use prosthesis. The imbalance was remarkable which hardened walking most of the time when I was standing my body got shaking intensively often this imbalance caused falling and it influenced on my activities daily living, also unconscious and mandatory increasing of back arch .casual back pain and increased inconvenience of prosthesis .

Methods
After using of prosthesis and endurance of its problem, council with my prosthesist and adjustments of forward and back bolts of foot ,adding some pads in dimension about 10 by 15 cms in shoes and under foot approximate balance to favorable condition but since these additional segments in shoe hardened its donning I had to revise at heel and foot, when I disclosed foot segments I observed some segments of pliable rubber which by emitting and shortening them this deficiency was eliminated .

Results
1.when adjustment of prosthesis for user is not possible by extreme adjustment of foot bolts, adding a pad under foot and in shoe improves quality of using prosthesis for standing and walking remarkable.
2. adding pad under foot and in shoe decreases balance gradually but does not return to pervious imbalance .
3.in these situation ,emitting and shortening of pliable materials at heel can help obtaining favorable range of balance.
4.emitting or shortening pliable materials at heel decrease plasticity of foot some deal .
5. therefore the best condition to fit prosthetic foot is in a way that beneath surface of heel is upper than beneath surface of foot (1.5-2cms) in horizontal situation.

Conclusion

When adjustment of prosthesis for user is not possible by extreme adjustment of foot bolts, adding a pad under foot and in shoe improves quality of using prosthesis for standing and walking remarkable. In these situation, emitting and shortening of pliable materials at heel can help obtaining favorable range of balance. Hthe best condition to fit prosthetic foot is in a way that beneath surface of heel is upper than beneath surface of foot (1.5-2cm) in horizontal situation.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3192-379]

A-K Socket Sand Casting Technique

Author
Devakula, M. L. Buddhibongsa (Mae-rim destrict TH)
The Prostheses Foundation

Author
Tippaya, Boon-yu (Mae-rim destrict TH)
The Prostheses Foundation

Coauthors
JIVACATE T, TIPPAYA B

Abstract
The Prostheses Foundation has been able to effectively make ischial containment sockets using a sand casting technique that utilizes a plastic bag and a bag of the foam pellets. In the last year, 100 transfemoral prostheses have been produced using this simple system.

Introduction
A well fitted and comfortable socket is essential to every amputee. A sand casting technique was introduced by Dr Yeongchi Wu and his associates from CIR for transtibial amputees that proved to be very successful in our workshops. Using the same fundamentals, we have adapted the earlier system to make well fitted, modified ICS socket transfemoral prostheses for our patients within one day.

Methods
We have developed a special plastic bag and a bag of polystyrene beads for the transfemoral limb which are easily applied to amputees by the prosthetic technician. After making a positive sand mold of the residual limb, minor rectifications are made to the mold and then a plaster of Paris bandage test socket is produced for an initial fitting. The plaster socket can be easily modified to the shape of the patient and can then be used as the negative mold for a new sand positive mold. Once the positive model has been created, a permanent plastic socket can be produced.

Results
We can now produce a finished, well fitted permanent ICS plastic socket in 3 hours and go on to finish an entire prosthesis in one day.

Conclusion
We have refined a technique of successfully making transfemoral sockets using the sand casting method.

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Image: sand casting AK_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3430-605]

Plantar Pressure Distribution Measurements in the Dynamic Alignment of Below-knee Prostheses: A Pilot Study of Three Prosthetic Feet

Author
Janssens, Koen (Linden BE) | Dr.
Katholieke Universiteit Leuven

Coauthors
Van Hees E , Biesbrouck E, Janssen P, Peeraer L (last and first author: also affiliation with Faculty of Kinesiology and Rehabilitation Sciences, KU Leuven, Belgium)

Abstract
The DYNALOP project aims to develop a scientifically based method for the dynamic alignment of below-knee prostheses, by utilizing the pressure distribution and CoP underneath prosthetic feet during gait. This study suggest that this development may be independent from the type of prosthetic feet.

Introduction
The alignment of lower limb prostheses is the optimal position and orientation of components in the prosthesis with respect to one another and the users body. This proper alignment is crucial, since inadequate alignment may result in inefficient gait patterns with increased pressure on the residual limb and risks for secondary injuries. However, in current clinical practice, aligning a prosthesis is still a subjective trial and error process including a static bench alignment followed by dynamic adjustments based on a visual gait analysis which requires a large amount of expertise. The main goal of the project is the development of a scientifically based method for optimization of the dynamic alignment of below-knee prostheses, by utilizing the measured pressure distribution and CoP underneath the prosthetic foot during gait. The purpose of the second phase of this project is to investigate plantar pressure distributions in transtibial amputees using three different prosthetic feet.

Methods
Five adults with an unilateral below-knee amputation (1 female, 4 males) participated in the study. All participants signed an informed consent form revealing all details of the experimental protocol, approved by the Ethical Committee. A new prosthetic socket was provided for each subject for the purpose of this study: the subjects existing socket was duplicated and fitted with three different Otto Bock feet in a standardized order (SACH, Trias, Axtion) for each test condition. These feet were chosen because they have very different mechanical properties. Before each gait test, the subject was asked to walk for five minutes to get used to the new condition of the prosthesis. Trials were completed at the subjects self-selected speed for each prosthetic setting. Kinematic 3D data was collected from 24 active markers, using the CODAmotion system, plantar pressure and CoP data were recorded with a Footscan® pressure plate, and ground reaction force data was derived from an AMTI system.

Results
For this pilotstudy, the analysis of the data was limited to the plantar pressure measurements. For analysis purposes, the plantar aspect of the foot was divided into ten areas of interest: the hallux, the lesser toes, the five metatarsal heads, the midfoot and the medial and lateral heel. The maximum pressures for each area

were analyzed and averages were calculated for all the participants. The pattern of the CoP in medio-lateral direction was evaluated and compared. Furthermore, ground contact time characteristics were assessed to analyze the speed of roll-over for each prosthetic foot. Symmetry with the roll-over pattern of the sound foot was assessed and compared with the results of a questionnaire, assessing the participants feelings concerning stability, comfort and effort of gait.
When walking with the own prosthesis (the own prosthetic foot and shoe), the medio-lateral displacement of the CoP seems to be rather small and the plantar pressure under meta 2-4 is higher than under meta 1 and 5. The maximal pressures seems to be comparable for the three tested prosthetic feet. The medio-lateral CoP displacement is quite similar for a given subject walking with the three kinds of prosthetic feet, but there is a lot of variety in the CoP pattern when the five subjects are compared. Also, there was less variety in the CoP pattern of successive measurements for the prosthetic feet compared with the sound feet of the unilateral transtibial amputee.

Conclusion
The results of this study suggest that the development of a scientifically based method for optimization of the dynamic alignment of below-knee prostheses may be developed independent from the type of prosthetic foot., and that a well-aligned prosthesis results –amongst other parameters- in a stable medio-lateral CoP displacement. However, this is a pilot study with a small group of patients and several biasing factors. An extensive study with statistical analysis of the data will be carried out to confirm the results.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3152-350]

Prosthetic Components: The Comparison of Muscular Atrophy in Trans Tibial and Trans Femoral Amputations with Silicone Liner Prostheses

Author
Mehdikhani, Mahboobeh (IR)
Rehabilitation research center, school of rehabilitation of Iran university of medical sciences - rehabilitation sciences

Coauthors
Hossain Shirin, Mohammad Kafili

Abstract
Silicone Suction Sockets were first introduced in the mid-1980s. These liners are made of a relatively thin silicone and their primary purpose is suspension of the prosthesis.

Introduction
Silicone Suction Sockets were first introduced in the mid-1980s. These liners are made of a relatively thin silicone and their primary purpose is suspension of the prosthesis.since 2000, designing prostheses with silicone liner is increased. the problem we have found with silicone liner is atrophy of stump. so, we planned to find of rate of atrophy with silicone liner.

Methods
In this study, Muscular atrophy in 30 lower limb amputees (15 trans femoral and 15 trans tibial) who received silicone liner was evaluated and compared.

Results
there are a significant difference between stump volume before and after wearing liner for 6 months ($p<0.05$) as the rate deceases by time. we also found that there is a difference between rate of atrophy in Bk and AK prostheses ($p<0.05$).

Conclusion
the rate of atrophy in BK prostheses is more than AK Prostheses.

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Atlas of amputation and limb deficiencies

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2926-124]

Success or Failing in Implanted Finger Prosthesis in Patients with Multifinger Amputation (Cases Reports)

Author
Yazdani, Meria (Tehran IR)
RehamedAria

Coauthors
mohammad ali Javanshir

Abstract
In this case study, we will attempt to highlight principle keys in application of implanted finger prosthesis that cause success or failure of treatment

Introduction
In rehabilitation of patients with multi finger amputation at the base of the distal phalanx the stump is too short for a standard finger prosthesis because there is no proper connection surface for attachment of prosthesis via suction system.
In this situation, orthopedic surgery can complete the rehabilitations treatment. A small series of patients with finger amputation have undergone a reconstruction aimed at fixation a finger prosthesis via an osseointegrated or cemented fixature.
In osseointegration there is an anchorage mechanism whereby nonvital components can be predictably incorporated in to living bone and that this anchorage can persist under all normal conditions of loading

Methods
The authors reviewed tree patients with traumatic multifinger amputation in surgery times and 14 month after attachment of implanted silicon finger prosthesis with radiographic evaluation and clinical supporting data to determine the level of failure and complication rate

Results
In this case report, maintenance requirements between patients, was associated with geometrical parameters of implants attachments and physical and mechanical characters of designing of screws that prevented of proper fitting of prosthesis. In this research it was a loosening of the implant in case 1also a failure occurred during the initial healing period and following bone repairing. After 6 month implant was removed and patient used of silicon cosmetic glove .In all of cases there was no bacteria induced inflammation in surfaces of implant but they had clear sprinkle or visible blood vessels .The patient 3 could perform daily activity and pad to side pretension successfully

Conclusion
In implanted finger prosthesis, complication of implant loosening can be prevented by adequate tightening of the abutment screw in the first place. All prostheses should be checked for alignment and signs of wear or breakage .The bones and implants should be measured for ability of weight. Radio graphically evaluation is necessary in Initial osseointegration for Seating of screws ,width and length of the implant,Fiting, baseline and Longitudinal evaluation of bone levels, also there are a number of association are which require early or urgent treatment such as Narrow diameter implants measurement , Excessive load ,Marginal bone

loss and Soft tissue complications Regular review and maintenance of patients are essential to maintain the health of implant supporting tissues to prevent minor complications and measure ones own long-term success at providing this treatment. With meticulous planning, provision of treatment and use of a tried and tested system, the complication rate is low

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3624-683]

Innovative Suspension Method for Shoulder Disarticulation

Author
Boone, David (Washington, D.C US)
OrthoCare Innovations

Coauthors
A. Pollock

Abstract
Upper extremity prosth become advanced in their functions, novel attachment systems be created allow the devices to fully demonstrate their abilities. The case will investigate a unique means of bridging the man machine interface, based on stringent parameters unable to be met by traditional techno.

Introduction
Robotic limbs currently under development for use by upper extremity amputees pose significant challenges for the body/device interface. Among these are increased reaction forces resulting from the arms' power and range of motion. Based upon the author's clinical experience, traditional shoulder disarticulation socket interface technologies are limited in their ability to accommodate for these requirements. Their bulk, covered surface area, and load limitations provide inadequate support for advanced prosthetics.
As part of the DARPA Revolutionizing Prosthetics 2009 program, a novel shoulder socket attachment method has been developed to permit increased loads and torques while improving patient comfort. The socket interface design features include minimal weight, low profile size, great adjustability, significantly enhanced load bearing, as well as increased subject comfort and non-limitation of range of motion.

Methods
A micro-frame stabilizing unit consisting of a semi-flexible carbon frame and distributed anchoring system was created. The frame is contoured around specific muscular and skeletal anatomy of the upper torso and is flexible for expansion during donning and doffing, but locks to the user while worn. The distributed anchoring system is a thin, lightweight material that is fixed to that secures to the frame, but is adjustable for comfort and security during unique loading. The garment provides a secure fit about the majority of the torso, and distributes the load of the prosth around a large surface area, resulting in minimal point specific loading.
The socket interface was tested in conjunction with the DARPA Revolutionizing Prosthetics 2009 initiative. The subject, a bilateral shoulder disarticulation male, has been fitted with the device both unilaterally and bilaterally on two separate occasions: first in a clinical setting for testing, and later in preparation for an extended trial.

Results
Through effective dissipation of mechanical forces, the shoulder disarticulation attachment system developed for this study is able to accommodate the increased loads associated with new robotic prostheses. By encompassing the entire upper torso, the system eliminates specific pressure points that traditional systems can cause. More importantly, as the system is dynamically loaded by the prosthetic limb, it is capable of spreading the force over a greater area.

The result is improved comfort while allowing for greater capabilities.
Upon the initial fitting, the subject was very pleased with the attachment system, particularly for the lightweight properties of the device. Further reactions included increased comfort and a belief that he would be able to function for longer periods of time using the system, compared with other suspension methods. He also expressed a feeling of secure attachment to the device and was pleased with the control that it allowed him.

Conclusion
The clinical case study described here demonstrates promise for this proposed approach. Further investigation will be conducted into actual force mapping using a pressure sensor network. With the commencement of clinical trials under the DARPA Rev Pro 2009 project, this attachment system will be tested on additional patients, resulting in further refinements, and ultimate clinical integration.

Image: Martin_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3625-684]

Quantifying Grip Force Measurement Through Haptic Feedback for Prothetic Control Improvements

Author
Chaubey, Pravin (Oklahoma City US)
Orthocare Innovations-Engineering - None

Coauthors
D. Boone PhD.
T.Chou PhD.
M. Markmiller
A. Pollock

Abstract
With the goal of novel prosth systems being the restoration of function, attention must be paid to closing natural sensory loop. Haptics, a currently proposed solution to this shortfall, has undergone limited efficacy testing. Ongoing scientific investigation meant to address this gap.

Introduction
Tactile sensory feedback, or haptics, is a fundamental sensory path and a necessity to function appropriately in ones environment. During any physical activity, the brain is constantly receiving sensory nerve feedback, which it uses to modulate muscle activity. This closed-loop enables a range of activities from sensing how tightly to squeeze a hammer to the soft touch of walking hand in hand. For an amputee using a typical prosth limb, this key function is largely missing. While a prosth socket provides limited sensation and indirect proprioception to the residual limb, the sensations are highly attenuated by the structure and materials of the prosth device. In an effort to address this shortcoming, artificial haptic systems have been investigated and tested, large scale acceptance by the field has not followed; due to a scarcity of quantifiable data regarding the benefits to the patient. Our team has concoducted test to determine if tactile feedbach measurably improves subject perfo.

Methods
To objectively determine the benefits of a haptics system, this study utilizes indirect force feedback from small, low frequency, multi channel vibrotactile tactors. These aide in eliciting targeted grip forces from patients using a customized myoelectric hand-shell with force sensors, from which the signal was acquired and processed. The tactors create strong localized sensation on the skin, and can be activated individually or sequentially to convey specific sensation or intuitive tactile instruction (Benali, 2004). Using a stimulus protocol adopted to quantify performance improvements, the subject was asked to perform a grasping task in which they attempted to match a previously-practiced force, of different levels, while relying on a pulsing vibrotactile feedback channel to convey achieved grasping force (Shannon, 1979 and Weisenberg, 1986). The designated grasping tasks were separated into different force levels so that performance at each level could be assessed independently.

Results
Methods:Data capture algorithms were implemented,
and the analysis included variance, determination of actual and target force deviation, and time to reach

the target force.
Results:
The results of the study showed that the use of indirect mapping haptic force feedback led to improved performance in the subgroup of subjects with previous myoelectric prosthesis experience, while naive subjects showed little improvement. Additionally, a drop in normalized error was statistically significant in the medium force task, which indicates that the supplementary haptics were most useful at mid-level grasping force ranges.
These findings suggest that selective application of haptics for users experienced in EMG control may be beneficial in improving grasping capabilities. Factors such as muscle fatigue, age, neural and mechanical characteristics, experience in using prosthetics, and training time must all be considered in analyzing the effectiveness of haptic systems. Further research is needed for the higher and lower force levels, before determining if the results are truly applicable to all levels of force.

Conclusion
Selective and specific implementations of haptic feedback systems in conventional prosthesis can help in augmenting the missing afferent pathway by providing the user with better kinesthetic and tactile information. This paper presents a means to collect data using a vibrotactile haptic feedback system, from which conclusions are drawn to evaluate the effectiveness of implementation in prosthetics. The improvements observed suggest that the addition of haptic system could improve patient outcomes.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3276-451]

Evaluation of the Tracer CAD Prosthetic Shape Capture System

Author
McGarry, Anthony (Glasgow UK) | Dr.
University of Strathclyde - National Centre for Prosthetics and Orthotics

Coauthors
McHugh B, Buis A.

Abstract
The aim of this study is to evaluate the accuracy, repeatability and reliability of the Tracer CAD prosthetic CAD system and to compare results with those obtained using traditional methods of shape capture (plaster of Paris).

Introduction
The quality of prosthetic socket fit can affect the function of the final prosthesis and may be compromised by errors during the residual limb shape capture. The amount of accuracy required to capture the shape of a residual limb is still debated as evidence is very limited, (Saunders et al. 2003, Fernie et al. 1984 and Lilja and Oberg 1997). Plaster of Paris and Computer Aided Design (CAD) systems are currently used with the residual limb exposed to different conditions. Limited measure of accuracy or repeatability of CAD systems exist when compared to plaster of Paris methods. A survey established the Tracer CAD system, to be commonly used in UK prosthetic limb centres. This system uses an electromagnetic contact scanner to capture the shape of the residual limb.
The aims of this study were to evaluate the accuracy, repeatability and reliability of the Tracer CAD system and compare results with traditional shape capture methods.

Methods
The Tracer CAD system was evaluated using four ‘hard’ models and one deformable manikin of known dimensions and volume: The diameter of each model was measured by a Mitutoyo, series 543 1DF Digimatic Indicator™), to an accuracy of five microns (0.005mm). Diameters were measured at four specific intervals. The volume of each model was calculated between each level and verified using water displacement.
The repeatability, accuracy and reliability of the Tracer CAD system were assessed on all models by repeated scans taken by four users. The repeatability and accuracy of plaster of Paris wrap casting was also assessed on three of the models.
Diameters and volumes measured by Tracer CAD and plaster of Paris were compared to means of the digimatic indicator to examine accuracy. The coefficient of variation of measurements was compared to show repeatability. Interclass correlation was used to compare measurement reliability.

Results
Systems were considered reliable when inter class correlation > 0.7 (Evers 2007). Repeatability was assessed using the coefficient of variation (CV) and deemed to be acceptable when CV < 5%. Diameter error greater than 1mm (Saunders 2003) and volume errors greater than 5% (Fernie and Holliday 1982, Lilja and Oberg 1997) were considered to be clinically significant.
Reliability between users of the Tracer CAD system was found to be high when assessing all models (ICC > 0.984).

Tracer CAD system repeatability was good (CV<5%) for diameter and volume measurements on solid models but less repeatable in areas of a manikin which were easily deformed (CV 9.66%). Plaster of Paris casting was more repeatable than the CAD system. Poorer repeatability of volume measurement was observed at the distal end of deformable and shaped models using this method of shape capture (CV=8.97%).
Plaster casts showed the best accuracy of diameter measurement of all systems on non deformable models (<1mm) and similar accuracy of volume measurement compared to Tracer CAD. Errors were largest on shaped and deformable models. Poorer accuracy was observed towards the distal end. Based on limited evidence, results indicate that methods of shape capture analysed do not show sufficient accuracy for prosthetic shape capture.
Inaccuracies using the Tracer CAD system may have been caused by incorrect landmark identification, bridging of the contact probe over complex shapes or deformation of the model.

Conclusion
Repeatability of shape capture of cylindrical models was good by Tracer CAD and plaster of Paris. However plaster of Paris showed higher variation in capture of distal end volume of both shaped and deformable models, and Tracer CAD less repeatability at the distal end of the deformable manikin.
Repeatability of shape capture using Tracer CAD is likely to be reduced in areas of the residual limb that are most deformable. This is likely to be at the distal end and would in some cases be clinically significant due to errors caused by the contact nature of this method of shape capture.
Based on evidence available, results indicated neither method to be accurate enough for prosthetic shape capture. Although acceptable results were obtained on a simple cylindrical model, Tracer CAD and plaster of Paris errors increased on the shaped model and further on the deformable manikin. Poor accuracy of shape capture was observed by both systems particularly toward the distal end.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3067-265]

Effective Rocker Shapes Created by Able-bodied Ankle-foot Systems for Fore-aft Swaying and Walking: Implications for Improved Ankle-foot Prostheses

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Coauthors
Wang CC

Abstract
Effective rocker shapes for walking had a radius of about 1/3 of leg length (LL), while shapes for fore-aft swaying had a radius over 2 times LL. A simple model suggests that the stiffness of a biomimetic prosthetic ankle would need to be 3-4 times higher for fore-aft swaying than for walking.

Introduction
Many lower limb prosthesis users have low balance confidence, which correlates with reduced social activities and quality of life [1]. Understanding simple goals of the able-bodied ankle-foot system for different tasks of daily living could lead to prosthesis designs that improve balance and balance confidence of their users. Earlier work showed that the effective rocker shape of the able-bodied ankle-foot system closely approximates a circular arc with radius of about 1/3 of leg length for level walking and this shape does not change appreciably with speed [2], added weight to the torso [3], or shoe heel height [4]. This study examined the effective rocker shapes created during fore-aft swaying and walking, with the hypothesis that swaying shapes are significantly flatter than walking shapes. Modeling examined the effective ankle stiffness values needed to achieve the rocker shapes, assuming full body loading during walking (single-support) and half body loading during swaying.

Methods
Eleven able-bodied persons were recruited and provided informed consent to participate in this study. Markers were placed on the subjects according to a modified Helen Hayes marker set [5]. A motion analysis system tracked markers on the body during walking and fore-aft swaying. Force platforms were used to measure the center of pressure of the ground reaction force under each foot during these activities. Effective rocker shapes during walking and fore-aft swaying were measured by transforming the center of pressure of the ground reaction force from a laboratory-based coordinate system to a coordinate system based on the shank of the leg [6]. The radius of each effective rocker shape was estimated by fitting a second order polynomial and taking the inverse of its median curvature. A post-hoc model was created to determine the torques and angles of the ankle necessary to achieve biomimetic effective rocker shapes for fore-aft swaying and walking, assuming a body weight of 980 N.

Results
The eleven subjects in the study had a mean age = 28 ± 4 years, mean height = 176 ± 10 cm, and mean weight = 71 ± 14 kg. The figure shows the effective rocker shapes for walking and for fore-aft swaying for one representative subject. The mean radius of the fore-aft swaying effective shape (219% LL) was significantly higher than that found for walking (33% LL) ($p = 0.003$), and the walking radii were similar

to those found in earlier studies [2-4]. The modeling indicates that the torsional stiffness required of a prosthetic ankle for biomimetic fore-aft swaying would need to be about 3 to 4 times higher than that needed for biomimetic walking, strongly suggesting different goals of the able-bodied ankle-foot system for these tasks.
The results suggest that ankle-foot prostheses would need two distinct modes to mimic the able-bodied ankle-foot system for these two tasks—a system that conforms to a circular rocker for walking and a flat effective rocker for standing and swaying. A simple approach to achieving biomimetic function may be achieved in the design of a single-axis ankle-foot system with a lockable ankle joint. The bumpers of such a system could be designed to provide the appropriate rocker shape for walking (ankle unlocked) and a flat effective shape for standing (ankle locked). A more practical approach may be the use of systems that compromise between biomimetic shapes for standing/swaying and walking (e.g. systems with flat rocker sections [7]).

Conclusion
Effective rocker shapes of the able-bodied ankle-foot system measured for fore-aft swaying were flatter than those found for walking. Ankle stiffness modeling suggests that the difference in rocker shapes cannot be explained purely by the reduced loading experienced during fore-aft swaying (double support versus single support loading), suggesting that the body is changing its control for this task. Although the able-bodied ankle-foot system is extremely complex, it may have simple goals of creating an invariant circular roll-over shape for walking and an effectively flat rocker shape for standing and swaying. Prosthesis users with balance problems may benefit from bimodal ankle-foot devices that mimic the walking effective shape in one mode and the standing/swaying effective shape in another mode. Prosthetic feet with flat rocker sections may also provide appropriate compromises between biomimetic walking and standing/swaying tasks.

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Image: Figure 1_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3339-514]

Influence of a Transtibial Prosthesis Alignment on the User's Feet Positions in Standing

Author
Kolarova, Barbara (Olomouc CZ)
Palacky Univerity Olomouc - Faculty of Physical Culture

Coauthors
Janura M, Svoboda Z, Rosicky J

Abstract
The different prosthesis alignment influenced the feet positions during natural standing. The changes in prosthetic ankle (increased plantar or dorsal flexion) conduce to enlargement of the base of support. Shorter prosthesis length results in lateral displacement of the prosthetic foot tip.

Introduction
Postural stability represents a basic pre-condition of preventing falls. The position of the feet and the shape of the base of support influence the patient's stability (Vareka, 2002). Loss of limb shifts the position of the centre of mass. In patient with transtibial amputation this shift may have relatively impact on postural control and function ability (Lusardi & Nielsen, 2007). Appropriate prosthesis alignment provides the amputee to comfortably bear weight on the limb (Shurr & Michael, 2002). The subjective evaluation of the prosthetists and the patient has an important influence on a quality of prosthetic alignment (Fridman, Ona & Isakov, 2003). The structure of prosthetic alignment carried out by various technicians differs also in the same patient (Geil, 2002). The aim of the study is to ascertain the influence of different prosthesis alignment on the feet positions and on the COP movement of the user during standing.

Methods
The observed group consisted of 13 males with unilateral transtibial amputation (age 56.0#13.04 years, body weight 87.4#13.19 kg, height 1.76#0.07 m, prosthesis using 9.96±11.97 years). Standing of subjects were tested in 5 various prosthetic alignments (2 trials in each): optimal, 1 cm shorter, 1 cm longer, 5° foot plantar flexion and 5° foot dorsal flexion. The positions of the feet were selected individually by each subject (natural standing, duration 60 s). For the COP movement analysis two force plates AMTI OR 6-5 (1000 Hz) were used. The positions of the feet were measured. Mediolateral (ML) and anteroposterior (AP) distances of the heels and toes (Heel AP, Heel ML, Toe ML), AP distance of centres of confidence ellipse (COP AP), angles between AP line and foot axes (sound, prosthetic) were calculated. A one-way ANOVA with a Fisher post-hoc test was performed using STATISTICA (Version 6.0, Stat-Soft, Inc., USA).

Results
Anteroposterior displacement
In prosthetic foot alignment with increased dorsal flexion prosthetic foot moved about 1 cm backward with regard to optimal alignment ($p<0.01$). Only in this alignment prosthetic foot was placed behind sound foot. The centre of confidence ellipse moved backward in this alignment too. In the alignment with increased plantar flexion the centre of confidence ellipse moved forward ($p < 0.01$).
Mediolateral displacement

In the alignment with increased plantar flexion and increased dorsal flexion Heel AP distance and Toe AP distance were greater. These differences were significant with regard to optimal alignment in two cases (plantar flexion – Toe ML – $p<0.01$, dorsal flexion – Heel ML – $p<0.05$).
Angle displacement
Significant differences in angle variables with regard to optimal alignment were found only for alignment with shorter prosthesis length. In this alignment angle between prosthetic foot axis and AP line and total angle between feet were greater.

Conclusion
The changes in prosthetic ankle in unilateral transtibial amputees to increased plantar and dorsal flexion conduce to enlargement of the base of support. In the alignment with increased dorsal flexion, the anteroposterior distances between heels and centre of confidence ellipse of prosthetic and sound limbs are smaller, in the alignment with increased plantar flexion this parameters are greater (prosthetic foot was placed more forward). The difference in angle between feet axes was found only in alignment with shorter prosthesis length. Shorter prosthesis length results in lateral displacement of the prosthetic foot tip. Longer prosthesis had not significant influence on feet position.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3360-535]

The Development of Self-Sustaining Prosthetic Centers in Underserved Areas – The Walking Free Program

Author
Lawrence, David (Richmond, Virginia US) | MSPT, PT
The Gait Center - Out patient physical therapy

Coauthors
Grisetti, GC, PT, EdD

Abstract
Programs designed by non-governmental organizations (NGOs) to meet the short term needs for prosthetic care may provide the devices needed but not the resources needed on a long-term basis.Training,which includes a long term commitment by the NGO to the underserved area will increase success.

Introduction
Physicians for Peace (PFP), a non-governmental organization located in Norfolk, Virginia, USA, has designed the Walking Free program to address the long-term needs of low-income and developing nations for prosthetic care and rehabilitation. The program is designed to assist governmental and non-governmental entities within underserved regions to enhance or establish their own self-sustainable prosthetic centers over a three to five year time period.

Methods
Using a multi-disciplinary collaborative practice model the Walking Free program addresses these areas of prosthetic care within the target country: 1). surgical and medical evaluation and management, 2). academic and clinical education 3). prosthetic production, 4). physical rehabilitation, 5) direct patient care and public education.
Project sites are established using specific guidelines:
Initiation Phase
An invitation by a host country is made. No projects attempted without a foundation of local community support. The region's political and socio-economic climate are studied. A team is established that can meet the core project needs.
A site visit is conducted with face-to-face meetings with the appropriate contacts, visual verification of out-of-country research and an assessment of the likelihood success.
Implementation Phase:
Based on the findings of the site visit a three to five year model and estimated mission schedule is created to demonstrate the long-term commitment.

Results
The Walking Free program has established self-sustaining centers in Diyabakir Turkey (initiated 2000) and in Santo Domingo, the Dominican Republic (initiated 2001). The development of a center in Port-au-Prince, Haiti was initiated in 2004 and is an on-going project. In addition, educational programs and training have begun in Amman, Jordan and Manila, the Philippines. More than 25 education and training missions have been conducted. Prosthetists from partnering countries have received training in the United States.Production data from all locations demonstrate an increase; survey data from technicians in the

program demonstrate an improvement in technical skill and self-perceived increases in professionalism and confidence.
Collaboration with Old Dominion University School of Physical Therapy has supported meeting the rehabilitation needs of the Walking Free Program. Outcome measures have been designed to evaluate the effects of training on clinical skills, productivity standard, management of resources and functional abilities.

Conclusion

The primary objective of these initiatives is to establish the capabilities of host countries to meet the current and future prosthetic and rehabilitation needs of the citizens on a permanent basis. Training nationals to manufacture and maintain prosthetic limbs and to provide the associated physical rehabilitation will achieve this objective. Meeting the long term needs of amputation patients in low income and developing nations will continue to remain a challenge for some time to come. Functional outcomes for this patient population can be improved when training, education and resources empower practitioners in underserved areas to meet the needs of their patients on an ongoing basis. A clearly defined collaborative relationship with the host country, the statement of a long-term commitment to complete the project and the use of culturally competent multi-disciplinary teams are essential for success.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3154-352]

Training Control of a MyoHand VariPlus Speed®

Author
Bouwsema, Hanneke (NL)
University of Groningen - Center of Human Movement Sciences

Coauthors
van der Sluis CK, Bongers RM

Abstract
Aim of the study was to compare three different types of myoelectric signal training. Three groups of able-bodied participants trained control of a myoelectric hand. No differences were found for the three training groups. However, individual differences in learning capacities were noticed.

Introduction
Producing a good myoelectric signal is imperative to control a myoelectric prosthesis in daily life (Hermansson et al., 2006). When patients are provided with a myoelectric prosthesis after amputation, they have to learn to produce a myoelectric (EMG) signal that fully utilizes the possibilities of the prosthetic hand. Training is needed to optimize the control, and is therefore an important first part of the rehabilitation program of prosthetic use (Dakpa and Heger, 1997; Smurr et al., 2008). Training can already start in the pre-prosthetic phase; electrodes can be connected to therapeutic biofeedback units like a myotester showing EMG-signals or a virtual hand, or to an isolated prosthetic hand. During the prosthetic phase, patients can also immediately practice functional training with their prosthesis fitted. The aim of this study was to compare the result of different types of myoelectric-signal training.

Methods
34 able-bodied right-handed participants were studied. Participants were divided into three groups. The first group trained with a virtual myoelectric hand simulated on a computer screen (PAULA software, Otto Bock®), one group trained with an isolated prosthetic hand (MyoHand VariPlus Speed, Otto Bock®), and a third group trained with a prosthetic simulator (Bouwsema et al., 2008). Half of the participants trained with their dominant side, and the other half with the non-dominant side. In a pretest, participants were instructed to open and close the prosthetic hand in three different velocities—slow, comfortable and fast speed. After the pretest, the participants trained opening and closing the hand on three consecutive days, 60 times each day. A posttest, similar to the pretest, was administered after the last training session on the third day. Peak velocity of the hand and EMG-signals were registered. The performance of the participants on the pretest and the posttest were analyzed.

Results
No differences were found for the different types of training. In the posttest, the EMG-signals showed many individual differences. Based on these differences in learning capacities, two groups could be recognized, High Capacity Learners (HCL) and Low Capacity Learners (LCL). After learning, the HCL could produce clearly distinct EMG-signals, which resulted in the ability to open and close the hand at different speeds, while LCL could not produce distinct EMG-signals.
Participants reached higher peak velocities on the posttest, and the peak velocities differed largely for the three velocity conditions; the highest peak velocities were reached in the fast speed condition, whereas the lowest peak velocities were reached in the slow condition. The HCL made more contrast in the three

velocity conditions compared to the LCL; in particular the peak velocities in the slow condition were much smaller for the HCL than for the LCL.

Conclusion

No differences were found for the different types of training. This implies that EMG training without a prosthesis, i.e., training with a virtual myoelectric hand simulated on a computer screen, leads to comparable control as training with original terminal devices. Important is that isolated EMG-training, without a prosthesis fitted, can start in the pre-prosthetic phase. During this stage, it can be determined early in rehabilitation what the highest level of control is for each patient. This, combined with the fact that most recent hands are also available as virtual hands, makes test prostheses aimed to train and evaluate EMG signals superfluous. Interesting was that although all participants learned to open and close the hand, individual differences in the learning capacities were noticed. If prosthetic users differ in learning capacity, this should be taken into account when choosing the appropriate prosthesis for each patient.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3278-453]

The Evaluation of Fused Deposition Modelling (FDM) Materials to Assess their Potential Use in Computer Aided Socket Manufacture

Author
Buis, Arjan (Glasgow GB) | Dr.
NCPO University of Strathclyde

Coauthors
Mclaughlin BG, Simpson D, Buis AWP

Abstract
This paper will discuss the results of testing a number of Fused Deposition Modelling materials. The mechanical properties of the materials will be compared with the fibre reinforced resin and copolymer polypropylene materials which are routinely used in the production of prosthetic sockets.

Introduction
Recent advances in FDM machines and materials may allow the manufacture of finished sockets directly from 3D CAD data. The mechanical properties of the new materials need to be tested and compared with conventional socket materials.
It is also important to recognise that concerns have been raised, [1, 2], over the use of polypropylene material to manufacture prosthetic sockets as research indicates that the material may not be sufficiently strong to meet the ISO standards [3-6].
The authors are of the opinion that the mechanical properties of all materials which may potentially be used for socket production should be tested and their mechanical characteristics compared before prosthetic sockets are produced for further testing to ISO standards.
If RP technologies are to be adopted within prosthetics, then an optimised process in which all the components (3D scanner, CAD software, RP machine) complement each other is required.

Methods
The RP test-specimens were prepared using the geometry described in Method 320C of BS2782-3. Five specimens of each of the following FDM materials were produced: ABS Dimension Elite, ABS+ M30 and Polycarbonate.
The laminated samples were prepared to a standard lay-up and each sample was digitally cut using a CAD file of the same dimension as the RP samples.
The polypropylene samples were prepared in a similar way to the laminated samples using the manufacture procedure suggested by the material supplier (North Sea Plastics).
The cross sectional area of each sample was measured accurately to allow the stress to be calculated during testing.
Tensile testing was conducted in an Instron testing machine with five samples of each material tested, the results for each sample were then averaged. A strain rate of 5mm/minute was used for all specimens and the level of stress was calculated using the dimensions at the location of failure, as measured prior to testing.

Results

The polypropylene samples did not fracture during testing and the tests were stopped when the samples had increase in length by 50%. At this stage the level of stress was no longer increasing. The polypropylene samples also contracted back to close to their original length when removed from the testing machine.
All FDM material samples fractured during the testing, as did the laminated specimens.
The fibre reinforced resin was the strongest material with a maximum tensile stress of almost 280Nmm-2.
The undraped polypropylene had a maximum tensile stress of around 27Nmm-2. The maximum tensile stress remains the same at around 28Nmm-2 when the material is draped.
There is a considerable difference between the tensile strength of the traditional socket materials, with polypropylene considerably weaker than fibre reinforced resin.
Two of the FDM materials, ABS+ Dimension Elite and ABS M30, showed very similar tensile properties to the copolymer samples.
The Polycarbonate sample has a maximum tensile stress approaching 60 Nmm-2. This is more than double that of the polypropylene samples and the other FDM samples. However it is still only 21% of the laminated samples.

Conclusion

In summary, these test show that
• The laminated resins are considerably stronger than the other materials tested – are they too strong?
• The draping process appears not to affect the strength of polypropylene.
• ABS+ and ABS-M30 materials have been shown to be of similar strength to polypropylene.
• Polycarbonate seems to be twice as strong as polypropylene and therefore the most appropriate material to continue evaluating.
Future work on this project will include:
• Further evaluation of polypropylene as a suitable socket material
• Production of polycarbonate sockets for testing to the ISO standards
• Production of polycarbonate sockets for clinical trials, subject to ethical approval.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3230-412]

Improved Function with High Performance Wrist Rotation

Author
Sears, Harold (Salt Lake City, UT US) | PhD
Motion Control, Inc. - home office

Coauthors
Harold H. Sears, PhD
Edwin Iversen, MS
Tony Jacobs, BS

Abstract
o A new wrist pro/supination component can produce higher torque and speed, within the same size and weight as earlier components
o Electric arm prosthesis wearers who desire more function desire higher performance in components, i.e., if higher speed and torque is available, active prosthesis users

Introduction
Higher performance can be provided with improved design, and utilization of new motor technologies.
Questions may arise – do individuals actually utilize powered wrist rotation?
o Earlier studies showed that high-activity electric TD wearers highly utilize the function of electric pro/supination (pro/sup).
o It should be expected that higher torque and higher speed would be utilized more by wearers, if provided without other drawbacks, e.g., higher weight or size.
o Variety of combinations, can provide a variety of benefits
o In-hand wrist combination allows longer length amputations to utilize wrist rotation, compared with earlier components
o Wrist rotation may be combined with flexion, if all functions are desired within the same TD.
o A water-resistant quick/disconnect allows easy connection of a variety of TDs to the electric rotation component.

Methods
o Using modern digital design techniques, a wrist design with higher performance was explored. Several generations of the design were required to produce a higher performance component.
o In-hand placement of the improved pro/sup unit has been offered, as well as a proximally-located module.
o Integration of the new rotation unit with a legacy Q/D component, allows the pro/sup unit to be utilized with earlier-fitted components, as well as with components from other manufacturers.
o A new water-resistant quick/disconnect unit also is integrated with the wrist rotation device, providing a greater resistance to water and dirt contamination.
o Utilization of the new component, and the pros & cons of the device are surveyed by questionnaire. The method is very useful for comparing a wearer's earlier device with a new component.

Results
o Survey of approximately 15 wearers documents:
o Tasks performed with former vs. present device.
o Method of performance of the task, detailing any change in performance, including advantages.

o Rating (better/worse) of present vs. former device, in areas of function, comfort, and convenience. Functions are recorded in a wide variety of activities, e.g., work tasks, kitchen tasks, ADL tasks, recreation, in an open-ended method, without limiting the responses of the subject.
o Utilization, i.e., extent of usage with the higher performance component, as measured by number of tasks performed, and wearing time vs. former device.

Conclusion
o Adoption of the new components has been successful – components placed with wearers are being utilized overall more frequently than the former pro/sup component
o Proximal placement is preferred, both for the weight distribution, and also the economy of utilizing a single component for pro/sup, rather than an integrated component in each TD
o Wearers of the new pro/sup device have specific suggestions for future developments which will increase their function still more.

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Image: hand w inH wrist_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3216-398]

Preliminary Development of the Legs Functional Parameters Questionnaire

Author
Rispin, Karen (Longview US)
LeTourneau University - School of Arts and Sciences

Coauthors
Husk C, Lew S, Schufeldt T, Gonzalez RV

Abstract
The need to accurately assess outcomes for prosthetic and orthotics is more urgent in low income nations. Limited follow-up reduces opportunity to adjust protocols during return visits. Preliminary field testing of a suite of lower limb outcomes for low income nations shows positive results.

Introduction
Improvement of mobility and lower limb function are goals in treatment of lower limb morbidities requiring prosthetic or orthotic intervention. There is an increasing understanding of the need to objectively report outcomes for clinical protocols; in developed nations there has been a push to develop and assess clinically useful tests for objective outcomes (Condie et al. 2006). Working conditions in clinics in low income nations present unique challenges; access to technology and expertise is limited; clients' initial visits and follow-up schedules are brief and erratic (Cummings 1996). However the need to accurately assess outcomes is more urgent because there is less opportunity to compensate for less than ideal protocols during return visits. Our intention is to develop and validate a simple protocol that can be completed and analyzed at developing world clinics. The trial protocol below was field tested in Kenya and Bangladesh with amputees utilizing three knee conditions.

Methods
A preliminary LEGS functional parameters questionnaire (pLFPQ) with visual analogue scale was developed consisting of 13 questions modified from the PEQ and seven trial questions (Boone 2006). A concurrent timed walk test (TWT) and Physiological Cost Index (PCI) estimated energy cost. To validate the LFPQ, temporal and spatial gait data was collected with a GAITRite computerized gait mat. Nineteen transfemoral amputees from Kenya and Bangladesh (27±5.3 years 16 M, 2 F) were tested with the LEGS knee, the LEGS knee locked with a locking jig; ten of the nineteen with the OrthoEurope 4bar (OE) knee utilizing the same socket and foot. Gait spatial data was standardized to biological leg length; gait temporal data to percent of gait cycle. Gait spatial data and TWT were standardized by biological leg length. Gait temporal data was normalized to % of gait cycle. LFPQ data was normalized by standard deviations from amputee median.

Results
Results from the preliminary LEGS functional Parameters Questionnaire indicated that perceived adequate energy to walk as long as needed (E) was significantly correlated with estimated daily time spent walking, and the Physiological Cost index but not with the distance walked in the Timed Walk Test. Perceived balance standing and sitting (C1, C2) correlated with perceived satisfaction with walking (K) and lower perceived effort (Q). Perceived agility on stairs (H,I) and in close spaces (G) were correlated each other

and with perceived stability (R). Perceived ease in stance (M) and stability (R) correlated with each other and with heel-to-heel base of support in gait. Unlike the Physiological Cost Index, the Timed Walk Test correlated with perceived comfort standing (B) and perceived standing and sitting balance (C1, C2).
Paired T-tests indicated LEGS and OE, both polycentric knees, had significantly higher perceived ease in sitting (J1) and swing through (O). Subjects perceived a more normal looking gait while with the LEGS knee (P), and reported a higher satisfaction with gait (K), lower effort (Q) and less silent function (E). While wearing the OE knee, subjects reported less walking balance (C2)and walked a shorter distance during the six minute timed walk test (Figure 1).

Conclusion
Results correlated with each other largely as expected, offering a preliminary validation of the LFPQ prototype. Perceived effort correlated with perceived energy cost; however other correlations indicated that subjects may be relating “effort” to awkwardness. PCI and TWT correlated with each other but correlated differently to LFPQ questions and responded differently to the three knee conditions indicating that TWT may be measuring something more like confidence. Subjects anecdotally indicated that the locked knee caused discomfort. Plans are underway to add questions regarding discomfort and to allow subject to weight the personal significance of parameters. Work is underway to test the LFPQ with subjects wearing knee braces and subjects with orthotics. Principle components analysis is planned when data is sufficient. Work will continue on the development the LFPQ as part of a suite of outcomes measures that can be easily administrated and analyzed in low income nations.

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Image: Preliminary LEGS functional parameters questionnaire graphic_None.jpg (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2880-78]

Early Postoperative Fitting of the Air- Limb Prosthesis for Transtibial Amputees

Author
Kristal, Anat (Givataym IL)
Sheba Medical Center - Orthopedic Rehabilitation

Coauthors
Dvir Z,Yzahar Z, Siev- Ner Y.

Abstract
The aim of the current study was to check whether an early adjustment of the Air-Limb prosthesis, will shorten the healing time of the stump and the process of rehabilitation.

Introduction
The method of immediate fitting of a Prosthesis has been developed in the past, aiming to reduce the healing time of the stump and the process of rehabilitation [1, 2]. According to this method, a temporary Prosthesis is adjusted immediately after the amputation, or during the first week after it. The rehabilitation process begins with the patient standing while partially bearing weight on the Prosthesis [1, 2].
In spite of many experiments and trials to adopt this process of rehabilitation, it has not been universally adopted, because of poor adjustment and damages to the stump caused by the materials used (Plaster of Paris) [3, 4]. Presently, as materials used have improved research and experiments are being renewed, to evaluate the efficiency of the process, using the Air- Limb Prosthesis. This Prosthesis is easily adjusted and provides graduated sequential compression that promotes stump healing [5].

Methods
20 Transtibial amputees were recruited and divided in to two groups: Research and Control. The research group received the Air- Limb 5 days post amputation and began exercising with it. The control group was managed with standard soft dressings.
Stump maturation, functional progress and length of rehabilitation were measured in terms of healing of the operational wound, reduction of the circumference of the stump, pain level, functional tests (2 minute walk, Timed up& go),and the duration of hospitalization. These were measured once a week, during the first 30 days of hospitalization, and at the beginning and end of rehabilitation, with the permanent Prosthesis

Results
The results of this research show that the research group was fitted with a permanent Prosthesis in half the time, in comparison to the control group, (40±49 days; 79±109 days). (p=0.34). Furthermore, the research groups total time of rehabilitation (from amputation till the end of rehabilitation with the permanent Prosthesis), was significantly shorter; 68±56 days in the research group compared to 125±87 days in the control group (p=0.46). In addition, both groups showed strong correlation between the time from amputation to the adjustment of a permanent Prosthesis and total time of rehabilitation (r=.988; p=.000).
There were no statistical differences between the groups regarding the functional status and maturation of the stump, except for shorter period to full healing of the operational wound in the research group.

Conclusion

Similar to Schon et. Al. findings [5], we also found that using a temporary prosthesis significantly shortened the rehabilitation process of Transtibial amputees (p=0.34). In the current study, both groups showed an almost perfect correlation between the number of days from amputation until the fitting of the permanent prosthesis and the numbers of days from amputation until the end of the rehabilitation with the permanent prosthesis. Different from the findings of Cohen et. Al. [3], that used a Plaster of Paris for the temporary prosthesis, in the current study the use of the Air- Limb prosthesis was proven to be safe since it didn't compromise the maturation process of the stump.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3323-498]

Studying of Effectiveness of Intra Sliding Deplacement of Socket Relation to Foot in Short Below Knee Stumps

Author
Balouch Kayvan, Behrad (IR) | CPO
JMERC - Biomedical Department

Coauthors
Yavari , Amir
Asadi , Aghil
Allami , Mostafa

Abstract
Shortness of stump in BK amputations complicates fitting appropriate prosthesis .they have some problems .This study is done clinically choosing of patients randomly .Based on clinical observation and remarks of amputees intra sliding deplacement of socket can decrease knee valgus and pain .

Introduction
Shortness of stump in below knee amputations complicates fitting appropriate prosthesis
Appropriate suspension of prosthesis medial and lateral stability of knee ,decreasing weight bearing surface and decreasing lever role of stump in prosthesis control , are main problems (in most of cases . this problem obligates prosthesist to use of femoral shell and external knee joints for controlling knee stability)
Medial and lateral of knee depends on adjustment of prosthesis alignment. in clinical observations most of short below knee amputees complain about knee valgus and pain at knee joint part during walking or standing. in this study , which is done on for below knee amputees with short stump we evaluate effectiveness of intra sliding deplacement of socket relation to foot in pain and knee valgus .

Methods
This study is done clinically choosing of patients randomly :
First patient: 40 years old , left below knee amputation with 10 cm stump and 14 hours usage of prosthesis in a day , muscle strength 4 and complete knee range of motion ,this patient had diabetes and cardiovascular problems
Second patient : 51 years old , left below knee amputation whit 10 cm stump and 8 hours usage of prosthesis in a day , muscle strength 3- and complete knee range of motion
Third patient : 59 years old left below knee amputation whit 7 cm stump and right below knee amputation whit long stump this patient used a crutch for movement muscle strength 3+ and complete knee range of motion this patient had neuroma at end of stump
Forth patient:42 years old ,right below knee amputation whit 9 cm stump ,13 hours usage of prosthesis a day , muscle strength 3+ and complete knee range motion
Prosthetic foot of first and third patients was SACH . and for second patient was single axis and forth patient was carbonic.

Results
Before sliding deplacement :in clinical observation ,every four patients had knee valgus ,except third patient all of them confirmed knee valgus.

First , second and third patient had pain in this situation but forth patient did not
After sliding deplacement :in clinical observation ,knee valgus was decreased in every four patients ,however this decreasing was more in first patient. In patients point of view first and third and forth decreased in knee valgus but in second patients ,it was not changed ,in first ,third and forth patients ,knee pain was decreased very much but in second patients it was not changed.

Conclusion

Based on clinical observation in this study and remarks of amputees (3of4) intra sliding deplacement of socket relation to foot in short knee stumps can decrease knee valgus and pain . it is better to do this in an experimental place and using of analyzers of gate to get exact results.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3324-499]

Opinion Assessment of Lower Limb Amputees about Advanced Knee Joints

Author
Allami, Mostafa (IR) | CPO
JMERC - Biomedical Department

Coauthors
Soroush , Mohammad Reza
Amirani , Omolbanin
Kabiri , Reza
Asadi , Aghil

Abstract
In this study to determine pneumatic, hydraulic and electronic (advanced) joints in functional improvement of knee disarticulation and above knee amputees in comparison whit simple mechanical joints , opinion assessment was done 124 over knee and above knee amputees.

Introduction
In a lower prosthesis , more imitation of natural walking , more advantages for amputee we can divide knee joints into two groups : one group is related to those whit just mechanical controls and the other group whit microprocessor control. The simplest available articulated knee is single axis that allows knee flexion but it does not control suspension phase obviously .fitting of controlled knees using mobile progress in past has obviated joints , facilitates adjustment of slow to fast speed of walking and also decreases energy consumption
About expense , cost of mechanical joints is 270_370 euro , pneumatic joints is almost 1500 euro , hydraulic joints is 1900_2600 euro and intelligent joints is 2200_3000 euro
It is obviously in spite of variable function of knee joint in knee disarticulation or above knee amputation relevant to traits of other segments and affect of all segments of prosthesis on each other addition to result of this project can be a basis for clinic experimental

Methods
This study was a kind of a survey which was done based on principals of opinion assessment. Under study group were over and above knee amputees that had delivered prosthesis from common center sampling of this study was available from 230 individuals that had got advanced knee joints from this center , 124 of them answered to telephone call and participated in study. Implements of data collecting were theory assessment questionnaire of above knee amputees which is processed based on articles and also council and cooperation of orthotists and prosthetists for studying accuracy of question and assessing of it is authority in an experimental study on 15 amputees , questionnaire was assessed and revised .This questionnaire divided into two parts.Questionnaire were assessed and revised after completing and then were analyzed whit SPSS finally received data were analyzed whit statistics export
Method of analyzing of data was descriptive statistics and stating of amplitude index.

Results

124 of above knee, over knee and hip lower amputees participating in this study were all men and had average age of 40.724 +/- 5.466 years. More percents of amputees (49.2%) believed that sitting and standing with this new knee joint was so simple in half of amputees , respiration is changed and gets more steady .most of them have remarked that their walking was got so better whit advanced knee joint than previous knee joint . most of them have remarked that their steps were not continuous with electronic joint and 3.7% of them could not flex their knees during going down the stairs .in 42% of cases electronic knee joint had conformity whit speed of amputee`s walking. 67.7% had a better way of walking with advanced joints. 85.5%of them had medium ,well and remarkable satisfaction of advanced joints function . in 47.5% of cases .amputees were encouraged to more walking. However tests suggested that advanced joint did not have influence on amputee`s persuasion for walking.

Conclusion

Result of this opinion poll suggested better way of walking with advanced joints (hydraulic and pneumatic) in comparison with previous mechanical joints . this result have conformity with results of Kriker , Krikey, Datta , Chin and Aginalo studies . with considering those patients that walk more than 3 hours per day we do not see any difference in duration of walking using these new joints is comparison with previous joints. It is like result of Datta study in this field. amputees believed that electronic joints facilitated their going down the stairs and gradient surfaces but it is different from result of Datta and Helm studies in this field Total result of this study is that hydraulic and pneumatic joints are so better than mechanical and all almost all users of these advanced joints are satisfied.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3224-406]

Application of the Novel Symmetry in External Work (SEW) Measure to Examine Kinetic Gait Differences between Prosthetic Feet

Author
Agrawal, Vibhor (Miami US)
University of Miami - Biomedical Engineering

Coauthors
Gailey RS, OToole CO, Gaunaurd IA, Dowell TG

Abstract
Symmetry in External Work (SEW) is a novel measure that can be used to differentiate gait kinetics between prosthetic feet. This study describes the application of the SEW measure to compare four prosthetic feet as well as the advantages and disadvantages of this technique.

Introduction
Research studies comparing gait characteristics among prosthetic feet have yielded mixed results[1, 2]. Experimental measures, such as energy cost, EMG, walking speed etc., have failed to consistently demonstrate gait variations among prosthetic feet. A new method, called Symmetry in External Work (SEW) can be used to quantify kinetic gait differences between prosthetic feet[3]. External work is the result of changes in kinetic and potential energy of the body center of mass (Figure 1). Ground reaction forces can be used to calculate external work during functional activities such as walking on level ground, ramps and ascending/descending stairs[4]. In people having a unilateral transtibial amputation, anatomical differences between the two sides would theoretically cause an asymmetry in work done by the amputated and intact limb. Since prosthetic feet have different structural and functional characteristics, it was hypothesized that SEW values will vary with the type of foot used.

Methods
SEW values were calculated for a 55 year old subject with a left traumatic transtibial amputation from 35 years ago. A replica of the subject's socket was fabricated for testing purposes and was used to test four different prosthetic feet - Proprio, Trias, Seattle Lite and SACH. The subject was given an accommodation period of 4–7 days with each test foot to determine comfort and alignment. He received gait training from a physical therapist specializing in amputee rehabilitation and gait in order to minimize gait deviations resulting from habit or lack of training. Vertical ground reaction force (GRF) data were collected using F-scan in-sole sensors as the subject walked on a 21 meter long level walkway, an incline and ascended/descended a set of 11 steps. Data collection and analysis with the F-scan system was done using previously validated methods[5]. Work done by the intact limb and the prosthetic limb was used to calculate symmetry index, which was expressed as a percentage.

Results
Equal work done by the intact and amputated limb would result in a symmetry index of 100%. During level ground walking, the mean (SD) symmetry indices were: SACH – 35.7% (11.1), Seattle Lite – 67.8% (19.3), Trias – 92.1% (2.5) and Proprio – 94.5% (1.1). The Proprio foot, because of its active dorsiflexion/plantarflexion feature and dynamic elastic response (DER) characteristics resulted in the highest symmetry

of all test feet. The two DER feet with high effective foot length ratios6- Trias and Proprio - produced potential and kinetic energy changes which were similar to the intact foot. The symmetry index of Seattle Lite foot was intermediate between the DER feet and the SACH foot. The 35.7% symmetry for the SACH foot was the lowest of all feet and represented substantial gait asymmetry. The center of mass (CoM) displacement curve for the Proprio was similar to that for the intact foot. The CoM trajectories produced by the two DER feet had a distinct trough (negative displacement) followed by a peak (positive displacement), which is comparable with the displacement curve of able bodied individuals. While ambulating with the SACH and Seattle Lite feet the negative CoM displacement was not clearly evident.

Conclusion

The SEW measure is able to differentiate gait kinetics between prosthetic feet during level ground walking. This measure can also be used for functional activities such as ramps and stairs. SEW calculations depend on three variables - ground reaction forces, the time required to complete a step and the displacement of the body CoM during the step. Prosthetic feet have different designs which influence these variables in unique ways during functional activities, resulting in variable SEW values. This measure has the potential to be used as a clinical tool, as limited instrumentation is attached to the patient and GRF data can be collected in 10 to 20 seconds using commercially available in-sole sensors. The mathematical calculations can be automated without the need for specialized software and the SEW values can be obtained relatively quickly. This measure is limited to the calculation of vertical work values as current in-sole sensor technology is not capable of measuring shear GRFs.

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Image: SEW abstract figure_None.JPG (see online)

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3272-447]

The Use of Problem–Based Learning to Teach Upper Limb Prosthetics

Author
Ritchie, Sophie (Glasgow GB)
University of Stractclyde - National Centre for Prothetics and Orthotics

Coauthors
Mclaughlin BG, Ritchie SL

Abstract
In recent years the staff of the NCPO have adopted a problem based learning(PBL) approach to upper limb teaching. This teaching model has proved to be very successful as it encourages deeper learning and equips the students with the skills required to assess and treat upper limb amputees.

Introduction
The prosthetic management of upper limb amputees requires a wide range of skills and a depth of knowledge that many experienced prosthetist take for granted. It has therefore always been a challenge for educators to ensure that graduates enter the profession with the appropriate skills to be able to effectively manage any patient. For this reason staff of the NCPO have adopted a problem-based learning (PBL) approach to upper limb prosthetic teaching to ensure that our graduates are ready to meet this challenge. Unlike more traditional methods of teaching, where students are presented with the information they are required to learn, during PBL a problem/question is posed requiring students to question, speculate and generate a solution. This method therefore encourages active and independent learning focused round a clinical problem, enabling students to arrive at general principles and concepts which can be applied to other situations.

Methods
Students need to find academic activities meaningful and worthwhile. This is evedent in PBL where real life problems become the context in which students learn academic contents and professional skills. PBL offers a number of real benefits to education in the healthcare professions:
•Structuring learning round clinical problems increases the relevance of teaching.
•Develops generic competencies and transferable skills.
•Encourages effective reasoning processes
•Supports self directed learning skills.
•Allows the student to take more responsibility for their learning.
•Encourages a deep approach to learning.
•Develops group skills for working with colleagues.
Previous findings have also indicated that:
•PBL students are better able to apply what they have learned to clinical practice.
•PBL students have better recall of information within a context
All theses known benefits are in line with the NCPO’s overarching aim to graduate the highest standard of professionals.

Results

Problems/scenarios are selected so that at the end of the program the learner is ready to move directly into the workforce. Traditional levels of content coverage are therefore considered less important, instead students learn the skills for seeking out the required knowledge as the occasion demands.

This is achieved by:

•Splitting the students into small, intimate groups.

•Putting the onus on the students to decide what they need to know.

•Encouraging students to reference theory, past experience and similar cases.

•Allowing students to ask questions and test possible answers in discussion and practical trials relevant to the problem that has been posed.

A system of continuous assessment, on many small activities throughout the module, combines to give each student their own module grade. This method ensures that deeper understanding and problem solving skills are at the forefront of assessment, rather than a more traditional emphasis on factual recall and memorization.

Conclusion

This teaching model has proven to be very successful in encouraging the students to engage in the learning process. When faced with a real upper limb amputee to care for, learning all the necessary knowledge leading to the treatment of this patient is a worthwhile activity for students and learning is usually more enthusiastic.

It has always been the case that to teach or expose students to every challenge seen in an upper limb prosthetic clinic is impossible. However, unlike more tradition declarative methods of teaching, it is felt that the skills students develop through PBL equip them with a greater ability to achieve a successful outcome for each patient they treat, making them better prepared for the reality of working within the specialised but rewarding field of upper limb prosthetics.

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Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2912-110]

A Case Study of the Rehabilitation of a Quadruple Amputee

Author
Davidson, Judith (Bondi Junction AU)
Prince of Wales Hospital - Occupational Therapy

Coauthors
Collins R, Gadge K, Rappaport A, Walter H, Murray A, Bowring G, Purvis J

Abstract
AA is a 52 year old ghanese divorced male who lived alone prior to developing leukemia in August 2008. He underwent chemotherapy during 2008 and then underwent bilateral trans-tibial and bilateral trans-radial amputations. He will live alone in government housing & with attendant care.

Introduction
Rehabilitation of AA has been an enormous challenge due to the quadruple amputations and cultural issues. He was unrealistic as to the outcomes of prosthetic options, always expecting the "perfect" solution. These problems have been compounded due to multiple social issues related to citizenship, entitlement to social security, homelessness and needing to live alone on discharge.
Whilst the rehabilitation team might propose numerous practical solutions to many problems such as equipment, training and changes to prosthetic prescription, rehabilitation will only be successful if the patient and team engage with one another and seek solutions that are embraced by all parties. What is important to the team is often resisted by the patient

Methods
Mr. AA has been highly motivated to walk and quickly became independently mobile on prostheses. Difficulties standing from low chairs and climbing stairs were eventually overcome with multi-axial feet, PTK sockets and practicse. Equipment required considerable modification.
Upper limb prosthestic rehabilitation was complicated by the patients strong distaste for body powered prostheses. The distaste was partly aesthetic, cultural and personal. Tolerance of myoelectric arms was complicated by residual limb volume changes and heterotopic ossification. Functional gains with daily tasks were slowed by the patients desire to be cared for by nursing staff whilst in hospital.
Attempts to promote independence in the ward setting were frequently frustrated.

Results
While AA is independent with prosthetic mobility, he is still resitatnt to some interventions that might ultimately provide full functional independence. Mf AA has achieved independence in various facets of his self care and community access skills. Despite this he remains very dependent on others for most services. His rehabilitation has been complicated by toxoplasmosis, monocular vision, the alienation of his ex-wife and his children. Inpatient was lengthened due to these difficulties in obtaining housing in the community and complex social circumstances.

Conclusion
Despite experience that quadruple amputees can become functionally independent, even obvious solutions to problems encountered in rehabilitation can be futile when not embraced by a patient well engaged with the rehabilitation process.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg240353/cg34040

Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [2967-165]

Price Comparison of Low-cost Prosthetic Components from Low-wage Countries vs Polypropylene Components Designed and Promoted by the ICRC and the SFD

Author
Poetsma, Peter (Managua NI)
International Committee of the Red Cross (ICRC) - Physical Rehabilitation Department

Coauthors
Gauthier P, Delgado C

Abstract
The fall in price of components produced in low-wage countries prompted a reassessment of the market to explore viable alternatives to what is used and promoted at present.
The findings confirm that field testing of low-cost, industrially produced components is timely and justified.

Introduction
Since the early 1980s the ICRCs Physical Rehabilitation Programme has developed its own line of prosthetic and orthotic components. At the outset it used wood, but for many years polypropylene has been the material of choice for production of sockets and components. The ICRC relies at present on a Swiss company (CRE) which produces components to the ICRCs specifications. A few countries in Asia (Afghanistan, Cambodia and Vietnam) managed to produce these components. The decision whether to outsource production of an original and specific line of components or to produce them locally has always been based on economic and quality criteria. In the past, commercially produced components were too expensive or/and insufficiently durable. With the surge of cheap goods from newly industrialized, low-wage countries, prosthetic components of standard design have become cheaper. The purpose of this study is to find the most cost-efficient set of components for use in TT and TF prostheses.

Methods
The Reference Table lists the prices quoted by different suppliers of low-cost components. The components needed for TT and TF prostheses are grouped together to calculate the price of the kits needed for both. The TT and TF tables list the kits and fixed-cost consumables available to produce both. Consumables such as polypropylene sheets and plaster bandage have a fixed price. The study takes into consideration only components with similar functions but different prices. Transport and custom clearance charges are not taken into account in the calculation. The latest catalogue prices were sourced between January and August 2009. Quotations were received in June 2009; the quote request was for the components needed to make up 30 kits for TT prostheses and 30 kits for TF prostheses. Quoted or listed prices obtained from the various sources were in Euros, CHF and USD. Exchange rates between the Swiss franc, the Euro and the USD used in the tables were those obtaining on 19 August 2009.

Results
-The ICRC-designed components for trans-tibial (TT) prostheses as produced by CRE are still clearly the cheapest solution. Components incorporated in complete prostheses which included all the other materials needed were still around 40% or USD42, 47% or USD50 and USD72 or 68% more expensive from the

three cheapest sources. The trans-tibial system designed by the ICRC has proved to be durable and easy to use.
-The ICRC designed components for the trans–femoral (TF) prostheses as sold by CRE are somewhat cheaper then the components from the sources of this study.
A prosthesis with all material needed and the different components integrated will be from the three cheapest sources USD 41 or 17%, USD 42 or 17% and USD 193 or 67% more expensive.
The ICRC-designed knee-joint is a simple single axis with lock design and has a hard shell. The knee-joint proposed by all but one of the sources studied was a modular single-axis joint without a lock, but with an extension assist and a weight-assisted break. This is a well-known design. The ICRC-designed knee-joint has proved to be durable and efforts are under way to improve its functionality. The knee-joints offered by the sources investigated have to be tested to confirm durability. The feet are included as consumables and not as components.

Conclusion

The choice of componentry is closely linked to the three main objectives of the ICRC and the SFD, i.e., access to services, quality of services and sustainability of services. The ICRC and the SFD promote the solution which is the most cost-efficient vs quality in their over 50 countries with140 projects. It is involved in the production of over 30,000 prosthetic devices yearly. Because of falling prices of low-cost, industrially produced components, it became necessary to study prices on the world market. The in-house designed polypropylene components proved to be the most appropriate to date. If the trend of falling prices of industrially designed components produced in low-wage countries should continue, those components could offer another option for use and promotion. Field testing would come next, and should this be successful there would be a reassessment of the present policy to reach an informed decision on the choice of components.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg240353/cg34945

Poster Session: Prosthetics
Wednesday 2010/05/12 | 12:00 - 14:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Poster [3206-392]

Preliminary User Evaluation Study of 2-site EMG Prosthesis Control Strategies to Allow Modulation of both Position and Stiffness

Author
Christenson, Jeff (Chciago US)
Northwestern University - Biomedical Engineering

Coauthors
Weir, RFff

Abstract
Three 2-site EMG prosthesis control strategies were developed with the intent to allow the user to modulate both position and stiffness. Pilot study data shows that users preferred a cocontration state stiffness controller with a standard position controller.

Introduction
Series elastic actuators (SEA) may have use in prosthetic devices. A SEA is created when a spring is placed between the motor and the output, which adds shock protection, and energy storage, among others. Also, the SEA can be programmed so that it appears as if the spring were softer than the actual hardness of the material. How soft the system seems can be controlled by the user. In order for a SEA prosthesis to be useful to a user, a control method must be evaluated which allows the user to vary the perceived softness. Electric prostheses are often controlled through electromyographic (EMG) sensors which measure the level of muscle contraction. The prosthesis moves based on the combination of 2 EMG muscle signals. Three control methods were developed which uses the 2 EMG sensor signals to simultaneously control position and softness of a SEA prosthesis.

Methods
Three methods of controlling the softness of the SEA were developed. The addition method adds the contraction levels of both sites and instantaneously sets the sum as the softness of the system. The contraction magnitude method has various levels of softness which are attained by the user cocontracting to varying levels of magnitude, such that a harder cocontraction sets the system to a harder value. The cocontraction cycle controller has various levels of softness which are cycled through each time the user cocontracts. The pilot study required the 4 subjects to use the three controllers to perform three tasks. Subjects wore 2 EMG electrodes, one placed on the top and other on the bottom of their forearm. Task one required the softness to be constant while the position varied. Task two required the position to be constant while the softness varied. Task three required both the position and softness to vary. User feedback and the desired position and softness values were recorded.

Results
The users evaluated the three controller based on ability to accomplish the task and ease of use. The cocontraction cycle controller was the received the highest ratings for both ability to accomplish the task and ease of use. The addition and cocontraction magnitude methods rated equally for ease of use while the addition method was preferred over the cocontraction magnitude controller for ability to accomplish the task. Users' comments all showed the cocontraction cycle method to be the preferred controller. The

quantitative data was analyzed for each task. For the constant position, varying softness task, all but one of the users had the lowest standard deviation of position while using the cocontraction cycle method. The cocontraction magnitude had the next best performance, followed by the addition method having the highest standard deviation. In the state controllers, false positives often occurred. A false positive occurs when the controller changes the state of the softness when the user had not commanded such a change. Through visual inspection, the number of false positives were evaluated for the constant softness, varying position task and the vary position and softness task. For the magnitude cycle task, 9 false positives were observed. For the cocontraction cycle, 10 false positives were observed. For the vary position and softness task, 5 false positives were observed for the cocontraction magnitude and 2 false positives for the cocontraction cycle.

Conclusion

The qualitative user response data shows that the preferred controller is the cocontraction cycle. All users felt they could most easily use this controller and accomplish the tasks. The quantitative data analysis also shows that the cocontraction cycle method best allows the user to maintain a constant position while modulating softness. The other two controllers were more difficult for the users to master. The fidelity of the cocontraction cycle needs to be improved to reduce and/or eliminate the false positives which occurred.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3786-932]

P&O Visions – Future Developments in P&O Care

Keynote Author
van der Linde, Harmen (Nijmegen NL) | PhD
University Hospital Nijmegen, the Netherlands - Rehabilitation Department

Abstract
Several changes within the care related to Prosthetics and Orthotics can be foreseen. Besides the development of high-technology P&O aids, the development of better directed treatment based on wishes, abilities and actual performance of patients, will be of importance. Indications and goal setting should probably be based more on activities and participation aspects according to the ICF model. While there is information available about biomechanical and physiological aspects when using a prosthesis or several orthoses, it would lead to significant improvement of care if research would also be aimed at disability and participation issues in the rehabilitation programmes.

Introduction
Based on the development of several guidelines in the field of prosthetics and orthotics there is more insight in the indication for specific P&O interventions. This leads to the development of more accurate training program’s in which a medical aid is an essential part. Specific training modules should also be developed within the context of socio-economic aspects which are different all over the world. Recognizing these different models and their consequences can lead to changes in P&O care.
Therefore, prognostic indicators and characteristics of patient groups need to be verified. Based on these factors we can also identify the possible cause for patients with a poor performance in rehabilitation programs. New treatment strategies can be designed for this probably large group of patients. Also the development of high-technology products for these "poor performers" could be of interest.
Essential will be the cooperation in the near future of clinicians and manufacturers in research and innovation of P&O c

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3512-None]

Innovations in Multifunction Prosthetic Hand Systems

Session Chair
Schäfer, Michael (Traunstein DE)
Pohlig GmbH

Session Chair
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Abstract
Recent years has seen a rise in the number of multi-axis prosthetic hands being developed or marketed. The advantage of such devices is that they can perform a range of grasp patterns and so more closely match the natural hand in functionality and appearance. There is a long history of such devices, but often the means to control them has limited their utility. Recent advances in materials technology, has combined to allow lighter motors and batteries and compact enough electronics to make the idea of a practical multi-degree of freedom hands a reality.
This symposium will bring together the results of a number of the latest projects to produce multi-axis hands, both commercial and experimental. This will allow the different technologies to be compared and contrasted and lessons over where such devices will take prosthetics over the next decade.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg52184

Symposium: Innovations in Multifunction Prosthetic Hand Systems
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3518-731]

Historical Review of Multi Function Hands

Author
Kyberd, Peter (Fredericton CA) | Dr.
University of New Brunswick - Insititute of Biomedical Engineering

Abstract
Multiple axis for a prosthetic hand creates flexibility in gripping. Barriers to use include the weight, reliability and price. The critical aspect is that the hand must be flexible and practical. Many solutions use flexible linkages so the grip is complaint. This paper reviews the choices made.

Introduction
The human hand is flexible and its shape is altered in response to a task. This uses large number of joints. Practicality means prostheses tend to use fewer motions and are more limited. Users then have to compensate with motions of other joints. This activity may create long term injuries. Thus a more adaptable prosthetic hand is a goal.
The existence in the human hand of a digit that can oppose the others broadens the hand's range. As the precision grip is most commonly employed in natural hands [1], conventional prostheses tend to implement this. Unfortunately for some grasps this grip is not appropriate and so less stable. Conventional solutions have a single motor with a rigid drive train, which is light, robust and comparatively cheap. The natural hand conforms the grip through the curling fingers. The natural hand is thus more adaptable and uses much lower grip forces. Multifunction hands must capture some of these features.

Methods
Much of the ideas of design go back many years [2. What changes is newer materials allow the result to be lighter, stronger, or cheaper. This summary outlines a few solutions used historically, in context of the newer solutions.
The primary areas of interest is the motive power, the common power source is generally electrical. Compressed gas has been used [3,4] but the limitations created by the difficulty of recharging precluded their application. An alternative that avoids this uses, hydraulic power charged by an electric compressor [5].
Another next choice is the number of motors. If a flexible drive is used conformal grip results from fewer motors, the Karlsruhe and Sven hands [5,6] use a single motor. Variations with more motors include the Belgrade [7] and the Southampton Hands [8]. Brushless motors have the potential to be more powerful or smaller. The Boston Elbow used one since 1993, more recently Otto Bock too uses this solution.

Results
One under investigated aspect of these designs is how is how to control the device. While direct nerve interface is seen as a solution, it is still not routinely practical. The experience from Functional Neural Stimulation is that many potential users do tolerate surgical interventions irrespective of the advantages generated. One practical solution is to leave the detailed control to the hand system itself [8], on board controller adjusting the grip to react to the circumstance.
The current generation of hands that are progressing into the field are represented by the papers presented in this symposium. The TouchBionics hand has five separate motors, two joint fingers and a semi-conformal grip by virtue of its stall detection on each finger. The Otto Bock Michelangelo, uses a single motor and

rigid fingers to apply grips, with a separate linkage to the thumb to allow both tips and lateral opposition. The DEKA hand uses a three and one equaliser split and a conformal grip, and they have chosen a verity of input solutions to instruct the arm. Finally, the Karlsruhe hand has greater novelty by being a different power source (electric pump to hydraulic drive) and a single actuation point with conformal gripping. The individual presentations from each of the teams will point up the virtues of each solution.

Conclusion

It is an exciting time to be in the field of upper limb prosthetics. The rise of innovation in motors, batteries and electronics mean that ideas that have been in tentative models of the past are now being incorporated into designs of multi-articulation/multifunction hands that can be used routinely in the field. The hands presented at this symposium represent the cutting edge of this work. It is now we can genuinely begin to establish what are the functional trade offs between the number of motors against the cost of weight, speed or price.

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Symposium: Innovations in Multifunction Prosthetic Hand Systems
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3519-715]

New Developments on the i-LIMB System

Author
Gill, Hugh (Livingston UK)
Touch Bionics

Introduction

The i-LIMB Hand has been fit to over 1000 patients since its market release in the summer of 2007. Addressing new areas such as control strategies, coverings, durability and socket mounting this presentation paper will share the detail of the Touch Bionics development team's work both current and future.

Methods

Cosmesis is the flexible skin covering that covers the i-LIMB Hand and ProDigits. By applying in-house expertise and new production techniques Touch Bionics has achieved major breakthroughs in the aesthetic appearance and performance of its prosthetic products. Feedback from early patient studies identified that software adjustments can allow patients to perform simple tasks and improve functionality. An example of this is thumb parking, instructing the thumb to close down against the side of the hand to allow a jacket to be out on. The presentation paper will address current 2-site control options available to patients and Bluetooth software interfaces for the professional. The modular construction of the i-LIMB Hand means that each individually powered finger can be mounted to the hand chassis – however constructional enhancements have developed robustness and the details of the construction and materials approach will be discussed.

Results

Data on the various product release versions will be shared in detail.

Conclusion

The i-LIMB Hand has quickly moved into the position of being an accepted mainstream device for upper limb amputees. The developments in the i-LIMB System will demonstrate how improvements will further consolidate this position.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg52184/cg54363

Symposium: Innovations in Multifunction Prosthetic Hand Systems
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3520-738]

Advanced Functionality of the New Axon-Bus® Prostheses System: the Michelangelo Hand

Author
van Vliet, Hans-Willem (Wien AT) | Dr. MSc
Otto Bock Healthcare Products GmbH

Abstract
Future arm prostheses will enable simultaneous control of multi degrees of freedom. For this a new technology platform is needed. The Axon-Bus® prostheses system is such a platform. Its first component, the Michelangelo Hand, comes to the market. Its new functions and benefits are discussed.

Introduction
Upper extremity prosthetics is characterised by diversity. The user's possibilities to control myo-electric prostheses differ extremely from one person to another. The clear cause of this is the anomalous anatomy of the stump. In contrast to this variety is the fixed expectation of the user. Using the prosthesis must provide clear functional benefits, its performance must be reliable and its appearance esthetical. Main requirements for advanced prostheses therefore are high levels of functionality, quality and design.
These requirements also apply to the other "customers". The CPO requires functionality in terms of flexibility to obtain the optimum fitting result per individual. The health insurance requires proof of beneficial functioning and quality to ensure long maintenance free use. The scientific community require flexible bus systems and components with multiple active axes to develop future control schemes, e.g. DARPA (1), TMR (2).

Methods
Focussing on the user, optimal fulfilment of the main requirements requires understanding of the intended use. The majority of users is uni-lateral. Aside form the esthetical appearance the main use of the prosthesis lies in support of the sound side: an apple is fixated with the prosthesis to be cut by the sound hand, a cell-phone is held with the prosthesis, the buttons pressed with the sound fingers. The main functional requirement therefore is to grasp, hold and release objects. The prosthesis must make sure, that as large a range of objects a possible can be held in an optimal manner. Hereby the following aspects need design matching: grip geometry, grip force, and –control, opening width, positioning, compliance, surface structure and –finish, reliability, speed and accuracy. The Michelangelo hand addresses all these aspects, aimed at optimal performance in a vast amount of activities of daily living (ADL).

Results
With Michelangelo several measures have been taken to improve grip geometry significantly:
- the myo-controlled thumb-positioning enables an additional lateral grip
- active movement of all fingers increases the surface area for force transmission
- both elastic and mechanically coupled compliance of the fingers help to ensure form closure with objects of various geometry and structure
- the far more anatomical skeleton structure of the prosthesis eases mimicking grasps of the sound side
- compliant materials in the fingertips give a more natural feel and helps fixation

Grip force and –control are superior to the Otto Bock SensorHandSpeed. A single finger withstands a force of 300N.

With the active thumb, the hand can be opened to an almost flat position, allowing to carry objects bigger than the hand (e.g. plates) and to grasp objects with diameter of 90mm.
Positioning is improved with a wrist allowing 360° rotation, 75° flexion and 45° extension. Both passive and active wrists will become available. The active prosthesis will have 4 myo-controlled axes.
Wrist flexion can be switched between locked (15°steps) and compliant, giving a “natural” feel of the prosthesis and benefits for many ADL’s, e.g. for driving bicycle (stated by a user in initial case studies).
Michelangelo is approx. 10% faster than the SensorHand and is durability tested with 500.000 grips with varying forces (50-100%) of objects with varying structures and dimensions.

Conclusion

The new Michelangelo Hand combines an aesthetic design, with advanced functionality for, firstly, the user: new kinematics, materials and functions as the active lateral grip and wrist flexion enable better grasping and fixating a larger variety of objects in more positions, improving the main function of supporting the sound hand. Secondly, the CPO can easily add future components due to the 3-wire bus system – various combinations of new components allow fitting of individual stump lengths and -conditions. Thirdly, the health insurer benefits from the high quality and durability. The scientific community, finally, can use a commercially available multi-DOF lower arm prosthesis with 4 myo-controllable axes for developing new control schemes, like pattern recognition. The Axon®-Bus prostheses system is the new required technology platform that allows the short term commercial development of advanced prosthetic arms that enable simultaneous control of 6 and more active axes.

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Symposium: Innovations in Multifunction Prosthetic Hand Systems
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3521-861]

Introducing a New Multiarticulating Myoelectric Hand System

Author
Schulz, Stefan (Weingarten DE) | Dr.
VINCENT Systems Medical Technics GmbH

Abstract
A new technology are presented; the motor driven modular VINCENT© Hand system, with allows the design of nearly anatomical partial hand prostheses and one of the worlds smallest and lightest multifunction hands within 6 motors. Both applications are discussed with his features and benefits.

Introduction
The prosthetic fitting after partial hand amputations turns out to be very demanding in the daily practice. Operations of hand surgery preserving or reconstructing the limb require a structured procedure adapted to the needs of the patient, which may differ according to the individual case. In the centre of attention of the prosthetic management there are essential needs for a reconstruction of the physical shape as well as the functions of the hand (1). The big challenges are prosthetic solutions for amputations at or proximal to the mid-metacarpal joint level, because there´s no functional component available for amputation levels at the metacarpalphalangeal joint that provided both a functional and aesthetic return although a majority of partial-hand amputees is presented at this level (2).

Methods
The focus of the developement was to design a prosthesis, which is able to realize partial hand treatments as well as fitting patients with anatomically orientated multifunctional hands. At the same time the goal was to develop a functional prosthesis with an aesthetic appearance. The special design was developed with the background of multiarticulating fingers, which allows a gripping function close to the nature. This method permits an adaptive grasp, which is supported by soft fingertips. In addition, a method of modular construction was implemented. The single fingers can be assembled as partial hand prosthesis. The clinical partners are AAD/Texas in the United States and Pohlig in Germany, who are representing a board of specialized upper extremity specialists.

Results
The Vincent© Systems GmbH - Medical Technics Group from Germany, has developed the Vincent Hand System components. It provides electrically driven single fingers, as well as the components to control them, including sensors, power supply, and PC-connection. In connection with an additional metacarpus system the single fingers can be assembled to a complete, lightweight hand. Despite the fact that the hand is very small it has 6 motors, one in each finger and two in the thumb.
The hand is built of a high strength aluminium. Theoretically the 6 motors offer 64 different grasps. The controller chooses 10 final positions suitable for the user, which can be controlled proportionally into arbitrary intermediate positions. Wireless PC-Interface and force feedback are additional options. Two different finger sizes and flexible fingertips available in different length permit an adaptation to a large variety of hand shapes.

Conclusion
The new VINCENT© System combines advanced functionality with aesthetic in a very compact design with less weight and maximum torque for that size. The single fingers, built of high strength aluminium,

can be assembled as partial hand prosthesis. In connection with an additional metacarpus system the single fingers can be assembled to a complete, lightweight hand. The controller chooses 10 final positions suitable for the user, which can be controlled proportionally into arbitrary intermediate positions.

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Symposium: Innovations in Multifunction Prosthetic Hand Systems
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3522-713]

VA Studies to Optimize the DEKA Arm

Author
Resnik, Linda (Providence, RI US) | Dr.
Providence VA Medical Center/Brown University

Introduction
The U.S. Department of Veterans Administration (VA) has been conducting clinical optimization studies of the Generation 2 DEKA arm for the past year.

Results
The DEKA system features a control system which allows multiple functions to be assigned to any given input. The user can select from “standby, “arm” and “hand” mode with different functions assigned to the same inputs in each case. The hand has 6 pre-programmed grip patterns and a sensor in the thumb that provides tactile feedback. Each subject has an individualized control scheme which may include a combination of foot control, switches, EMG and air bladders. User control options include a single input to allow cycling through grips
unidirectionally, using 2 inputs for bidirectional grip cycling or several inputs for direct grip selection.

Conclusion
Subjects in the VA study have used the DEKA hand to perform many activities that they could not do with their
conventional prostheses such as cutting with scissors, turning a key to unlock a door, using a tweezers and operating a power drill.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg52184/cg54444

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3830-None]

Future Technology

Session Chair
van der Linde, Harmen (Nijmegen NL) | PhD
University Hospital Nijmegen, the Netherlands - Rehabilitation Department

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg559714

Symposium: Future Technology
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3831-928]

Interfacing with Biological Structures – The Next Level of Rehabilitation

Author
Dietl, Hans (Wien AT) | Dipl.-Ing. Dr.
Otto Bock Healthcare Products GmbH

Introduction

In recent years major research and development activities have led to a number of new approaches in rehabilitation, with many research groups demonstrating initial results based on new devices which take advantage of the latest available technologies. Most of those novel devices are beautiful masterpieces of engineering. However, because the success of a device for Rehabilitation is directly related to its usability and efficacy, successful rehabilitation
occurs only when a close integration of the functions of the device with the body is achieved. The critical factor for success lies in the interfacing between the human body and the device. Rehabilitation technology for future devices therefore rightly focuses on this area.

Results

The typical interface between a prosthetic device and the human body is the prosthetic socket. Several well known concepts are available and every few years shapes seems to be re-invented. In the end the quality of this interface is the key to the functionality of the prosthetic system as a whole. Although key principles remain constant, new functions of a prosthetic system (e.g. the dynamic forces of a fast moving upper extremity prosthesis or a transfemural prosthesis that supports stair ascending) lead to new requirements for socket design. Adaptive socket concepts attempt to balance the requirements in respect of load transfer and comfort for the user, while simultaneously addressing the problem of the volume change of the residual limb during use. An alternative to prosthetic sockets is the approach of osseointegrated transcutaneous attachments. Over the last decade this concept has been applied on transfemural amputation levels, as well as on all amputation levels up to transhumeral of the upper extremities. In general it has been shown that the quality of rehabilitation after limb loss can be improved by this technique, and the challenges of the anchoring of the implant seem to have been sufficiently addressed. Today's research focuses on the areas of overload protection and an improved treatment of the percutaneous passage. The frequent occurrence of infection episodes has prevented this concept from becoming a standard procedure of treatment after limb loss.

Conclusion

Key research groups work on improved sealing by bioactive surfaces, which should lead to ingrowth of tissue or infection barriers. Another alternative concept is the support of an artificial limb by the SISA (Subcutaneous Implantable Socket Attachment) implant, which bypasses the problem of a transcutaneous passage. The interface between the residual limb and the prosthetic device is achieved by a subcutaneous implant, which provides a geometric shape optimized for load transfer to a matching minimal socket. Because tissue loading (a general problem of sockets) still exists, the interface must be designed for minimal pressure on the tissue. Adaptive socket designs will play an important role in this concept. Electronic interfaces must transfer information about the status of the device or the user's intent. The control of rehabilitation devices is based on the acquisition of biosignals, which represent either the status of a task which is performed by the subject or the planning of a task.

References

A typical biosignal representing status is the knee angle or the loading of the lower leg, while a typical signal for task planning is an EMG signal, which is used for the control of a prosthetic arm. Advanced systems for rehabilitation require various sensors, which enable signal acquisition for interfacing. Lower extremity prostheses usually interface to biosignals by indirect methods. A good example is the new 3B1 prosthetic knee, where a multi-axial force sensor reads the forces in the ankle area, a moment sensor monitors the knee moment, the absolute angle of the lower leg in space and the knee angle are detected, as are the accelerations. The acquired signals allow a clear interpretation of the status of movement or the plan for future movement. For the control of upper extremity prostheses the EMG is most commonly used. Devices with high functionality need to acquire the information of many muscles of the residual limb, and although the use of surface electrodes limits the application only to muscles c

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Symposium: Future Technology
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3832-None]

The Purpose and The Intent (What Bio Mechanical Function to Replace and Why)

Author
Janusson, Hilmar Bragi (Son en Breugel NL) | Dr.
Össur Europe BV

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg559714/cg560423

Symposium: Future Technology
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Miscellaneous

Congress Lecture [4098-926]

Go ahead: Advanced Control for Lower Extremity Prosthetics

Author
Kampas, Philipp (None AT) | Dipl.-Ing.
Otto Bock Healthcare Products GmbH - R&D

Abstract
Examples of improving gait and support in activities of daily living in passive knees by using advanced sensorics and control schemes are discussed.

Introduction
Walking with knee flexion during stance phase is the natural way of level walking. The knee flexion is a means of shock absorption and reduces modulation of the center of gravity. While standing a locked knee it is favoured to allow even loading of both legs.

Methods
An instrumented prosthesis is used to give inputs to a state machine controlling the knee resistance. The state machine offers discrete switching of states and continuous transitions within states. The state machine controls the knees resistance up to blocking the knee flexion and extension to produce active alignment changes during the gait cycle, to limit stance flexion for level walking and to lock the knee during standing. Continuous control surfaces using advanced sensors as input allow smooth transitions between activities like level walking and walking down stairs and ramps as well as standing on both legs.

Results
Several leg prostheses offer walking with stance flexion. However they either in case of a limited stance flexion do not allow to walk down stairs and ramps with stance flexion resistance or in case of unlimited stance flexion the control of the flexion is - even when supported by stance flexion resistance - finally up to the wearers hip musculature. As the moments produced depend on the roll-over of the foot and are therefore influenced by any irregularity of the ground walking with unlimited stance flexion causes cognitive demand on the wearer. A microprocessor controlled prosthesis has been developed that incorporates active alignment changes during the gait cycle and electronically controls stance flexion. This facilitates initiation of stance flexion and limits the amount of stance flexion. It allows a smooth transition from level walking with limited stance flexion to walking down stairs and ramps with unlimited stance flexion. Microprocessor knees do usually not offer a locked mode during standing and if so, this mode has to be engaged by some deliberate activity. Due to advanced sensors it is possible to achieve an intuitive locking of the knee during standing that does not have to be activated or deactivated by any deliberate activity. The deactivation is again intuitive and smooth due to continuous control surfaces using the advanced sensors as inputs.

Conclusion
Examples of improving gait and support in activities of daily living in passive knees by using advanced sensorics and control schemes have been shown. Active alignment changes during the gait cycle make the initiation of stance flexion easier. It is possible to control the amount of stance flexion electronically without compromising on walking down stairs and ramps. A two dimensional continuous control surface allows smooth transition from level walking to walking down stairs and ramps. An intuitive lock of the knee for standing can be achieved by advanced sensors. Unlocking is smooth due to continuous control

surfaces using the advanced sensor inputs. This offers a convenient possibility for standing on both legs and loading them evenly.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3157-None]

Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics

Session Chair
Postema, Klaas (Groningen NL) | Prof. Dr.
University Medical Center Groningen - Rehabilitation

Session Chair
Wolf, Sebastian (Heidelberg DE) | Dr.rer.nat.
Orthopädische Universitätsklinik Heidelberg

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg38940

Symposium: Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3160-769]

Lateral Balance during Walking and Standing on a Narrow Ridge

Author
Postema, Klaas (Groningen NL) | Prof. Dr.
University Medical Center Groningen - Rehabilitation

Coauthors
Carolin Curtze, Bert Otten, At Hof

Introduction
Many balance measurements are performed with the subject standing quietly. Standing quietly is not a challenging task and is also not a task in which many falls occur. A more important situation exists during walking. We studied lateral balance of amputees during walking, to get insight in the adaptation mechanisms to the prostheses. During standing quietly balance is mostly provided by ankle strategy. However, counter-rotation movements of the arms help to prevent a threatening fall. Therefore, we developed a simple and cheap test that challenges the subjects in a way that not only the ankle strategy is used, but also the counter-rotation movements of the arms. The test should discriminate between high and low balance performers.

Methods
Walking on the treadmill
Six experienced above-knee amputee walkers and six matched controls, walked on an instrumented treadmill, at three speeds for periods of two minutes. The treadmill walking surface was divided into a left and right half, each with four force transducers, to measure the vertical ground reactions force.
The Center of Pressure (CoP) was calculated from the distribution of the forces. The projection of the Center of Mass (CoM) was computed from the CoP data. During standing (no motion of the CoM) there is stability as long as the CoM falls within the base of support, often defined as the area between the feet. During walking the CoM moves from right to left and vv. The speed of this movement influences the ‘effective’ position of the CoM. This position is the XCoM. The XCoM can be computed from the CoM and the speed of the CoM.
Standing on a narrow ridge Ridges of 25 mm height and different width (100, 80, 60, 40, 20, 10 and 4 mm) were made. The time, the subject was able to keep balanc

Results
Walking on the treadmill
The amputees walk with a bigger step width. Placing one foot (prosthetic side) more laterally, may explain the temporal asymmetry in single leg amputees. In the control subjects the CoM makes a sinusoidal movement, which stays, during one leg stands phase,clearly medial to the CoP. However, every step the CoP is placed only a small distance lateral to the current XCoM position. In the amputees the distance CoP-XCoM, for the prosthetic leg, is greater than in the sound leg and in the controls. In the controls and the healthy side of the amputees the CoP pattern shows variability from step to step. This variability is caused by the ankle
strategy for balance. When the XCoM is coming a little bit close to the CoP, with the ankle strategy the subject can compensate for this, as a feedback control mechanism. The amputees cannot use an ankle

strategy. Indeed the pattern of the CoP shows a very stereotypical pattern. They only can use a forward control strategy, by placing the feet more laterally, which is clearly the case.
Standing on a narrow ridge
62% of the young people showed a maximal score. Thus, they were able to stand for minimally 20 seconds on the ridge of 4mm. All young participants had at least one attempt on the 20 mm ridge or narrower. 20% of the elderly were not able to maintain balance for more than 20 seconds on one leg on the floor. Their maximal score was # 1. Only 10% of the elderly reached the ridge of 10mm, meaning a maximal score between 6 and 7 points. 30% of the

Conclusion
Walking on the treadmill
The amputees walk with a wider step width. Because they lack the feedback ankle strategy for fine tuning of the balance, they have to use a feed forward system. This is ‘stepping out’, in other words, placing the foot a bit more lateral. This creates a safe pattern in which the XCoM stays within the ranges of the CoP. This stepping out causes an asymmetry of the temporal factors. So, this asymmetry seems to be a useful adaptation to the lack of the ankle strategy.
Standing on a narrow ridge
By gradually reducing the width of the base of support, all subjects come to a point that they need more than the ankle strategy for keeping balance. They use the counter-rotation arm movements.
This also means that all subjects are challenged during this balance task. For the high performers there is a relative ceiling effect. This effect might not exist if these participants are asked to stand on the 4mm ridge as long as they can. However, we did not do so, because our interest is not in th

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Symposium: Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3161-708]

Influence of Electronic Knee Joints on Safety and Dynamic of Amputees - a Clinical-Biomechanical Study

Author
Wühr, Juliane (Münster DE) | Dr. Dipl. Phys.
Klinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Coauthors
L. Linkemeyer, B. Drerup, HH. Wetz

Introduction
The advent of electronic knee prostheses, i.e. the computer control of stance and swing phase, has opened up a new quality in the provision of above-knee amputees. All in all, a more secure, natural and efficient gait is expected. The technology of the two available systems - C-Leg (Otto Bock) and Rheo Knee (Össur) - differs in some details. Therefore, from the biomechanical and clinical viewpoint a comparison is important in order to find out, whether differences between the two systems can be detected and how they affect the provision of the patient. The purpose of the study is to compare and evaluate the electronic knees in terms of functional improvement regarding to safety and dynamic. The second aim of the study is to critically review the indications for the electronic knees and to determine if these indications are appropriate.

Methods
So far 79 trans-femoral amputees with mobility level 1-4 took part in the study comparing electronic and mechanical knees. Neither of these patients was using regularly one of the two tested microprocessor joints. As a prerequisite, optimum fitting of the socket had to be provided. This was supervised by a certified prosthetist-orthotist using the L.A.S.A.R. Posture (Otto Bock). After the examination by an orthopaedic surgeon biomechanical measurements were taken using an optoelectronic gait analysis system (Vicon V460) in combination with 2 Kistler force plates and the GAITRite System (SMS Technologies). Clinical results were achieved by an indoor and outdoor parcours, where the patient e.g. had to walk ramps, descend stairs and walk on different grounds. At last a questionnaire is filled out, asking the patients for their self perception of the electronic knee joints. Based on these data, the functional improvement is assessed.

Results
In a previous study we found that there are 4 criteria required to evaluate the functional improvement. Two criteria refer to the aspect of safety and two criteria refer to the aspect of dynamic. Electronic knee-joints are recommended for amputees who fulfil at least one aspects of safety and one aspect of dynamics.
We found that over 80% of our subjects benefit from an electronic knee joint. No correlation was found alone for the mobility level, time since amputation or reason for amputation. Our results indicate that patients with short stumps prefer the Rheo Knee because it requires less forefoot force to activate the swing phase. Elderly subjects and amputees with multiple disabilities prefer the C-Leg as they feel more secure. Sometimes athletic amputees dislike the C-Leg because they feel that it interferes with their intended movement. The Rheo Knee is recommended for mobility levels 2 and 3 whereas the recommendations for C-Leg include mobility levels 3 and 4. We found that more patients with mobility level 2 have a benefit from the C-Leg as compared to the Rheo Knee while patients with mobility level 4 often prefer the Rheo Knee. So the mobility level alone can not be used as a predictor for a successful provision with an electronic knee. Instead of the mobility level other criteria like age, multiple disabilities but also coordinative and cognitive

abilities including different combinations of them seem relevant for the optimal using of a prosthetic knee joint. Therefore a testing procedure and/or a

Conclusion
We found that the C-Leg offers the patient a high degree of safety with sufficient dynamics whereas the Rheo knee offers the patient a high degree of dynamics with sufficient safety.

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Symposium: Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3162-824]

Assessment of Temporal and Loading Symmetries of Transfemoral and Transtibial Amputees during Walking in Daily-living Conditions

Author
Cutti, Andrea (Vigorso di Budrio IT) | Dr.
INAIL Centro Protesi - Motion Analysis Laboratory

Abstract
The symmetry of the stance time and of the vertical force peak at loading response was assessed on transfemoral and transtibial amputees by means of baropodometric insoles. Significant differences between groups were only found for the stance time symmetry.

Introduction
Lower limb amputees show gait temporal and loading asymmetries [1,2] which are considered the main causes for the development of comorbidities such as knee osteoarthritis at the sound side [3]. Despite the relevance of these parameters, the literature lacks of studies on broad populations and on amputees wearing electronically-controlled knees. The aim of this study was to assess these parameters in a daily-living environment on three consistent
populations of lower limb, traumatic amputees:
-transfemoral amputees wearing a C-Leg (Ottobock, D) (AKAC);
-transfemoral amputees wearing a mechanical polycentric knee (AKAM);
-transtibial amputees (BKA).
A population of able-bodied subjects was also assessed as control group (CNT).
More specifically, the indexes assessed were:
STS) Stance time symmetry: stance time(sound)/stance time(affected)
P1S) Symmetry of the first vertical force (VF) peak at loading response: VFpeak(sound)/VFpeak(affected).
SR) VF showing a sound three-rockers foot progression.

Methods
12 AKAM (age 46±10), 26 AKAC (42±12), 25 BKA (47±14) and 10 CNT (27±2) participated in the study. All amputees completed the rehabilitation training; wore a dynamic prosthetic foot; walked without aids. Each subject walked at a self-selected speed along a straight corridor of 80 meters, wearing 2 PedarX (Novel. D) baropodometric insoles inside the shoes. The VF data were processed as in [4] in order to extract the stance phases.
Within each population, only the subjects showing a VF peak at both loading response and terminal stance were considered for the P1S calculations (group S12). For each subject, for each couple of consecutive strides, we computed STS and P1S; the median values of these indexes were then aggregated and compared by population.

Results
STS) As showed in figure 1, all populations were statistically different, with AKAM being the most asymmetric and CNT being almost perfectly symmetric. No differences were found between the STS of the populations and the respective S12 sub-groups. V1S) No statistical significant differences were

found between populations' median values (kruskal wallis test); tested for the homogeneity of the variance (Levene test), all amputees populations were found
homogeneous and significantly different from the CNT. Conversely to previous findings [1-5], the amputees assessed in this study did not show an univocal trend to load more their sound side. No correlation was found between STS and P1S globally and at a population level.
SR) For each population, the percentages of subjects included in the group S12 were: AKAM 58.3%, AKAC 42.3%, BKA 88.0% CNT 100%.

Conclusion

Results show that all the amputees present an asymmetric gait and, in many cases, a compromised foot rocker-sequence, even when fitted with high-end components.
The results for STS are similar to previous findings, appearing correlated with the mobility level.
Conversely, the P1S results did not show the same trend as STS as reported in previous studies; in particular, the amputees, despite showing a median P1S value similar to the CNT (due to the spread of data around the optimal symmetry value), presented a similar, common variance significantly higher than the CNT. These findings suggest that, accordingly to [5,6], a perfect temporal symmetry in not sufficient to equilibrate the impulsive loads between the sound and the affected sides; considering the role that such impulsive, repetitive forces have in the development of joint osteoarthritis [7], it appears that the rehabilitation process should aim for more subject-specific goals, supported by quantitative data.

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Image: Cutti Raggi - symposium_824.jpg (see online)

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Symposium: Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3163-798]

Effects of Prosthetic Foot Stiffness on Swing Duration Variability in Amputee Gait

Author
Major, Matthew (Salford GB)
University of Salford - Centre for Rehabilitation and Human Performance Research

Coauthors
Twiste M, Kenney L, and Howard D

Abstract
Effects of prosthetic foot stiffness on swing duration variability (SDV) are reported. Subjects walked on an adjustable slope treadmill using a purpose-built prosthetic foot that allowed for stiffness modulation. Low dorsiflexion stiffness generally produced low SDV and was perceived as most stable.

Introduction
Previous work showed that lower limb amputees are at an increased risk of falling as compared to age-matched healthy controls [1] and have reduced confidence in their balance [2], both contributing to their restricted mobility, activity and participation. It has been shown that variability in temporal-spatial gait parameters is correlated with instability and risk of falling in a number of different populations [3]. For example, trans-tibial amputee fallers exhibit greater swing duration variability of the prosthetic limb than non-fallers [4]. However, although it is reasonable to assume that gait stability in amputees is affected by the mechanical properties of the prosthesis, the relationship between stability measures and prosthesis properties remains ill-defined. It was this study's objective to investigate the influence of trans-tibial prosthesis stiffness properties on the swing duration variability in amputee gait.

Methods
A purpose-built prosthesis (Figure 1) allowed for independent control of dorsiflexion and plantar flexion stiffness properties. Prosthetic limb swing duration variability was investigated for four different foot configurations: low/high dorsiflexion stiffness (DF) and low/high plantar flexion (PF) stiffness (2x2 factorial design). Subjects walked at self-selected and fast (150% of self-selected) speeds on a level surface, 5% grade incline and 5% grade decline. Kinematics were measured using a reflective marker-based camera system in order to detect single support and define swing duration. The coefficient of variation (CV) defined swing duration variability: a lower CV reflecting greater gait stability [3, 4]. Subjects were also asked to give a subjective stability score for each test condition. Effects of DF and PF stiffness on swing duration variability were statistically analysed with the Friedman test for non-parametric repeated measures ANOVA (significance set at $p<=0.05$).

Results
Despite noticeable differences in the average CV of prosthetic swing duration between each foot setup for all walking conditions, statistically significant differences were only found in the decline walking condition (increased variability for high DF with low PF versus the two foot setups with low DF). Low DF stiffness produced generally lower values of prosthetic swing duration variability for the majority of walking conditions. A notable exception is fast walking, in which high DF and high PF stiffness produced lower prosthetic swing duration CV, indicating that a stiffer foot might be more beneficial for stability with

increased speed and prosthetic limb loading. The CV was also calculated for additional temporal-spatial gait parameters (e.g., step length, width, and time), of which noticeable differences were observed between each foot setup for all walking conditions. Low PF together with low DF stiffness tended to produce the most symmetric gait (quantified by the ratio of swing duration time of the sound limb to prosthetic limb) for all walking conditions. Irrespective of foot setup, fast walking produced the most symmetric gait. In fact, the symmetry ratio for fast walking remained at an average of 0.92 across all foot setups. For the majority of walking conditions, subjects rated foot setups with low DF stiffness as the most stable, which also generally produced lower values of prosthetic swing duration CV.

Conclusion

This paper discusses a new approach to investigating the relationship between the mechanical properties of a trans-tibial prosthesis and gait parameters associated with stability. The novelty of this study is that the methodology provides for a systematic exploration which is decoupled from the constraints imposed by the use of commercial products. Although generally not statistically significant, differences in prosthetic swing duration CV were found between foot setups for all walking conditions. A larger study is required to further explore this finding. Subjects rated foot setups with low DF stiffness as the most stable for all walking conditions, and high DF as the least stable; results which are generally consistent with measures of prosthetic swing duration CV. A limitation of this study is that the purpose-built foot isolated changes of mechanical behaviour to the sagittal plane only; mechanical stiffness modulation in the coronal or transverse plane was not investigated.

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Symposium: Gait Analysis for Determination of Balance, Stability and Safety in Prosthetics
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3164-802]

Safety of Transtibial Amputees When Walking on Stairs

Author
Wolf, Sebastian (Heidelberg DE) | Dr.rer.nat.
Orthopädische Universitätsklinik Heidelberg

Coauthors
Laetitia FRADET, Merkur ALIMUSAJ, Frank BRAATZ

Abstract
According to 3D gait analysis results, TTAs show reduced values in safety indicators in stair descent which possibly explains their increased risk of falling. The ankle adaptation feature by a new microprocessor controlled ankle seems to improve safety in this condition.

Introduction
Transtibial amputees (TTAs) suffer from the partial loss of their extremity in different aspects: muscle strength, proprioception and balance as well as joint mobility. These factors increase their risk of falling compared to age-matched, able-bodied individuals [1]. When walking on stairs the demand on muscle strength and balance is higher compared to level walking and thereby emphasizes motor deficits [2]. It is well-known that populations being prone to risk of falling modify their gait in order to reduce the risk. However, the mechanisms inducing falls in this patient group when walking on stairs are not yet identified. The presented study aims to test a variety of parameters associated with balance and safety during stair walking in TTAs. Further, the influence of a stair adaptation mode of a new microprocessor controlled ankle (Proprio®-Foot, Össur) on these parameters is evaluated.

Methods
Thirteen patients were provided with the new prosthetic ankle (Proprio®-Foot, Össur). After at least 14 days of adaptation patients returned to undergo an instrumented 3D gait analysis (12 camera system, Vicon, Oxford) while walking on a stair case which was equipped with two force plates (Kistler, Winterthur). TTAs walked with the new prosthetic ankle in two conditions: In 4° dorsiflexion according to the stair adaptation mode and in neutral alignment. 12 healthy subjects followed the same protocol to serve as control.
Five parameters were determined: 1) foot positioning and 2) distance of the centre of pressure (COP) relative to the stair edge at initial contact (IC), 3) displacement of the centre of mass (COM) relative to the COP, further 4) toe clearance to the stair edge in swing and 5) coefficient of friction (CF) in loading response obtained by dividing the shear forces by the vertical force [3]. Unpaired T-tests were used for comparisons between groups and paired T-tests were used for comparisons be

Results
A summary of data comparing the data of controls with the prosthetic and the sound side of the patients both with and without the stair adaptation mode during stair ascent is listed in Table 1. TTAs place both their prosthesis and their sound foot significantly deeper into the stair case (~5cm) with some but not significant effect of the ankle adaptation towards normal foot positioning. Also the COP beneath the prosthetic foot is located deeper in the stair case compared to normal stair walking, an effect which is significantly diminished with the adaptation. The COM-COP distance is significantly larger in the involved side of TTAs compared to normal with again a significant reduction due to the ankle adaptation. Toe clearance and CF in loading

response appear close to normal and with a significant reduction in the CF induced by the prosthetic ankle adaptation.
During stair descent, the prosthetic foot is placed further beyond the stair edge than normal but the COP at IC is located deeper in the stair case, COM-COP distance is significantly smaller than normal whereas the CF in loading response typically is significantly larger in the involved side compared to normal. None of the five parameters is altered significantly by the ankle adaptation in stair descent.

Conclusion
During stair ascent, TTAs use a gait strategy such that foot tip and COP are located deeper in the stair case and COM-COP displacement is larger compared to normal indicating a safer gait. Reduced CFs corroborate this finding. Toe clearance does not appear to be critical. During stair descent, the lack of ankle motion in the prosthetic foot forces the patients to roll over the stair edge and thereby compromises the TTAs' safety as attested by a more forward positioning of the foot beyond the stair edge and the greater CF found for TTAs. Even though none of the five parameters is altered significantly by the ankle adaptation the foot positioning on the stair and the COP show the tendency towards increased safety. Stair ascend therefore does not appear critical in TTAs. It is mainly the challenge of stair descent where TTAs show reduced values in the safety indicators possibly explaining their increased risk of falling. The 4° ankle adaptation by the Proprio®-Foot seems to improve safety in stair down walking.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3673-None]

Orthotics - Spinal Deformities

Session Chair
Würsching, Andreas (Zagreb HR)
Kuca Zdravlja d. o. o. - Management

Session Chair
Chen, Chih-Kuang (Taoyuan TW) | MD
Chang Gung Memorial Hospital at Linkou - Department of Physical Medicine and Rehabilitation

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Session: Orthotics - Spinal Deformities
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2895-93]

Early Night-Time-Bracing – an Alternative in Idiopathic Adolescent Scoliosis (IAS) Management

Author
Selle, Andreas (Dresden DE)
Orthopädie- & Rehatechnik Dresden GmbH - Orthopädietechnik

Coauthors
Seifert J

Abstract
As a result of physical and psychological stress we often find very weak compliance for traditional Scoliosis-Full-Time-Bracing in comparison to Night-Time-Bracing. The investigation shows that Early Night-Time-Bracing (16-25° COBB) can effectively stop IAS progression and prevent Full-Time-Bracing.

Introduction
The application of a Full-Time-Brace is still the "Gold Standard" of conservative AIS therapy. However, the changeover from only physiotherapy to Full-Time-Bracing appears to be a far-reaching physical and psychological challenge for a child or a teenager [2,8] and so we often find very weak compliance for 23-hour treatments [8].
As a result of a recent compliance study we found significantly better compliance rates for Early Night-Time-Bracing (92%) in comparison to Full-Time-Bracing concepts (less than 60%). Most of our patients and parents (98%) stated that they would like to be early treated part-time at night at the state of moderate curvature instead of waiting and taking the risk of progression.
In the past we got encouraging short term results with Night-Time-Bracing of moderate curvatures [7]. So the aim of our investigation was to find out whether or not Early Night-Time-Bracing (16-25° COBB) can effectively stop IAS progression and prevent Full-Time-Bracing successfully.

Methods
Out of all of our AIS brace-patients since 2000 (671) we selected the Early Night-Time braced patients. Out of that group we excluded patients with further diseases (neuromuscular, tumour diseases, cicatricial scoliosis, spinal malformations, other growth disturbances), patients who moved, patients with very high reaching thorathic curves and all patients with follow-up's of less than 3 years. That left us with a small group of 20 patients with initial COBB angles of 16-25°, all treated in one institution with a Dresdner Night-Time-Brace (fig.1), without further treatment, with an average age of 11.6 years at the point of brace discontinuation and an average follow-up of 5 years (3.1 - 7.8).
Treatment was considered successful if there was improvement or at least 5° progression of primary curve and no progression (neither primary nor secondary curve) above absolute value of 25° COBB. We decided to treat patients with COBB-angles of more than 25° full time.

Results
We obtained primary correction of 87.8%. The primary in-brace-correction should not be overvalued because it is taken in lying position. Much more meaningful is "true correction" in upright, standing position without wearing the brace after a period of treatment. After an average of 5.2 years (3.1 - 7.8) we found true correction of 24.4% for primary curve and 12.2% for secondary curve.

All in all we obtained a success rate of 85% (improvement or constancy). The majority of the patients have ended treatment at Risser 4. Some patients haven't reached Risser 4 yet and are still going on to wear their braces.
We could suspend treatment in 4 cases before Risser 4 because of single-digit COBB-angles after an average of 1.9 years (1.1 – 3.4). We've been keeping these patients under control and have them still integrated in the group, but they could pause treatment because of perfect results.
We had to complete the treatment to Full-Time for 3 patients (15%) because after longer periods of Night-Time-Bracing their COBB-angles got worse and crossed the 25° COBB-mark. They nonetheless had comfortable Part-Time-Bracing times of an average of 4.6 years (2.3 – 6.6). Their progression could be stopped by Full-Time-Treatment. No one passed the 30° COBB-mark and no surgery was needed.

Conclusion
Early Night-Time-Bracing is a sufficient method to stop IAS progression and to avoid Full-Time-Bracing. It is possible to suspend treatment if scoliosis decreases significantly (low risk of overtreatment) and to change to Full-Time-Bracing if a curve progresses. Early Night-Time-Bracing is also beneficial for the 15% of patients who does progress later, because it enlarges the period of living without a brace at daytime.
93.8% of our patients feel their quality of life affected by a brace. 91.4% of full-time treated patients stated daytime as the most frustrating time. So Night-Time-Bracing should become an integral part of IAS therapy in between only physiotherapy and Full-Time-Bracing [7].
IAS patients with initial COBB-angles > 25° have not been included in the investigation. In literature we find worse results at higher COBB-angles [1,3,4] and comparable results only for single curves [5] and lower apexes [6]. We recommend treating patients with COBB-angles > 25° full-time [7,8].

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Image: fig. 1 Dresdner Night-Time-Brace_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg227991/cg33953

Session: Orthotics - Spinal Deformities
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2990-188]

A 24-Month Prospective Study to Monitor the Process of Progress in the Active Control of Torso Symmetry in AI-scoliosis during Brace and PT Treatment

Author
Matussek, Jan (Bad Abbach DE) | Dr.
Asklepios Klinikum Bad Abbach

Coauthors
Hofbauer R, Dullien S, Stemper S

Abstract
The systematic 3-dimensional mirroring of trunc asymmetery in conservative adolescent idiopathic scoliosis (AIS) treatment with modern custom-made derotation braces (Cheneau-type) in the case of defined thoracic curvatures –
A 24 month prospective study of surface optometry and radiological feature

Introduction
Due to widespread pessimism towards conservative brace treatment of idiopathic scoliosis (IS), there is a general call for better clinical evidence in the evaluation of treatment results. Especially, as surgical options are agressively promoted and indicated by keen surgeons and companies.
The options of conservative IS treatment as a highly interdisciplinary concept still suffer up to date of many poorly controllable factors that have immense impact on the outcome and treatment quality may vary considerably. Indication of IS treatment, the patient`s compliance, sophisticated TLSO design and the right physiotherapy are still far from being common sense. To avoid overblown expectations in the conservative IS treatment of patients and to protect adolescents of frustrating treatment periods, a realistic prognosis of the proposed treatment path has to be defined after 6 months.
The proposed brace treatment has to be highly transparent; used braces (Cheneau) must mirror truncal asymmetry.

Methods
22 female IS patients with defined curvatures (n:18 type King III and n:4 type King IV; LENKE A 3) , expected further sceletal growth of >2 years were braced with the latest active TLSO (Cheneau) for an average of 21 hrs. daily.All the adolescents complied with the SOSORT brace-wearing requirements (Negrini 2009). Initial standing a.p. and lateral spine x-rays as well as lateral bending views facilitated the classification into subtypes of spine deformities of which only patients of Lenke group A1 (N) and Lenke A3 (N) (Lenke 2001), comparable with King type III and IV (Smith 2008) and Rigo type A1 and A2 (Rigo 2008). Lenke A1 (N) patients show a structural thoracic main curve with a flexible lumbar curve (n:13w); Lenke A3 (N) show a main structural thoracic curve and a structural lumbar curve. Frontal Cobb angles initially averaged 36° (between 29° and 60°) for the main thoracic curve with peak vertebra Th 9 (+/- 2) (vertebra with highest rotation).

Results
Sagittal view Cobb angles for the same curve had a mean value of 25° (15° and 39°) and thus a reduction of thoracic kyphosis. The assessment of rotation of the vertebral body due to the method of

Nash/Moe rendered grades 1-3 at peak vertebra level. Patients with visible bony deformations in the X ray (vertebral wedging, segmentation/formation deformities) were excluded from this study. Computed optometric surface and spine X- ray studies were scheduled at t (start with brace therapy), t(6 months), t(12 months), t(18 months) and t(24 months). At t(6 months), the primary correction is evaluated with an standing in-brace spine film ap/lateral. If the frontal Cobb angle of the main thoracic curve does not respond with a minimum of 40% correction, the patient was excluded from the study. Landauer (2003) could show, that a lack of a reasonable primary in-brace correction leads to a very uncertain prognosis. The daily brace-wearing compliance in our survey averaged 18,6 hrs (16,2-23,6 hrs.). Braces underwent a process of maintainance and adjustment every 3 months and were usually adapted to skeletal growth every 8-12 months.

Conclusion

Once the primary 3 D-correction after 4 months of brace treatment and physiotherapy programmeval-ued more than 40% (n:18 LENKE A 1 and A3), these improvements could be main-tained or even improved during the next 20 months. The patient´s compliance could be improved through this net succes. On primary correction < 40% , we observed with the other 8 patients a signifi-cant loss of correction in spite of continued treatment.

Summary:

In well defined IS curvatures, the primary 3 D-correction in a modern TLSO after 4 months is believed to be a reliable prognostic parameter for the conservative treatment potential. The interdisciplinary orthoteam together with the patient`s family have thus a reliable tool at hand to decide weather to continue a succesful and optimistic treatment start or to quit a less favourable course of progress. The debated questions whether a treatment failure is attributed to a non- functional brace or missing patient´s compliance are thus not important.

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Image: MOT-Preis 2009 Diagramme_None.doc (see online)

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Session: Orthotics - Spinal Deformities
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3328-503]

Effectiveness of OMC Brace for Treatment of Idiopathic Scoliosis – Taiwan Experience

Author
Chen, Chih-Kuang (Taoyuan TW) | MD
Chang Gung Memorial Hospital at Linkou - Department of Physical Medicine and Rehabilitation

Coauthors
Tsai CH, Wong MK

Abstract
We investigate the effect of Osaka Medical College (OMC) brace on 95 patients with idiopathic scoliosis in Taiwan. After a year follow up, we found that initial diagnosis of idiopathic scoliosis at younger age symbolizes poorer prognosis. In addition, more alternatives for scoliosis is recommended.

Introduction
To investigate effectiveness of Osaka Medical College (OMC) type brace for treatment of idiopathic scoliosis in high humidity area as Taiwan.

Methods
A total of 95 patients from outpatient orthopedic or physical medicine and rehabilitation clinic in Chang Gung hospital were recruited. To investigate their age, gender, curve type, side of curve vertex, major curve level and change of Cobb's angle by retrospective chart review for following up.

Results
78% of the cases had decreased, unchanged or increased less than 5 degrees of Cobb's angle after one year follow-up. The younger age group of initial diagnosis as scoliosis had poor effect of correction than those being diagnosis in older age .There were significant different between failure and non-failure of outcome by OMC bracing in these two groups(P=0.028). However, there were still high drop-out rate of bracing due to high humidity result in discomfort with OMC brace. We had 26 cases lost follow-up within 1 year. We should provide more options of choice for different types of bracing to overcome the high drop out rate high due to high humid weather in Taiwan for better outcome in the management of scoliosis.

Conclusion
In our study, among 58 cases, 78% of the cases had decreased, unchanged, or increased less than 5# of Cobb's angle after 1 year follow-up. OMC brace is an effective spinal orthosis for the treatment of idiopathic scoliosis in Taiwan. There was significant difference of age of initial diagnosis between failure and non-failure group(p = 0.028). Initial diagnosis of idiopathic scoliosis at younger age symbolizes poorer prognosis.

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Session: Orthotics - Spinal Deformities
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3145-343]

Best Practice Standard of Brace in the Treatment of Scoliosis

Author
Weiss, Hans-Rudolf (Gensingen DE) | Dr. med.
Praxis Dr. med. Weiß - Orthopädie

Coauthors
Werkmann M

Abstract
Different bracing concepts are used today for the treatment of scoliosis. The use of the „Chêneau light“ brace and the Gensingen brace as described as the latest CAD CAM technology leads to correction effects above average when compared to the correction effects of other braces described earlier.

Introduction
Different bracing concepts are used today for the treatment of scoliosis. The plaster cast method worldwide seems to be the most practiced technique at the moment. CAD (Computer Aided Design) systems are on the market which allow brace adjustments without plaster. The latest development however, is the use of the ScoliOlogiCTM off the shelf system enabling the orthopaedic technician to construct a light brace for scoliosis correction from a variety of pattern specific shells to be connected to an anterior and a posterior upright. This „Chêneau light“ brace, developed according to the Chêneau principle, promises a reduced impediment of quality of life in the brace. However, material reduction should not result in reduced effectiveness. Therefore the primary correction effect in the „Chêneau light“ brace has been evaluated and compared with that of other braces used today. Similar correction effects have been achieved with the Gensingen brace lately.

Methods
The correction effects of the first 81 patients (main diagnosis Adolescent Idiopathic Scoliosis (AIS) [n = 64] or Early Onset Scoliosis (EOS) [n = 15]), treated according to the principle of the „Chêneau light“ brace were evaluated after an average treatment time of 6 weeks by a full-body X-ray made in the standing position whilst wearing the brace and compared with the last X-ray before bracing. The average curvature angle of the whole group was 35,6°, the average age was 12,9 years (SD 1,9), average Risser sign was 1,3 (SD 1,5), average Tanner rating 2,75 (SD 0,7).

Results
The Cobb angle in the whole group was reduced by an average of 16,4°, which corresponds to a correction effect of 51%. The differences were highly significant in the T-test ($T = 17,4$; $p < 0,001$). The best correction effects reported in literature so far are about 40% in two different studies. The correction effect was highest in lumbar and thoracolumbar curve pattern (62 %; n = 18). In thoracic scoliosis the correction effect was 36 % (n = 41) and in double major curve pattern 50 % (n = 22). The correction effect correlated slightly negative with age ($r = -0,24$; $p = 0,014$), negatively with the Risser stage ($-0,29$; $p = 0,0096$) and correlated negatively with the Cobb angle measured before treatment ($r = -0,43$; $p < 0,0001$).

Conclusion
The use of the „Chêneau light“ brace leads to correction effects above average when compared to the correction effects of other braces described in literature. The reduction of material seems to affect the

desired correction in a positive way. In curve patterns where the Chêneau light brace is not available the patients can be fitted with a new CAD / CAM brace with similar in-brace corrections, called the Gensingen brace.

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Session: Orthotics - Spinal Deformities
Wednesday 2010/05/12 | 15:00 - 16:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2770-10]

Fibrematerials in Corset Construction

Author
Würsching, Andreas (Zagreb HR)
Kuca Zdravlja d. o. o. - Management

Abstract
The presentation gives an overview of characteristics and special features of new materials. Examples are shown, possible combinations between diagnosis and design are discussed and the when and where for appropriate use are presented. Individual specific handling techniques are not discussed.

Introduction
Beside the classic PE, as of recently, new materials are available to be used in the construction of the corsets.

Methods
Thermoplast PE/ PP WITH GLASSFIBRE-REINFORCMENT presents the most economical change in constructing. Still using the basic characteristics of PP or PE by combining it with stripes of these glassfibre reinforced stripes the corset can become stronger and still remain flexible in all other areas. Especially the re-shapability by thermoforming / heat gun gives this material combination and its simple use the first place in our everyday activities.
Preimpregnated /Epoxid based fibres are not new to the market, still the possibilities of using them in trunk orthotics has still not been completely explored. Since the year 2000 we are using them to cover those cases when extreme thinness and weight reduction are a priority.
The duroplastic character of the finished corset has to be compensated with flexible elements to give the patient a supporting, but not locked-up feeling while wearing those constructions.

Results
TFC Impregmaterials with thermoplastic characteristics are the latest development achieved with materials which are based on a LPET matrix. After the preparation of the plaster-positive, according to blue-prints or standard elements the material is cut out of hard sheets, with heat gun warmed to flexibility, applied to the model. A play with thickness and fibre structure can create a complete unique construction which can be completely stiff, very flexible, of all the stages in between the two.

Conclusion
Focusing on compliance and everyday imperative to use the corset, in order to achieve therapeutical result we have to search for and implement techniques which improve the performance of corsets: to make them lighter, more aesthetic/invisible, more specific in function - all of which can be achieved with correct application of these modern material.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3759-None]

Diabetic Foot - Current Concepts

Session Chair
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Session Chair
Bowker, John H. (Miami, FL US) | MD
Miller School of Medicine, University of Miami - Department of Orthopaedics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg392512

Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3760-805]

Evaluation of the Diabetic Foot

Author
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Abstract
The diabetic foot demands repetitive, complex decision making. A concise, complete, and time-saving evaluation of the diabetic foot is essential for correct and appropriate decision making. Based on pathophysiological concepts the lecture will give an algorhytmic overview of the non-invasive evaluation of the diabetic foot with special emphasis on biomechanical impairments.

References
Bowker John H., Pfeifer Michael A: Levin and ONeals The Diabetic Foot. Seventh Edition. Mosby 2008.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg392512/cg392873

Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3761-774]

Diabetic Foot Ulcers: Prevention and Management

Author
Bowker, John H. (Miami, FL US) | MD
Miller School of Medicine, University of Miami - Department of Orthopaedics

Coauthors
Prof. John H. Bowker

Abstract
The prevention of diabetic foot ulcers is based on the identification of patients with certain risk factors, the determination of their level of ulcer risk and the implementation of preventive measures, including focused education and provision of protective footwear.

Introduction
Competent management of a diabetic ulcer begins with determination of the remote and proximate causes of the ulcer, evidence of penetration to underlying bone, and the possible roles of infection, ischemia, smoking and chronic hyperglycemia on ulcer healing. Methods of ulcer off-loading/plantar weight redistribution include those which are totally dependent on patient compliance and those which are not compliance-dependent. The ultimate goal of the diabetic foot care team is breaking the pernicious cycle of recurrent ulceration and thus preventing major lower limb amputations in this vulnerable population.

Conclusion
A precise, coherent approach to the prevention and management of diabetic foot ulcers can lead to a reduction in the incidence of major lower limb amputations.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg392512/cg393054

Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3762-775]

Diabetic Foot Infections

Author
Bowker, John H. (Miami, FL US) | MD
Miller School of Medicine, University of Miami - Department of Orthopaedics

Coauthors
Prof. John H. Bowker

Abstract
With proper wound care, prompt, appropriate surgery, focused antibiotic therapy and optimum control of metabolic disorders including hyperglycemia, ketosis and nutritional deficiencies, infection can be controlled and a functional foot salvaged in most cases.

Introduction
Twenty five percent of diabetics will develop a foot ulcer during their lifetime and of those, 40-80% will become infected. Infections of the foot are 9-12 times more common in diabetics than in nondiabetics, largely due to loss of protective sensation and attendant delay in seeking treatment with major lower limb amputation a common sequela. This paper will present those factors which predispose diabetic persons to foot infection as well as those which make the treatment of diabetic foot infections such a challenge to the clinician.These include loss of protective sensation, metabolic derangements, dysvascularity and even the peculiar anatomy of the foot. Yhe diagnosis and progression of foot infections absent intervention will be discussed as well as examples of effective surgical intervention. The roles of antibiotic therapy as well as adjuctive therapies such as hyperbaric oxygen and revascularization in achieving foot preservation are considered.

Conclusion
With diabetes mellitus at pandemic levels worldwide, the incidence of diabetic foot infections continues to increase with a concomitant rise in major lower limb amputations. With prompt, informed management of these infections, however, it is possible to salvage a functional foot in the majority of cases.

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Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3763-915]

The Charcot Foot

Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Introduction
Neurogenic osteoarthropathy often ends in dislocations of the foot with consecutive ulcers and a high risk of amputation.

Methods
205 surgeries (195 patients) using with complex dislocations and/or chronic ulcers fixateur externe or Steimann´s Pins in patients with NOAP were included. The average follow-up time was 21 months. Goal was walking without pain in customized orthopaedic shoes and avoiding amputation.

Results
No primary amputations were necessary. Patients activity improved by more than 1 level. Most common minor complications were persistence or reoccurence of ulcers in 56 patients. Only 7 new flare ups of NOAP were observed. In 15 patients 2° amputation was necessary. Ca. 50% of the patients could be mobilized in customized orthopedic shoes 18 mo post-operativ.

Conclusion
By using a fixateur externe many amputations could be avoided and pateint´s activity can improved. The interdisciplinary team-work of orthopedic surgeon, orthopedic shoemaker and orthopedic technician is essential for long term success.

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Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3086-284]

Could Biomechanical Screening Prevent Charcot Feet?

Author
Munro, William (Clydebank UK)
Anatomical Concepts (UK) Ltd - Rehabilitation Engineering

Coauthors
Jones, D

Abstract
This paper outlines a hypothesis linking repetitive biomechanical strain in the functional joints of the foot to atrophic or hypertrophic deterioration. This hypothesis implies that biomechanical factors can allow identification of the foot at risk of Charcot deterioration to be recognised early.

Introduction
In the desire to prevent or treat neuropathic, diabetic lesions it is essential to manage the various interfaces between the shoe, orthosis and the foot at risk.
It has long been acknowledged that neuropathy is therefore a problem of mechanics and not just of medicine. For this reason the orthotist has a vital role to play as a member of the diabetic foot care team.
Amongst the spectrum of related problems, Charcot arthropathy presents a particular challenge to the clinic team; constituting a progressive, often rapid, deterioration of the weight bearing joints, usually in the foot and ankle. The patient may present with a hot swollen foot that can be mis-diagnosed as early radiographic signs are absent. If missed this condition can lead to severe mechanical disruption to the function of the bony anatomy.

Methods
Two main theories (neuro-traumatic and neurovascular) explain the pathogenesis of Charcot foot.
Neuro-traumatic theory attributes bony destruction to the loss of pain sensation and proprioception combined with repetitive and mechanical trauma to the foot.
The neurovascular theory suggests that joint destruction is secondary to an autonomically stimulated vascular reflex that causes hyperaemia and periarticular osteopenia with contributory trauma.
We theorised that intrinsic muscle imbalance with increased heel and plantar forces can produce dramatically high loading of the foot, propagating micro fractures, ligament laxity and progression to bony destruction.
If persons with hypermobile feet, for example, also present with diabetic neuropathy we wondered if they may be at greater risk of developing a Charcot foot.

Results
This hypothesis links repetitive biomechanical strain in the functional joints of the mid and forefoot to atrophic or hypertrophic deterioration in the fore, mid or hind foot.
This hypothesis implies that biomechanical factors may allow the foot at risk of Charcot deterioration to be recognised early so that appropriate orthotic management may be applied in a timely fashion.
Neuropathic arthropathy is either Atrophic or Hypertrophic. Classification using the Eichenholtz system for Hypertrophic lesions enables the healthcare professional to identify the critical prefragmentation stage whereby early diagnosis will allow intervention that can prevent deformity.

We speculate that there are differences in the progression of Charcot arthropathy in patients with type 1 compared with type 2 diabetes.
These differences may hold the key to both drug and mechanical prophylaxis.

Conclusion
Treatment options and potential screening techniques will be discussed illustrating the range of orthoses available.
Currently a research protocol is in development, which will allow for the systematic collection and dissemination of information to support or deny this hypothesis. If prophylactic orthoses are effective in preventing the destructive effects of Charcot this would be a significant advance.

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Symposium: Diabetic Foot - Current Concepts
Wednesday 2010/05/12 | 15:00 - 16:30 | Subtopic/Track: Foot and Shoe

Congress Lecture [3764-755]

Off-Loading for the Diabetic Foot

Author
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Abstract
Diabetic foot ulcers due to internal or external pressure zones cause major problems in the treatment of those patients. As a result of the following infections a higher number of amputations occur out of these problems. Therefore pressure release, pressure distribution in the treatment of ulcers or infections, even in the prevention of ulceration on the diabetic foot are of main importance. In the literature there are several techniques of pressure reduction described. International literature mainly deals with a treatment by total contact casting, there is evidence of effectiveness for this technique. Due to the fact that in German speaking countries there is traditionaley a high reputation for orthopaedic shoe fitting and orthotic treatment there are different other approaches as for instance orthopaedic shoe fitting with insoles and rocker bottoms or orthotic treatment with pressure release orthosis. These techniques are discussed with a view on evidence in literature. In the presentation the different ad

Introduction
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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3746-None]

Open Forum 3

Session Chair
Mallya, Hortensia (Moshi TZ)
Kilimanjaro Christian Medical Centre - Tanzania Training Centre for Orthopaedic Technology

Session Chair
Radocy, Robert (Boulder, Colorado US)
TRS Inc.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg347573

Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [3089-287]

Implementation of Local Manufacturing for the Legs M1 Knee in the Developing World

Author
Ayers, Stephen (Longview US) | Dr
LeTourneau University - School of Engineering

Coauthors
Stephen R Ayers, Roger V Gonzalez

Abstract
The authors have successfully developed and implemented the LEGS M1 polycentric knee . The M1 is designed to be an inexpensive, low maintenance knee option which helps improve patient gait while meeting the manufacturing, rehabilitation and cultural constraints of various international sites.

Introduction
Over the past five years, the authors have developed the LEGS M1 polycentric knee to provide an improved knee option for developing world amputees [1-3]. The aim of the LEGS program has been to design, test and deploy a high-quality prosthetic knee which can be locally manufactured and sustained by clinics in the developing world. It is felt that on-site manufacturing promotes a sense of partnership and pride in the prosthesis, encouraging long-term growth and a pattern of self-help not found in donations or shipments of prefabricated parts. This view has been strongly supported by national staff at the project's field evaluation clinics. The key to developing a knee which can be effectively manufactured on a local level lies in identifying and building on current skill sets and tool options found in developing world clinics. The design also minimizes the number of critical dimensions and has increased tolerances to help ensure proper knee function despite manufacturing deviations.

Methods
The initial phase in developing the M1 manufacturing process was assessment of skills and tools in typical developing world clinics. LEGS personnel assessed clinics in 5 countries. Additional direction was obtained from US prosthetists with developing world experience. These studies indicated that most clinics would possess a band-saw, a drill and some type of sanding apparatus. It was also determined that a properly qualified prosthetist would typically have obtained some training in the use of this equipment as part of their prosthetics training.
An initial template based manufacturing method was developed from this information however field evaluations highlighted issues with consistent positioning of the mechanism pivot points and a high reject rate.
An improved method was developed using a drilling jig which controls both the critical positioning of the mechanism pivots and the general geometry of the knee elements. A pictorial guide for this method has also been developed.

Results
The new manufacturing system uses two drilling jigs to control the position and size of the holes for the mechanism pivots. The jigs use hardened steel drill guides which are rated for the production of several

thousand parts. The jigs are provided to suitably qualified clinics once they complete the training program for the knee.
Field assessment of these jigs in Kenya, Bangladesh, Sierra Leone and Senegal has indicated that they are effective in controlling manufacture of knee components. The knee is fabricated from two main blocks and three link blocks which are rough cut from plastic stock and sanded to fit in the jigs. By requiring them to fit in the jigs the general geometry of the knee is controlled. Drilling of the pivot points is controlled by the drill guides once the block is positioned in the jig. The jig method has shown the ability to control hole position to within 0.2mm which is well within the 0.5mm tolerance allowed. The pictorial manufacturing guides developed for the process have also shown themselves to be effective cross-culturally.
Sourcing of the raw plastic stock has been the greatest challenge in implementing local manufacture of the knee. Import restrictions create significant roadblocks to accessing the plastic however these challenges do not appear any more significant to those facing the importation of completed knees. Knee hardware consists of common metric sized bolts which have been found in all venues to date.

Conclusion
The LEGS M1 knee presents clinics in the developing world with an opportunity to improve their service offerings to amputees. A robust and effective manufacturing process has been developed which allows a polycentric knee to be fabricated locally in developing world clinics. Field experience has shown the knees can be manufactured with consistent quality by local personnel using existing skill sets and tools. LEGS continues to work with clinics on issues of sourcing plastic stock. A multi-year study on jig durability, training methods, retention of skills and the consistency of end-products is currently underway and will continue over the next few years. Assessment of the knee in relation to patient outcomes is presented in another paper at this congress.

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Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [3090-288]

Implementation of a New Polycentric Knee Technology in the Developing World

Author
Ayers, Stephen (Longview US) | Dr
LeTourneau University - School of Engineering

Coauthors
Stephen R Ayers, Roger V Gonzalez

Abstract
The LEGS M1 Knee is a low-cost, polycentric knee unit which can be locally manufactured in the developing world. The knee has been transferred to 10 clinics in 4 different countries. The strategy used for dissemination of the M1 Knee technology to clinics in the developing world is reviewed.

Introduction
The LEGS M1 Knee is a 4-bar polycentric knee specifically designed for implementation in the developing world (Figure 1.) [1-3]. It is designed to provide improved outcomes in patient functionality while maintaining a very affordable cost structure. The benefits of polycentric knees are documented in the literature [4,5], yet access to this type of technology in the developing world continues to be limited due to the high cost, low quality control, and poor durability of existing options. The M1 Knee has been designed to overcome these barriers by providing service providers with an option they can construct and maintain locally at low cost. The knee can be easily manufactured with simple hand and power tools, common to most prosthetics clinics in the developing world. The M1 Knee has been successfully tested to the requirements of ISO10328. To our knowledge, the M1 Knee is currently the only locally manufactured knee in the developing world to have successfully passed this testing.

Methods
To promote uptake of the M1 Knee, we have developed a strategy for implementation and transfer of the technology in the developing world. One of the key considerations is the creation of an environment where technology is pulled into the marketplace by the end-users rather than pushed by a technology developer. This has been achieved by engaging our field clinics in the knee design process. As partners have seen their concerns addressed in design refinements any resistance to the knee has tended to dissipate. These partners have then promoted the technology to other service providers in their regions.
To address growing interest in the knee, we have developed a 5 day in-service training program for clinics seeking to implement the knee. It provides hands-on training in knee manufacture, fitting and rehabilitation issues specific to articulating polycentric knees. Programs involve 3 to 4 clinics from a local region with each attending clinic providing several key prosthetics personnel.

Results
LEGS Technology Training Workshops (TTWs) have been conducted in 3 countries: Sierra Leone, Bangaldesh and Senegal. A TTW is scheduled for Kenya in May 2010. Feedback from attendees has been extremely positive. While some scepticism can exist at the start of a workshop, the emphasis given to answering attendee concerns has meant that all participants to date have left with the stated intention of implementing the technology in their practice.

LEGS has developed a series of pictorial manufacturing guides which are provided to attendees. These guides appear to function well cross-culturally. LEGS also provides each attending organization with the simple jig set used for manufacturing the knee. These jigs allow for a consistent quality in manufacturing of the knee mechanism using simple power tools common to most prosthetics clinics across the world. The utilization of existing technician skill sets in combination with the jigs is seen to be an effective method of achieving consistent manufacturing outcomes.
Follow-up of the initial TTW in Sierra Leone after 1 year indicates that at least one of the organizations has utilized the knee technology in their clinic, however difficulties in sourcing raw materials has limited their implementation. LEGS is working to help resolve this issues. The initial follow-up has indicated good retention of TTW after 1 year. Further follow-up of each TTW is scheduled.

Conclusion
Initial efforts of transferring the new LEGS M1 knee to clinics in the developing world have been positive. By utilizing an end-user “pull” strategy for both technology development and initial information diffusion, researchers have successfully provided users in the developing world with an improved prosthetic knee option. The researchers experience indicates that the integration of key end-users into the early stages of the technology development process can aid later dispersion of the technology in a given region. The 5-day TTW appears to be an effective means of transferring the technology to end-users with good retention of training being demonstrated one year after initial training. Plans are currently underway for extended follow-up with clinics and the development of a follow-up training program. It is thought that lessons learnt in the M1 Knee program may provide useful insight for developing of other prosthetics components.

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Image: LEGS M1 Knee_None.jpg (see online)

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Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [2948-146]

A Detailed Study on Disability in India with Respect to SAARC Nations: Guidelines for Prosthetics & Orthotics Services through CBR

Author
Datta, Tarit (Bonhoogly IN)
National Institute of the Orthopaedically Handicapped - Prosthetics and orthotics

Author
Ghosh, Dipanwita (Dakshineswar IN) | Dr.
Hiralal Mazumdar Memorial College for Women

Coauthors
Ghosh D, Reader in Economics, HMM College for Women, Kolkata: 700 035

Abstract
The aspect of generating measures in P&O management for rehabilitation of locomotor disabled in India has been affected by dearth of resources, trained personnel & weak linkage effects. As no country-specific model of CBR in P&O is available, we would present our own Indian model for rehabilitation.

Introduction
WHO 2000 study on disability reports that the disabled form 10% of the population in developing countries. Our study on disability statistics in India with respect to SAARC nations reveals acute under enumeration in disability figures & shows that greatest number of disabled to be in locomotor sub-class. Quoting the Washington City Group on Disability Statistics (UN) we have seen that the diagnostic method adopted by the SAARC nations has led to the under enumeration. We have also found that in India the number of people with loss of limbs, paralysis, dysfunction of limb is remarkably high within the class. The quality of rehabilitation for them is, however, dismal. Rehabilitation programme in India has been not been egalitarian. It has been concentrated in relatively well-offish area & has failed to reach the masses of our country. As life is a mere survival for the disabled, he is ignorant about the P&O which would improve his functioning. He has somehow adjusted to live without it.

Methods
Apart from the decadal Indian Census that enumerate the number of disabled, the only other dedicated study on disability was done by the National Sample Survey Organization, under the aegis of the Ministry of Statistics & Programme Implementation, Government of India, in their 58th round in the July-December 2002 period. This round provided detailed statistics on disability of all kind & also reported the degree of rehabilitation in broad quantitative details. We decided to organize our paper on the basis of the NSSO report, as it was last survey on the disabled with a national coverage. We applied standard statistical methodology on the raw data and found out the number of people in the locomotor disability category who received aids & appliances on the basis of the source of acquisition. We also found out the number of persons who acquired aid but were not using it regularly on the basis of causes. We enumerated the number of non-recipients of aid by causes for non-acquisition.

Results

The number of recipients in the rural and urban areas stands at 11894 (in'00) & 5409 (in'00). However, despite the fact that the number of locomotor disabled in rural areas is thrice that in the urban class, the acquisition rate is much higher in the cities. This clearly indicates that the rehabilitation programmes have been concentrated in the better-off regions. Moreover, the recipients have received government assistance mainly in acquisition of generalized mobility aids as wheel-chairs & tricycles, while most of the case-specific acquisition in P&O has been from outright purchase. Among the people who have acquired aid 77% use it regularly. The rest do not use it as they find it uncomfortable (47.8%), 9.7% find difficulty in maintenance and repair & 42.4% do not use it for other reasons. The actual figures of the number of persons who have not received any aid/appliance despite professional advices to acquire it stands at a staggering high of 67,932 (in '00) in the rural category and 21,105 (in'00) in the urban class. As is expected in the backdrop of a poor country with 70% of the people living in a rural set-up with poverty rates more than double the urban poverty rate, 34849 (in00)of the non-recipients from rural areas & 8189 (in 00) from urban areas cite cost-crunch as the reason for non-acquisition. With the per capita health expenditure pegged at $80 for India (government spending only 0.7% of GDP)as against $4887 in US & $2820 in Germany, the situation is grim.

Conclusion

We feel a correct enumeration of the disabled would go a long way in formulating a policy better suited to the need of the disabled.

We relate the capability approach of development to the ICF model. If development is expansion of capability, improved commissioning of P&O would mean development (Qizilbash, 2006).

We propose to maintain the WHO defined 4-tier model & state that the Central level would support, advice Government in planning national policy for P&O involving ISPO & other professional bodies. As ISPO/ WHO statement (2003) admits that there is a dearth of resources in this field, we feel that the allocation in this field should be extended; the chain of allocation should be geared up to make P&O service available for the majority & nearer to where they live. As 85% of the Indian population work for the informal sector without any social security benefits, social main-streaming of health services is essential for rehabilitation in case of their work-place related injuries.

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Image: Table 1_None.docx (see online)

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Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [2868-68]

The Challenge of Prosthetics and Orthotics (P&O) Services and Community Based Rehabilitation (CBR) in Rural Tanzania

Author
Mallya, Hortensia (Moshi TZ)
Kilimanjaro Christian Medical Centre - Tanzania Training Centre for Orthopaedic Technology

Coauthors
Mallya H

Abstract
This presentation provides an overview about the challenges and structure of CBR services in Tanzania related to P&O services and the mid-level rehabilitation workers in the Maasai villages of the rural area in northern Tanzania.

Introduction
There is a gap between the CBR work and the P&O programs (ISPO/WHO 2004). The two should be linked so that they can work in harmony. Early detection of disabilities, identification of persons requiring P&O services should be carried out at community level. The CBR workers should be educated about P&O so that they can raise awareness of technical rehabilitation service care and be able to identify orthopaedic related disabilities. This would demonstrate the link between CBR and P&O services and furthermore sensitize and inform the community about physical disabled persons. The disabled identified in the rural areas would then be referred for P&O services to the specialized centres. Follow-up of clients will be also strengthened through this CBR and P&O combined and harmonized system.

Methods
The method used to receive and retrieve information about the existing CBR system in Northern Tanzania was done randomly through:
• Physical visits to homes for children with physical disability.
• Information received from CBR workers and community health workers.
• During supervision of clinical placement students from Tanzania Training Centre for Orthopaedic Technologists (TATCOT) in different rehabilitation centres in the country.
• Analysing the information currently available, developing and making use of an action plan to improve the situation by raising awareness for the need of P&O services in order to promote the existing rehabilitation system.
An explanation is given of the problems facing the referral system in Tanzania related to P&O rehabilitation and role of the Non-Governmental Services integrated in the National Health Care System.

Results
The following was found:
• Children with physical disabilities were referred to children's homes, in order to get self-care training/ health care and education up to secondary education level.
• Children who are in need of surgery have a chance through donor organizations to have surgical interventions.
• The few children who reside near TATCOT get treatment and are fitted with orthopaedic appliances.

A plan of action was developed to improve the situation. Rural centres for children with physical disabilities were identified during TATCOT student visits. The follow-up of clients provided with P&O devices was carried out and newly identified clients were referred to TATCOT and Kilimanjaro Christian Medical Centre for orthopaedic appliances and surgery. For those children who have to be fitted with complex appliances, TATCOT has agreed to assist and provides services during the clinical placements of its students twice a year. A proposal of a regular surgical service provided by an overseas team of surgeons has been realised. Children can therefore have surgery and have a chance to be fully rehabilitated through the regular service provision at orthopaedic service stations established in nearby rehabilitation centres. This plan will be extended to further strengthen the technical rehabilitation service care as well as referral system in rural northern Tanzania.

Conclusion

The provision of awareness in the Maasai villages through CBR has improved the situation of children with physical disability. The intensive information to the parents and the community at large has raised the possibility to provide orthopaedic services to the children. In other words it has improved the referral system for rehabilitation services in the northern zone of Tanzania. The continual financial support through Christian and non-governmental organizations have contributed greatly to the rehabilitation of children from the Maasai villages. This work confirms that if both P&O and CBR work together it will result in better more accessible and better rehabilitation services.

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Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [2970-168]

Implementation of Sustainable and Appropriate Quality P&O Services in Low and Middle Income Countries

Author
Baeriswyl, Marcel (Berlin DE) | Master Orthopedic Mechanic (OMM / CPO-D)
Johanniter-Unfall-Hilfe - International Assistance

Coauthors
Du Plessis, J, Orthopaedic Technician, Director of Theranova, Romania

Abstract
Illustrated by the successful cooperation between Johanniter International and the Orthopaedic Centre Theranova in Oradea, Romania, we would like to emphasise our principal guidelines for planning and implementing sustainable and appropriate quality P&O services in low and middle income countries.

Introduction
The World Health Organisation estimates that 7 to 10% of the human beings are physically disabled. The ICRC estimates that 0.5% are amputees. Due to population growth, poverty, diseases and violent conflicts, the number of people who need rehabilitation services increases each year.
International organisations aim at increasing accessibility to appropriate quality local orthopaedic services for people with mobility disabilities all over the world, but unfortunately only a few projects have managed to provide enough technical and management capacity to local partners to continue the services at a satisfactory level and to generate enough funds to continue the work in the long term.
Illustrated by the successful cooperation between Johanniter International and the Orthopaedic Centre Theranova in Oradea, Romania, we would like to emphasise our principal guidelines for planning and implementing sustainable and appropriate quality P&O services in low and middle income countries.

Methods
In Romania, where approximately 900,000 persons live with physical disability, there is still a lack of appropriate quality orthopaedic care. The need in Western parts of the country has been successfully addressed by the local provider Theranova in Oradea with support of Johanniter International Assistance. Main methods have been: establishing a professional 600 m²-Orthopaedic Workshop in Oradea; expansion by three local branches and mobile teams; constant training of service providers in the country on the latest treatment methods, e.g. ischial containment above knee prosthetic design, modern orthotic scoliosis treatment; professional human resource development, procurement of cost-efficient but good quality materials; introduction of a fair system for user fees; lobbying for recognition by the Romanian National Health Insurance (NHI).
Future plans include EC-funded fully equipped „mobile workshops" targeting N and NE Romania and transfer of the service to neighbour countries.

Results
Results:
- Good quality P&O services offered by decentralised workshops are accessible in wide parts of NW Romania and beyond. In 2008, the centre treated 1300 persons and counting.

- The orthopaedic centre has established a well trained and highly committed team with low employee fluctuation. Knowledge is transferred to other service providers.
- Theranova's services are partly paid by the National Health Insurance (NHI). Payments from the NHI covered 29%of the total cost in 2007.
- The centre has different funding sources including patient's contributions (18% in 2007), and donations (53% in 2007). Nevertheless, since the budget of the NHI allocated for people with physical challenges was cut by up to 50%, Theranova still depends on donations.
- Theranova sets benchmarks for P&O services in Romania: Together with other organisations, it was in charge to organise the first national P&O Conference in Romania in May 2009, where the Director reported about trend-setting techniques and treatments for the country. After the conference, he has been invited to consult and train other centres.
- The awareness (and example) of good quality P&O services and their potential increases among medical professionals and policy makers as well as on the political level in small communities and at county level. The promotion of this basic human right to be independent and self sustaining is crucial to future approach and understanding and treatment of people with special physical needs.

Conclusion

The following factors are crucial for planning and implementing sustainable and good quality orthopaedic services:
- Support of the government
- Long-term commitment of donor agencies and partners
- Diverse funding sources including local resources
- Appropriate systems of user fees
- Constant and high quality training
- Use of appropriate cost-efficient technology
- Introduction of decentralised facilities

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Image: Darius_in_action_168.jpg (see online)

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Session: Open Forum 3
Wednesday 2010/05/12 | 15:00 - 16:30

Congress Lecture [2900-98]

Case Study: Testing and Evaluating the Plastic Soda Bottle Transradial Socket Prosthesis

Author
Radocy, Robert (Boulder, Colorado US)
TRS Inc.

Coauthors
Radocy R

Abstract
The project involved constructing and testing a prototype of a new, low cost, trans-radial prosthetic technology based upon a innovative design by Dr. Yeongchi Wu and his staff at the Center for International Rehabilitation in Chicago, USA. Productive outcomes resulted and additional research, development and testing are recommended.

Introduction
An article in the June 2009 Edition of Prosthetics and Orthotics International by Wu, Casanova and Ikeda revealed a novel technique for fabricating a low cost, transradial prosthesis that might be appropriate technology for developing countries. Having curiosity Bob Radocy and the staff at TRS Inc. in Colorado decided, with encouragement from Dr. Wu, to experiment with, test out and share the experience of this potential technology. The prosthesis was fabricated and tested by the subject at TRS headquarters with promising results.

Methods
A single subject approach was used. Being a transradial amputee, the author volunteered to be fitted with a prosthgesis constructed using the published fabrication technique and unique materials but with enhanced design attributes to increase the prosthesis's strength capabilities. The subject has a short, transradial residual limb. The prosthesis was fabricated based upon the techniques described by Wu, et al. This technique utilizes plastic soda bottles that exhibit characteristics similar to heat shrink tubing. Three 2-liter soda bottles and one 500 milliliter bottle were used. Strips of fiberglass-reinforced tape were applied to increase the socket's strength. A PVC tube pylon was secured into the end of the bottle's neck to create an endo-skeletal, self-suspending, prosthesis. The final prosthesis had three layers of plastic material throughout the main socket and a four layer socket brim. A TRS Grip 2S terminal device was secured to the end of the pylon. The prosthesis was tested by applying increasing

Results
The subject was put through a series of prosthetic lifting tasks that ranged in load from five pounds (11 Kg) to 65 pounds (143 Kg) to determine the strength and capabilities of the prototype. The prosthesis performed well at five pound and ten pound loads when stressed both in axial and transverse directions. At fifteen pounds of transverse loading a slight deflection in the forearm section of the prosthesis began to appear. Deflection increased proportionally at twenty pounds transverse loading. Axial loading did not appear to impact the integrity of the prosthesis at these loads. The subject then challenged the system by engaging a twenty pound steel dumbbell. The subject brought the dumbbell in a military press position and performed several vertical presses. The prosthesis performed well and provided enough security for

stable control of the weight. Then the testing returned to the basic axial and transverse loading protocol. A twenty-five pound load was applied to the prosthesis, which was then brought into full elbow flexion to create the transverse load test. At full flexion the prosthesis began to delaminate and fail under this load. No additional transverse loading was applied. Distal axial load testing continued at twenty-five, forty-five and sixty-five pounds respectively. The subject did not experience socket failure or slippage and the prosthesis remained intact except for the slight delamination and cracking that had occurred earlier in the testing under elbow flexion transverse loading.

Conclusion

The plastic soda bottle prosthesis prototype exceeded performance expectations. The additional layers of plastic bottle material reinforced with fiberglass tape appear to create a prosthesis with enough physical integrity to perform a wide variety of vocational activities and tasks of daily living. The fabrication was simple. Fabrication techniques can be improved and materials experimented with and tested. The cost of the materials required to fabricate the prosthesis, excluding the terminal device, were less than ten dollars (US). The design, materials and fabrication technique appear to be very applicable to situations where more expensive prostheses are not possible and or where professionally trained prosthetic fabricators are not available. Additional development and research are recommended to refine the techniques and to determine the best combinations of materials required for even more robust and functional prostheses. Quantifying the strength and shrinkage characteristics of the materials is recomm

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg347573/cg33960

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3660-None]

Lower Limb Prosthetics - MRI Socket

Session Chair
Klasen, Sebastian (Stuttgart DE) | Dipl.Ing.(FH)
Fraunhofer IPA - Orthopädie und Bewegungssysteme

Session Chair
McHugh, Brendan (Glasgow UK) | Dr
University of Strathclyde - National Centre for Prosthetics and Orthotics

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Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3589-669]

Lower Limb Prosthetics I: Constructing an Anatomically-Correct Structural Model of the Residual Limb

Author
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Coauthors
Tawfik, S
Kondor, S
Kistenberg, R
Browne, E

Abstract
Magnetic Resonance Imaging (MRI) data are obtained for the residual limb. In a postsegmentation step of the MRI data, three-dimensional solid models of major tissues of the residual limb are constructed and optimized for enhanced performance of numerical analysis and simulation.

Introduction
Current design methods of lower limb prosthetic sockets are labor intensive requiring a number of iterations before attaining a best socket fit. Therefore, a closed loop computer based design methodology has been proposed. The main foundation of this design
methodology is to obtain an anatomically-correct structural model of the residual limb from MRI data. Volumetric geometries of major tissues such as bones, tendons, muscles and fat are obtained from the segmentation process carried out in Mimics (Materialise. In a subsequent step, 3-matic (Materialise)was used to provide fidelity for each
volumetric geometry while being transformed into a three-dimensional solid model. Contact surfaces between tissues and attachment points of tendons or muscles with bones are optimized to alleviate numerical simulation anomalies. Finally, an optimized threedimensional structural model of the residual limb is developed for subsequent analysis of
the proposed methodology.

Methods
The segmentation process of MRI data conducted in Mimics results in three-dimensional volumetric geometries of tissue structures. These three-dimensional volumetric geometries lack surface smoothness and include holes and/or small inclusions as shown in Figure 1. These imperfections are filtered out using the Wrap and Smooth functions provided in Mimics remeshing module. The resulting three-dimensional volumetric geometries are based on digital CAD surfaces, i.e. triangulation of their generating
surfaces. Further refinements are carried out in 3-matic in terms of obtaining better surface definitions of three-dimensional volumetric geometries. Subsequently, Initial Graphics Exchange Specification (IGES) data of the optimized three-dimensional models
are obtained and exported into ABAQUS Finite Element software.

Results

Three-dimensional IGES representations of major tissues, bones, tendons, muscles, and fat are developed. Figure 2 shows a three-dimensional solid model of the tibia for a transitibial amputation. The developed three-dimensional model of the tibia is
characterized by a smooth surface and absence of inclusions and/or holes in contrast to the volumetric geometry shown in Figure1. The IGES format of the tibia is subsequently imported into ABAQUS Finite Element software as an independent part of the lower
limb structure. Major benefit of using Mimics and 3-matic is the proposed sequence is maintaining the global coordinate system and relative position of individual tissue within the structural model of the residual limb.

Conclusion

A process to construct an anatomically-correct structural model of the residual limb is established in a number of steps. At first volumetric three dimensional geometries of major tissues are obtained in a post –segmentation process of the MRI data in Mimics. The volumetric geometries are repaired by removing inclusions, holes and surface irregularities. A surface refinement of the resulting volumetric geometries is carried out in 3-matic. Finally, optimized three-dimensional solid models of major tissues are
exported into IGES format ready to import to Finite Element Analysis.

Image: Abstract1_669.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg220897/cg71363

Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2897-95]

The Error in Measurement of Transtibial Amputation Stumps in Vivo: a Comparison of Four Different Methods

Author
Bolt, Arjen (NL)

Coauthors
Bolt A, Geertzen JHB, Emmelot CH, Baars ECT, Dijkstra PU

Abstract
In our study we investigated the reliability of 4 methods to measure stump volume on in-vivo stumps. Calculated repeatability coefficients (RCs) vary from 129 ml until 158 ml and are substantially higher compared to measurements that were performed on stump-models (1).

Introduction
Stabilisation of stump volume is a necessary condition for good first prosthetic fitting (2). To determine the right moment for prosthetic fitting it is important to measure stump volume change over time. Reliability of instruments on in vivo stumps that are or can be used in daily practice is not known. Aim of this study is to analyze reliability of four methods for stump volume measurement and to determine which method is most useful in clinical settings.

Methods
Four instruments were investigated: water displacement, circumferential measurements, the Design TT ® system and the Omega Tracer ® system. Measurements were performed on 32 patients on 2 occasions. On each occasion the four methods were applied by two researchers. Based on these measurements repeatability coefficients (RC's) for each method and variance components to estimate the influence of the different variables (occasion, session, observer, method) and their interactions on the RC's were calculated.

Results
The grand means of the methods show systematic differences in volume measurements between the four methods. Calculated RC's vary from 129 ml for the Omega Tracer ® system until 158 ml for the the Design TT ® system. Error variance is 11.7% of total variance and is explained by the method, the interaction amputee-method and the interaction amputee-occasion.

Conclusion
The four methods can not be used interchangeably, the observers however, can. RC is lowest for the Omega Tracer ® system, indicating the largest reliability. In spite of this the repeatability coefficient is still high, which can partially be explained by the measurement procedure. The RC's are substantially higher when measurements were performed on an in vivo stump, compared to measurements on stump-models.

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Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3274-449]

An Investigation into Prosthetic CAD Use in the UK

Author
McHugh, Brendan (Glasgow UK) | Dr
University of Strathclyde - National Centre for Prosthetics and Orthotics

Coauthors
McGarry A, Buis A.

Abstract
A survey was conducted to investigate the use of CAD in prosthetic manufacture in the UK. The survey employed a questionnaire designed to determine the methods used, frequency of use and the perceptions of clinical staff.

Introduction
Researchers agree that residual limb shape must be captured accurately and precisely although the degree to which this is required continues to be debated 1, 2, 3. It was hoped that the introduction of Computer Aided Design (CAD) techniques would minimise errors and that measurements produced would facilitate greater understanding of how to achieve optimal prosthetic socket fit 4, 5, 6.
Different CAD systems have been developed for use in prosthetic shape capture but neither the extent of use or the relative merits of these systems has been decided conclusively. . Systems use both contact and non contact methods, and employ different modes of shape capture (mechanical digitisers; electromagnetic scanners; optical laser systems and digital photography). Current systems do not permit the limb to be loaded whilst data is collected.
To understand the extent of use of different prosthetic CAD systems a survey of all UK limb centres was carried out.

Methods
Following a pilot study, a postal survey was sent to one prosthetist in every prosthetic centre in the UK. Due to the limited number of prosthetic centres in the UK (n=43) it was possible to include all in the survey. All respondents were required to comply with conditions of ethical approval sent separately by post.
The survey consisted of 22 questions with regard to CAD/CAM use (type of use and frequency). Questions were designed to give an overall picture of the systems in use; what categories of patients they are being used for and why; how prosthetists were trained; and what effect this has on use? There was a balance of open and closed questions to ensure that the questionairre was not too time consuming for the respondent to complete. This facilitated management and meaningful analysis of data whilst allowing the respondent to reflect and express opinions and feelings on important CAD issues.
Data was analysed at the National Centre for Prosthetics and Orthotics (NCPO).

Results
Of the original 43 surveys, 29 were returned. Prosthetists employed at centres (n =162 full time equivalent) were responsible for the management of approximately 43225 patients with amputation.
Of centres which completed surveys, 58.6% used CAD (n =17) and 41.4% did not (n=12). Of all centres, including those who did not respond, 39% of centres used CAD.

Different CAD systems were employed in different centres. The most common, Tracer CAD was used in 76.5% (n= 13) of centres. Of those using a CAD system, 41% (n=7) had evaluated other systems. A variety of different training strategies existed to implement systems.
The ratio of prosthetists employed at each centre to the number of patients was found to be lower at centres using CAD. However, prosthetists expressed the opinion that time saving was a clinical benefit associated with CAD systems. Accuracy and repeatability of systems was also thought to be beneficial compared to traditional methods.
Most centres using a CAD system (n=13) were satisfied with their system. However, only 78.5% of all prosthetists who had access to CAD systems used them. An additional 63.4% do not have access to a CAD system. This means that overall 47% of all prosthetists used CAD.
The mean number of patients supplied with a new socket created by CAD in all centres was 24%. This ranged widely between 1% and 80% at different centres. It took between 0-2 diagnostic check sockets to produce a satisfactory socket regardless of the system used.

Conclusion

Different CAD systems are in use in UK prosthetic centres. Systems provide advantages such as note keeping and lack of plaster mess which may be beneficial for both the prosthetist and patients.
The main advantage of CAD expressed by prosthetists was time saving. However, time saved by CAD systems does not show an increase in patient to prosthetist ratio.
Another advantage of CAD expressed by prosthetists was that data recorded by systems was repeatable and accurate. No evidence exists to support this opinion
Training is in CAD use is variable at different prosthetic centres. A structured, planned approach is required to introduce, educate and train individuals as they develop their use of CAD systems.
Tracer CAD and T ring measurement systems were found to be the most commonly used systems in the UK and thus, following on from this survey, a scientific evaluation of their performance was commenced.

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Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3194-381]

Ultrasound Pre-study of the Kinematics of the Residual Tibia within a Trans-tibial Socket during Gait

Author
Klasen, Sebastian (Stuttgart DE) | Dipl.Ing.(FH)
Fraunhofer IPA - Orthopädie und Bewegungssysteme

Coauthors
Uplegger C, Bächle T, Dr.Schneider U

Abstract
The motion of the residual-tibia within a trans-tibial socket was examined so far only by X-ray. In this pre-study now the motion of the residual tibia is to be described during gait using ultrasound data. The results of measurement raised here are to adapt a better socket fit individually.

Introduction
This pre-study measured the motion of the residual tibia within a trans-tibial socket during gait using ultrasound for first time.
Four 9MHz linear array transducer were selected in order to provide an optimal image of the tibia. The field of view of all four transducers is 39mm and each transducer was connected to a separate diagnostic ultrasound scanner EchoBlaster128 (Telemed, Lithuania).
By mounting the ultrasound transducers on the outside wall of the socket it is possible to set the movement of the Tibia within the socket direct in connection to the socket. However, overruns may occur due to poor contact at the interface between transducer and stump during gait cycle. This can be prevented and/or minimized by exact position-ing of probes in forward, an optimal socket fit and the use of “Sonar Aid” (Geistlich Pharma, Switzerland), aqueous coupling medium for diagnostic ultrasound.

Methods
At the measuring socket, four ultrasound transducers were positioned in such a way that the Tibia is on target during the entire gait cycle. Subsequently, two points of reference were specified: proximal the Tuberositas tibiae and distal at the end of the tibia, to those in each case two ultrasonic probes were anterior and laterally aligned. For stabilization serves a metal-rack, which fix the probes by means of cube caps. Threaded rods and axial pivots connect the mounting plates and thus avoids the change in angle of the probes among themselves. According to this model the measuring socket could be manufactured. In each case the four ultrasound transducers were as-signed to an IPC (Bressner, Germany). These IPCs contain an Intel Core2Duo processor with 1,6GHz and 2GB DDR II RAM main memory. USB 2.0 connect the diagnostic ultra-sound scanner with the IPCs. The four IPCs are interlaced over a SWITCH among themselves. All devices of the measurement setup are supplied via a 12VDC supply.

Results
First results show a movement of the tibia in a-p-direction while stance-phase of 3.09+-0.41° and while swing-phase of 3.48+-0.41°. In m-l-direction shows the tibia a movement while stance-phase of 4.3+-0.78° and while swing-phase of 5.9+-0.75°. These results are acquired with only 15Hz. So they are sustained by only a few data points. The measurements will be repeated with another ultrasound system in the next few

months. There are also problems with the contact between the ultrasound-probe and the skin especially between initial swing phase and initial contact, which will be also corrected by redesign of the socket.

Conclusion

These pre-study shows the possibility of measuring the movement of the tibia within a transtibial socket. But there are some problems which have to be solved in the future. Therefore it is necessary to build up a second test rig with only one PC and hardware-synchronized Ultrasound-probes. The probes have to be fully integrated into the socket. Also the capture-frequency has to be much higher as in this measurement setup. A capture-frequency of 100Hz is aspired for the next measurements. These arrangements will have the opportunity to investigate the movements of the tibia and the femur within a prosthetic socket during gait without ionising radiation.

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Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3592-672]

Fitting a TTm pop® and TFm pop® Liner to 211 Patients who had had Lower Limb Amputations. Results of a French Multicentre Study

Author
Ehrler, Solange (Strasbourg FR) | PhD
Centre de Réadaption Fonctionnelle Clemenceau - Service d´Orthopédie

Coauthors
Dr. Eveno, G.Durand, Dr. Dehesselle, A.Gourmelon,
Dr. Bonnet, C.Pinelli Cadre, Dr. I. Deroide, MT. Maniez

Abstract
TTm pop® and TFm pop® liners provides stability of residual limb(amputation stump)in 86% of cases, even when cicatrisation is not yet complete.This technique requires appropriate training to use it correctly, as well as an understanding of the few contraindications that absolutely must be observed.

Introduction
TTm pop® and TFm pop® liners were first used in Germany and Belgium between 1999 and 2001 in 41patients who had had an amputation because of vascular disease. The results of this first study clearly showed that the technique could be used from the third day
postop. The average time required to stabilise the residual limb was 11 days (3). A pilot study on the use of these liners was carried out at the Clémenceau Rehab Centre (CRF) in Strasbourg in 2006 (2).
On the basis of these results, a nation-wide multicentre study was started in France, involving five rehab and readjustment teams: Clémenceau Rehab Centre – Strasbourg: Dr. Ehrler; Serge Coulon, orthopaedic technician La Tourmaline Rehabilitation Centre – Nantes St. Herbin: Dr. Eveno; G.Durand, physio Le Carbet Rehab Centre – Martinique: Dr. Dehesselle; A.Gourmelon, physio Le Floride Physical Medicine and Rehab Centre-Barcarès: Dr. Bonnet; C.Pinelli senior physio Valenciennes General Hospital: Dr. I. Deroide; MT. Maniez, senior nurse

Methods
In our multicentre study, a TTm pop® or TFm pop® silicone liner was fitted over the residual limb, on the 18th postoperative day, on average.
The indications and the contraindications of this technique were clearly demonstrated.
Contraindications are:
- Systemic contraindications: congestive cardiac failure, burns, unstable transplants
- Local contraindications: necrosis, infection, fixed flexion 40°
We fitted 211 liners:
- 132 TTm pop® for 132 patients with transtibial amputations
- 70 TFm pop® for 70 patients with transfemoral amputations
These amputations were mainly of vascular aetiology (86%), divided as follows:
Arteritis: 65
Diabetic arteritis: 116
Trauma: 19

Tumour: 10
Congenital: 1

Results

The residual limb was stable in 174 of our patients, corresponding to 86%. It confirmed on the basis of the following criteria:
- 67patients required a single prosth fitting
- 134patients required two prosthesis fittings, but without changing the size of the liner in 107 of these cases. Changes to the prosth were made either by using the technique of another prosth liner (or: another technique for the prosth liner) or an alteration in the type of shaft.

Of our knowledge at that time, it seemed important that we maintained compression of the stump as much as possible with the silicone liner. Studies of the compression from liners made of various materials, such as silicone, polymer gel or urethane, show that only silicone really provides compression (class 2 compression((3). This obviously applies to the TTm pop® and TFm pop® liners but also to the prosth liners subsequently used with the prosth. Finally, the stabilisation and the formation of the residual limb ensure rapid cicatrisation, which leads to certain savings, something that we did not evaluate in our multicentre study in France. But the European study, which was based on precise socioeconomic factors, showed a 20% reduction in costs for the prosthetic care of a patient who had undergone an amputation. Our study showed an average hospital stay of 77 days per amputee, and the Strasbourg teams prosth ratio, i.e. residual limb fitted/prosth made, has fallen from 1.84 to 1.22 since the introduction of this technique

Conclusion

Treatment with a TTm pop and TFm pop liner allowed us to ensure the stability of the amputation stump in 86% of cases even if healing was not complete.
This technique reinforces the multidisciplinary nature and solidarity of the carers involved with the amputee. Nevertheless, an associated healthcare worker (physiotherapist, nurse, orthoprosthetist) should be included in the multidisciplinary team. Together with the consultant doctor or surgeon this associated healthcare worker forms the focal group responsible for this care situation.

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Session: Lower Limb Prosthetics - MRI Socket
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3116-314]

First Statistical Evidences about the Differences between the Use of an Assisted or Passive Vacuum Socket System in Unhealed Stumps of TT Amputees

Author
Brunelli, Stefano (Rome IT) | Dr. med.
Fondazione Santa Lucia - Scientific Institute for Research, Hospitalization and Health Care

Coauthors
Delussu AS, Averna T, Pellegrini R*, Brunelli S
Santa Lucia Foundation, Rome, Italy
* ITOP, Palestrina, Rome, Italy

Abstract
This study compares two prosthetic systems to generate vacuum suspension in trans-tibial amputees with unhealed wounds on the stump in terms of trend to heal the stump lesions, time to prosthesis fitting and start of gait rehabilitation, and mobility.

Introduction
Recently, the use of Total Surface Bearing (TSB) sockets in trans-tibial (TT) amputees has increased, because they provide a more uniform distribution of the pressure on the stump and reduce shear forces as compared to Patellar Tendon Bearing (PTB) sockets. TSB suspension is created by a vacuum system. The vacuum can be obtained by an active pump connected to a shock absorber (VASS –Vacuum Assisted Socket System), or passively by a one way valve positioned in the distal part of the socket. The subatmospheric pressure inside this suction socket (SS) is generated during weight bearing in the stance phase extruding the air between the socket and the liner. The generated vacuum could promote healing of stump wounds even if the presence of an unhealed stump wouldn't allow for fitting a prosthesis because of the dange to worsen the skin lesions (1). The aim of this study is to evaluate if these new suspension systems can be useful in amputees suffering from unhealed wounds on the stump.

Methods
We enrolled 20 dysvascular TT amputees suffering from post surgical wound healing failure/problems or patients already wearing a permanent prosthesis and suffering from dermal ulceration due to the use of his/her prosthesis. Other inclusion criteria were stable clinical condition, intact mental status, K-level 2 or 3 (2) and age 18 to 75 years. All subjects referred to our Institute since 2006 meeting the inclusion criteria were randomized to either the VASS Group (VAG) using the TEC-Harmony® system or the suction socket group (SSG) using a TSB with a standard one-way expulsion valve.
Each subject was monitored once a week in the first month, every 2 weeks in months 2 and 3 and at 5, 7 and 9 months after inclusion.
We measured the axes of the wounds, the time until prosthesis fitting and start of gait rehabilitation was possible and tested the ability to use the prosthesis with the Locomotor Capability Index (LCI) (3).

Results

We enrolled 16 male and 4 female patients. 12 subjects were randomized to the VAG (mean age 54±15 yrs) and 8 subjects to the SSG (mean age 69±7 yrs). 4 patients dropped out (3 from the SSG and 1 from the VAG). 4 patients are completing their follow up (FU) in the next 6 months.

The mean time since amputation was 301±286 days in the VAG and 132±11 in the SSG. The patients were discharged from in-patient rehabilitation on average 6 weeks after prosthesis fitting with no significant difference between groups.

In the VAG, at the first evaluation, the mean long wound axis was 2.5±2.4 cm and the mean short axis was 1.6±1.7 cm. In the SSG, at the first evaluation, the mean long wound axis was 2.6±0.9; the mean short wound axis was 1.8±1.1 cm.

In the VAG prosthesis fitting and start of gait rehabilitation was possible immediately after admission, on average after 12.9±7.6 days. At 9 months FU the wounds of all patients in the VAG had healed completely despite permanent prosthesis use. In the SSG patients did not tolerate prosthesis use at all, therefore prosthesis fitting and start of gait rehabilitation was only possible after complete wound healing, which occurred on average after 52.8±23.5 days.

With respect to ambulation capabilities the VAG demonstrated higher mean values of LCI as compared to SSG at 9 months FU with 31±12 vs. 19.9±19. Due to the limited patient number enrolled that difference did not reach statistical significance, but can be considered clinically relevant.

Conclusion

When an unhealed wound is present on the stump, the possibility to use a prosthesis is a challenge to the rehabilitation of TT amputees. Our study focused on the efficacy of two kinds of vacuum socket systems (active pump or passive suction) in subjects with this problem. Our preliminary results show that a VASS permits to fit a prosthesis and start rehabilitation earlier and reach walking autonomy faster and at a higher level than a suction socket. Wound healing during prosthesis use was only achieved with the VASS, whereas the suction socket could only be fit after complete wound healing which was achieved by prosthesis discontinuation, wound care, and drug treatment. The wound healing property of the VASS could be related to the constant generation of a high negative pressure between the stump and the socket by the active pump (4, 5). This property could not be demonstrated in the passive suction systems. A larger trial is desirable to confirm the results of our study.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3649-None]

Modern Treatment in Chronic Low Back Pain

Session Chair
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Session Chair
Kladny, Bernd (Herzogenaurach DE) | Prof. Dr.
m&i-Fachklinik Herzogenaurach - Abteilung für Orthopädie

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Symposium: Modern Treatment in Chronic Low Back Pain
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Back Trouble

Congress Lecture [3650-702]

Chronic (Low) Back Pain: Risk Factors, Differential Diagnostics and Treatment Strategies

Author
Casser, Hans-Raimund (Mainz DE) | Prof. Dr. med.
DRK Schmerz-Zentrum

Introduction

The commonly used term “backache“ is not a specific diagnosis. It rather refers to a diffuse symptom complex, which is mainly characterized by sustained pain, particularly in the lumbar-sacral region, which may be accompanied by pain emanating into the legs. This symptom complex typically occurs in patients with chronic backache problems. Due to its bio-psycho-social consequences, mono-disciplinary diagnostic and therapeutic action is not really a viable option.

Results

The results of recent studies and clinical experience call for a timely identification of patients with an increased risk of chronification - which can be facilitated by “psycho-social screening”, i.e. by way of instruments such as the “Heidelberg Questionnaire” HKF R10. Patients with an increased risk of chronification thus identified should then be immediately subjected to a pain-therapeutic assessment process, followed by an inter-disciplinary exchange among experts, so as to facilitate outlining a suitable multi-mode therapy program.

Conclusion

In view of the related evidence-based medical findings and the well-known economic consequences of chronic backache, the relevant basic provisions of the health care system and its policies and rules should be applied and utilized to their full potential, e.g. implemented as “integrated preventive care agreements”; however, this should also include adequate support for the providers of such health-care services.

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Symposium: Modern Treatment in Chronic Low Back Pain
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Back Trouble

Congress Lecture [3651-734]

Best-Practice-Recommendations for Objectives, Contents and Methods in the Rehabilitation of Chronic Low Back Pain - A Review of Current Literature

Author
Hofmann, Jana (Erlangen DE)
Institut für Sportwissenschaft und Sport

Introduction

The cooperative project „Quality management in the process of care management of back pain“ (Bertelsmann Stiftung, 2007) focuses on the development of an integrative care management conception to improve the quality in the care of back pain. Paying attention to existing quality deficits in the sector of rehabilitation with its interfaces to curation and aftercare, one aim of the task force “rehabilitation” was to provide best-practice recommendations for objectives, treatment principles, and components of therapy in the rehabilitation of chronic low back pain in Germany for persons in the age of 18 – 65 years.

Methods

The development of the best-practice recommendations was based on three work steps: a) Search of Databases (2000 - 2006) for international systematic reviews in English-language. The findings summarize the best available evidence on the effectiveness of active forms of treatment with a biopsychosocial approach in the therapy of non-specific chronic low back pain (8 hits), (b) Interviewing experts for successful national intervention forms in the therapy of nonspecific chronic low back pain (7 hits) as well as c) consensus-finding process for the development of the best-practice recommendations. For an update of the best available evidence, an additional search of databases (2007 - 2009) was performed after national and international systematic reviews (5 hits).

Results

Interdisciplinary rehabilitation in the therapy of chronic low back pain turns out to be effective if it is carried out with high intensity, individually tailored to the needs of the patients and characterized by multiprofessional cooperation (Guzman et al. 2002). An essential component is exercise therapy to reduce fear of movement, to advance movement skills and to encourage positive experiences with exercise as well as to improve physical conditioning. Exercise therapy should also be directed towards the return to work and to normal daily activities and should be supervised by interdisciplinary qualified physical therapists or an interdisciplinary team (Hayden et al. 2005, Guzman et al. 2002, Schonstein et al. 2003). Further essential components are cognitive-behavioral treatment and patient education interventions as well as stress management interventions to identify and modify maladaptive cognitions and to improve pain coping skills (Ostelo et al. 2005, Hoffman et al. 2007).

Conclusion

The implementation of the best-practice-recommendations leads to an improvement of the quality of care of chronic low back pain. Further clarification of underlying working mechanisms

is necessary for the enhancement of the short-term effectiveness and assurance of the long-term effectiveness
(Bethge & Müller-Fahrnow, 2008).

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Symposium: Modern Treatment in Chronic Low Back Pain
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Back Trouble

Congress Lecture [3652-720]

Multidisciplinary Team Approach in Rehabilitation of Low Back Pain Patients

Author
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Introduction

According to a recent by Hüppe and Raspe effects of multidisciplinary treatment programs for patients with chronic low back pain in Germany seem to be rather weak and not to have persisting effects. Factors which could counteract possible benefits of treatment are, among others, psychic and job-related stresses and strains persisting after treatment. A multidisciplinary, in-patient treatment program for patients with chronic low back pain, therefore, was amendet by multidisciplinary diagnosis and assignment and measures to support vocational solutions.

Methods

To evaluate the effects of the multidisciplinary program in comparison to a control group with the usual care, a prospective longitudinal study was conducted. 307 patients were assigned to the multidisciplinary in-patient treatment program, whereas 176 patients with comparable complaints had the standard rehabilitation program. Besides the full sample, we analyzed a subgroup of patients with chronic low back pain.

Results

We found positive moderate and strong effects in the intervention group concerning function, pain, psychic strains as well as the number of sick days and return to work rates 10 months after discharge. Effects in the intervention group exceeded the effects achieved in the control group. Beside the full sample, we analyzed a subgroup of patients with chronic low back pain, who received an intense activating group treatment. Also in this subgroup we found moderate and strong effects of treatment superior to those in the control group for function, psychic strains and sick days.

Conclusion

We attribute these persisting and superior effects in the treatment group to an efficient treatment of occupational and psychic problems as well as to more homogeneous treatment groups attained by a multidisciplinary diagnosis and team-based assignment. They also show the significance of in-patient-treatment which effective, when – based on multidisciplinary diagnosis – differential treatment groups can be formed.

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Symposium: Modern Treatment in Chronic Low Back Pain
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Back Trouble

Congress Lecture [3653-703]

The Role of Orthotics in Chronic Low Back Pain

Author
Kaphingst, Wieland (Kennesaw, GA US) | Dipl.-Ing.
Bauerfeind Inc. USA and Bauerfeind AG

Abstract
The presentation at hand will therefore provide an overview of the topic in presenting a mix of descriptive spinal anatomy of the relevant spinal segments, the effects of spinal patho-mechanics and will outline corrective effects and limitations of biomechanic correction provided through the means of spinal orthoses.

Introduction
The Department of Medicine, University of Washington, Seattle, WA, concludes, after statistical analyses of clinical research in the year 2002, that about 1/4 of all adults in the USA report lower back pain within the last 3 months; visits of the physician for reasons of low back pain are in the range of 2.3 % of all physicians visits in the USA.
Other resources (statistics of workmen's compensation organizations) tell us that low back pain is considered as a leading reason for absence from work internationally.
This information from sources in the US may be assumed in similar size for other industrial nations with sufficient probability.

Results
Thus "Chronic Low Back Pain", triggered by pathomechanical-degenerative or pathomechanical-traumatic conditions, may be considered a leading cause of pain-related conditions, of sick-days at work and a burden to the afflicted individual as well as to society.

Conclusion
Orthotic principles and their biomechanical effects therefore seem worthwhile to be considered more intensively, if spinal pathomechanics with its functional, neurological and other effects are treatable by the "physio-mechanic", or "biomechanic" measures of orthotic correction.

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Symposium: Modern Treatment in Chronic Low Back Pain
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Back Trouble

Congress Lecture [3654-918]

The Orthotic and Prosthetic Perspective in Age-related Diagnosis of Low Back Pain

Author
Landauer, Franz (Salzburg AT) | Dr.
Universitätsklink für Orthopädie Paracelsus Medizinische Privatuniversität

Introduction
For a targeted orthotic treatment in chronic back pain, a biomechanical assessment of the cause of pain is necessary.

Methods
Causes of back pain frequency will be biomechanically assessed and brought into line with a possible orthotic supply.

Results
In children disorders of the congenital lumbosacral junction are the first noticeable reason of complaints. Malposition or scoliosis are the first clinical signs. The link between scoliosis and back pain is increasingly found in lumbar curvature with a rotational component. A spondylolysis or spondylolisthesis is more frequently in very active children. The diagnosis of CRMO (chronic recurrent multifocal osteomyelitis) is known only since a few years and
needs specific treatment. For the adolescent the Scheuermann disease is typical. From this age we have to look for the first manifestation of rheumatic causes, like spondylitis ankylosans. Also a bone tumor has to be considered. The adulthood is characterized by disc problems. In this focus on the disc rare diagnoses with therapeutic consequences such as spondylodiscitis or metastases must not be missed. Acute or recurrent pain can occur from the facet joints or muscular overload. Professional overloads are on the first place. Sometimes psychological stress factors start the symptoms, or lead to strengthening and chronic pain.
With increasing age, it is the monosegmental instability, which is the result of a previous disc surgery. Segmental fusions have become a current priority issue. With advancing age
structural disorders become more frequent such as osteoporotic fractures and spine deformities affecting the surrounding segments. The decreasing mobility leads to the loss of compensation mechanisms. Coxarthrosis and low back pain become a diagnostic unit.

Conclusion
Increasingly, it is also the spinal stenosis leading to mobility restrictions.
The age of the patient is a main factor for the diagnosis of low back pain. A rapid diagnosis and targeted orthotic treatment in respect of contraindications is necessary.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3661-None]

Lower Limb Prosthetics - Hip

Session Chair
Raggi, Michele (Vigorso di Budrio IT) | B.Sc.
INAIL Centro Protesi - Motion Analysis Laboratory

Session Chair
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg221444

Session: Lower Limb Prosthetics - Hip
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3059-257]

Biomechanical Aspects of the Helix3D Hip Joint System

Author
Bellmann, Malte (Göttingen DE) | Dipl.- Ing. (FH)
Otto Bock HealthCare GmbH - Research Biomechanics

Coauthors
Bellmann M, Schmalz T, Blumentritt S

Abstract
Kinematics and kinetics of 6 hip disarticulation patients with the Helix and 7E7 Hip Joints were analysed during gait. The results show that the Helix offers functional advantages: A more symmetrical gait pattern results from knee and hip characteristics which are significantly more physiological.

Introduction
After hip disarticulation amputation, all joints of the lower extremity must be replaced by a hip disarticulation style prosthesis. Since the development of the Canadian hip disarticulation prosthesis [1], all prosthetic hip joints available for this type of fitting have been of a similar design and their functionality has thus far been assessed as low [2]. Therefore, for more than 50 years, the resulting gait pattern of hip disarticulation patients (HDs) has been characterised by abrupt extension of the hip joint at the beginning of the stance phase [3]. This presentation analyses the possibility of improving the gait pattern of hip disarticulation patients with an innovative hip joint.

Methods
In the study, the conventional 7E7 prosthetic hip joint was compared with the polycentric Helix3D Hip Joint with integrated hydraulic control unit. The C-Leg® and C-Walk® (all components: Otto Bock, D) were used as the knee and foot components in both prostheses.
Based on biomechanical data, the gait of 6
HDs was analysed with both hip joints. Two synchronised systems were used to record the movement parameters; an optoelectronic camera system (VICON 460, Oxford Metrics, GB) with six CCD cameras to record the kinematics and two linked force plates (KISTLER AG, CH) to record the kinetics.

Results
The characteristics of the foot, knee joint, hip joint and pelvis exhibit significant joint-specific differences.
With the Helix3D Hip Joint, maximum plantar flexion at the beginning of the stance phase is reached much earlier – at 10% of the gait cycle – compared with the 7E7.
The knee angle exhibits stance phase flexion of 10° with the Helix3D Hip Joint while the peak value is significantly lower with the 7E7. In addition, the maximum swing phase knee flexion angle of the C-Leg® is also greater with the Helix3D Hip Joint. The difference between the maximum knee angle of the prosthesis and the contralateral side is thereby significantly reduced to 8º for the Helix3D Hip Joint compared with 17º for the 7E7.
The hip angle and hip angle speed of the Helix3D hip joint are also clearly more physiological in comparison with the 7E7. With the 7E7, maximum extension of the hip joint is reached very quickly while maximum extension is reached much later with the Helix3D hip joint (figure 1).

The pelvic movement in the sagittal plane is particularly noticeable. At 25°, the range of motion in HDs with the 7E7 is increased by approximately 600% compared to the physiological range. With the Helix3D Hip Joint, it is reduced significantly to 20°.

Conclusion

The motion analysis shows that the Helix offers functional advantages for HDs.
Among other things, this is due to the fact that stance phase damping allows the user to extend the hip joint with dampening. This makes movement in the hip joint much more physiological. Also the very large range of pelvic tilt motion typically seen in HDs is reduced. In addition, this hip joint makes it possible to carry out almost physiological stance phase knee flexion, which also results in earlier maximum plantar flexion of the prosthetic foot. This increases the ground surface support sooner and minimises the risk of slipping. The difference in the knee angle gradient between the two hip joints is revealed with respect to the maximum angle in swing phase. This is much larger with the Helix and therefore reduces the asymmetry between the prosthetic and sound side.
Therefore, the Helix provides a more symmetrical gait pattern and a reduction of the load on the sound limb.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg221444/cg36435

Session: Lower Limb Prosthetics - Hip
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3623-682]

Gait Analysis of Newly Developed Hip Disarticulation Prosthesis Walking - Rotation Axis of Hip Joint is on the Side of Socket

Author
Naito, Hisashi (Toyonaka JP) | Dr.
Osaka University - Department of Mechanical Science and Bioengineering

Coauthors
Yamasaki N,Aikawa T,Inoue T,Matsumoto T,Tanaka M

Abstract
We developed a new hip disarticulation prosthesis (HDP) of which hip joint is attached on the side of socket. In order to evaluate the new HDP, walking experiment was performed on two subjects. Gait was clearly improved especially in motion of pelvis and knee joint of prosthetic side.

Introduction
Now, the Canadian type HDP [1] is commonly used as prosthesis for hip amputees. The HDP has well dynamic and static stability because of characteristic alignment of hip and knee joints, that is, neutral posture of these joints are apparent hyper-extension. However, in gait using the HDP compensatory movements of lumber and ankle joint are often observed. On the assumption that that the compensatory movements are occurred from the characteristic alignment, a new HDP was developed. Hip joint of the HDP is attached on the side of socket was developed, then, the neutral alignment of hip and knee joint is closer to normal anatomical skeletal structure. On gait analyses using the HDP, lumber joint motion was smaller and knee joint motion of sound side was more natural than that during walking with Canadian type HDP which is used in daily living by subjects.

Methods
Figure 1 shows schematic illustration of new hip joint and pictures of developed HDP. The rotation axis of hip joint is attached on the side of the socket and load bearing is supported by rail and roller, which are attached on the bottom of stump side of the socket and the top of femoral part, respectively. Range of extension and flexion movement of the hip joint is mechanically limited by contact element. Only during extension movement passive joint resistance moment is generated using oil damper. The HDP is good match with stable knee joint. The alignment of the knee joint was tuned by reference to trans-femoral prosthesis alignment. Walking using the developed HDP and the conventional HDP which is used in daily living by each subject was measured on two subjects by using Vicon 512 system (12 cameras) and Kistler force plate (8 plates). In the experiment, cadence 70 steps/min and 10 times trial in each case are defined as normal condition.

Results
Figure 2 and 3 show lateral stick views of one step walking with the developed HDP (a) and conventional HDP (b) of subject 1 and 2, respectively. In stick views, solid lines and dashed lines indicate sound side body segments and amputated side limbs, respectively. Figure 4 and 5 show lumber joint angle average and standard deviation of one step walking with each HDP of subject 1 and 2, respectively. In both subjects' walking, distinctive changes between walking with the two different HDPs were observed. Knee flexion motion in swing phase of prosthetic leg seems natural flexion-extension motion in walking with the

developed HDP. It is considered caused by that the neutral alignment between femoral and tibial segment is non-hyperextension in the developed HDP. On lumber joint motion in walking with the developed HDP, its amplitude is smaller and flexion just minutes after prosthetic heel contact get remarkably lower and much more moderate.

Conclusion

A new HDP of which hip joint is attached on the side of socket is developed. Walking experiment was performed on two subjects for evaluating the new HDP. Gait was clearly improved especially in motion of pelvis and knee joint of prosthetic side.

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Session: Lower Limb Prosthetics - Hip
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3214-396]

Application of a Motion Analysis Protocol for the Assessment of High-tech Prosthetic Components: a Case Study Concerning the Otto-Bock Helix3D

Author
Raggi, Michele (Vigorso di Budrio IT) | B.Sc.
INAIL Centro Protesi - Motion Analysis Laboratory

Coauthors
Cutti AG, Govoni G, Gherardi L, Davalli A

Abstract
The aim of this work was to assess the effect of the novel Otto-Bock (D) Helix3D hip joint, on the gait of a hip-disarticulated amputee, compared to the standard Otto-Bock 7E7. Results showed multiple improvements of gait with the Helix3D, including a lower net metabolic cost and improved symmetry.

Introduction
We developed a protocol to assess the gait of amputees when using novel lower-limb prosthetic components in everyday life environments. As an example of application, the aim of this work was to assess the effect on gait of the Helix3D (a novel hip joint by Otto-Bock, D), using as reference the same amputee walking with his standard prosthesis featuring an Otto-Bock 7E7 hip joint. More specifically, we wanted to test if the amputee, when walking overground with the Helix3D, shows:
H1) a faster self-selected comfortable (CS) and slow speeds (SS);
H2) a degreased net metabolic cost;
H3) a reduced Stance Time Asymmetry (STA) between the sound and the prosthetic side, with the index
STA=abs((ST_SOUND -ST_PROSTHETIC)/ ST_SOUND)*100
shifting toward 0;
H4) a reduced Asymmetry of the Vertical ground reaction Force Peak at loading-response (VFPA) between sound and prosthetic side, with the index
VFPA=abs((VFP_SOUND -VFP_PROSTHETIC)/VFP_SOUND)*100
shifting toward 0.

Methods
After giving his informed consent, a 38 year-old hip-disarticulated amputee (K3) was acquired twice, once with this usual prosthesis, and after two months of use of the Helix3D.
To test H1 and H2, the protocol described in [1] was used. VO2, VCO2 and Heart Rate (HR) were measured by means of a K4b2 (Cosmed, I) on the patient: 1) resting in sitting position for 10 minutes; 2) walking at CS and SS along an 80m long corridor, until HR, VO2 and VCO2 reached a steady-state. CS and SS were measured with a stopwatch.
To test H3 and H4, the plantar pressure values were measured by means of a PedarX (Novel, D) during two walking trials at CS and SS along the 80m corridor. For each side and step, ST and VFP were calculated from the integral of the pressure over time. For each couple of consecutive steps, we calculated the indexes STA and VFPA. STA and VFPA were aggregated by speed and prosthesis in box-plots with notches and compared between groups through the Wilcoxon test.

Results
Regarding H1, with the Helix3D the SS changed from 2.7 to 3.3 Km/h, and the CS from 3.1 to 3.6 Km/h.
Regarding H2, with the Helix3D the net metabolic cost of walking changed from 0.29 to 0.19 mL/Kg*m at the SS, and from 0.31 to 0.24 at CS.
Results for H3 are reported in Fig. 1a. At SS, STA showed a significant reduction with the Helix3D compared to the 7E7 ($p=0.0001$); at CS, no significant differences were found between the two prostheses ($p=0.72$). Importantly, with the 7E7 the STA at the two speeds was substantially different ($p<0.0001$), while with the Helix3D the results were almost comparable ($p=0.04$).
Results for H4 are reported in Fig. 1b. With the Helix3D, the VFPA improved at both SS and CS; similarly to H3, the differences found between the two speeds for the 7E7 ($p<0.0001$), were not found with the Helix3D ($p=0.60$).

Conclusion
In conclusion, using the Helix3D, the amputee improved the energetic efficiency of his gait, reduced the force peak asymmetry at the loading response and showed a higher adaptability to walk at different speeds. The convergence of these results suggest that the Helix3D could be of great benefit for hip-level amputees, and strongly support the continuation of the study on a much broader population.

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Image: Abstract Helix_new_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg221444/cg40480

Session: Lower Limb Prosthetics - Hip
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3065-263]

An Alignment Method for Hip Disarticulation and Hemipelvectomy Prostheses: A biomechanical Evaluation

Author
Bellmann, Malte (Göttingen DE) | Dipl.- Ing. (FH)
Otto Bock HealthCare GmbH - Research Biomechanics

Coauthors
Ludwigs E, Blumentritt S

Abstract
By determining the load balance point on the prosthetic side and the individual pelvic tilt, a verified, functional sagittal plane alignment of HD style prostheses is provided and only plantar flexion needs to be adapted during static alignment optimisation using the L.A.S.A.R. Posture.

Introduction
In a hip disarticulation style prosthesis, the sagittal plane is especially critical for proper functionality1. If the prosthetic components are not positioned according to biomechanical principles, potentially unsafe situations and non-physiological movement patterns of the user may result. For hip disarticulation and hemipelvectomy amputees, the only option for actively controlling the prosthesis is through pelvic motion2,5. Therefore, a neutral socket tilt and the position of the prosthetic components – the socket, hip joint, knee joint and prosthetic foot – in the sagittal plane are of particular importance.
Established alignment methods use the geometry of the pelvic socket as a guide for the purpose of bench alignment2,3. Another method takes the pelvic socket tilt under load into account4. However, none of these methods have considered what criteria should be used for the static alignment optimisation of the prosthesis under load in clinical fitting practice.

Methods
The functionality of various prosthetic alignments was investigated in a study of the 7E7 and Helix3D prosthetic hip joints (both Otto Bock)5,6 with 6 test subjects (4m, 2f).
The new alignment method that was used is divided into three steps:
1. Determine a sagittal socket reference line under load (load balance point on the prosthetic side with neutral pelvic/socket tilt)
2. Bench alignment of the prosthesis
3. Static alignment optimisation using L.A.S.A.R. Posture
Starting from this established alignment, the socket was shifted 12 mm/24 mm to the anterior / posterior respectively. Each alignment was assessed subjectively by the test subjects and a gait analysis while walking on a level surface was conducted. An optoelectronic camera system (VICON 460, GB) combined with two force plates (Kistler, CH) was used for measurement.
The validity and reproducibility of the new alignment method was verified by 16 additional prostheses with various socket technologies from different users.

Results
Comparative test:
Biomechanics:

The external sagittal knee moments change systematically when the socket is shifted. A posterior shift by 24 mm causes flexion moments to act around the knee axis of rotation during loading response. This leads to a different magnitude of stance phase knee flexion with both hip joints. An anterior shift by 24 mm increases the knee extension moments and initiation of swing phase becomes more difficult with both hip joints.
The optimum configuration was achieved with a 12 mm posterior shift for the 7E7 and a 0 mm shift (neutral alignment) for the Helix3D.
Subjective assessment:
The subjective assessment of the alignment variations by the test subjects (standing comfort and security, security during load transfer, initiation of swing phase, overall evaluation) agreed with the biomechanical parameters for the respective optimum alignment. The bench alignment parameters for the respective hip joints are shown in Figure 1.
Verification of validity and reproducibility:
The subsequent verification of the new alignment method showed that it leads to a reproducible, functional prosthetic alignment – regardless of the patient characteristics and socket technology – and that the alignment merely needs to be optimised for individual plantar flexion under load. However, this optimisation is an established part of the method and serves to assure fitting quality.

Conclusion

Figure 1: Alignment recommendations for a hip disarticulation style prosthesis
Based on good reproducibility when determining a sagittal alignment reference line on the hip disarticulation style socket under load (load balance point on the prosthetic side with neutral socket tilt), the method presented here facilitates alignment in the sagittal plane. This represents an improvement over previous methods with respect to biomechanical aspects. It is absolutely necessary to adhere to the chronological sequence of the individual steps to ensure that prosthetic alignment in clinical fitting practice is done quickly and is stable as well as functional.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3583-None]

ICF (International Classification of Functioning, Disability and Health)

Session Chair
Burger, Helena (Ljubljana, Slovenia SI)
Institute for Rehabilitation, Republic of Slovenia - Centre for P&O

Session Chair
Kohler, Friedbert (Sydney AU) | Associate Professor
Sydney South West Area Health Service

Abstract
This symposium will give an understanding of the ICF, its current and future clinical applicability and potential use.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70973

Symposium: ICF (International Classification of Functioning, Disability and Health)
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3584-756]

An Overview of the ICF

Author
Rauch, Alexandra (Nottwil CH)
Schweizer Paraplegiker-Forschung

Abstract
The International Classification of Functioning, Disability and Health (ICF) is the basis for the conceptualization of the rehabilitation strategy and is of relevance for the curative, preventive and supportive health strategies. The ICF and the ICF-based conceptualization of the rehabilitation strategy are again the basis for the organization of human functioning and rehabilitation research in distinct scientific fields and the development of research capacity with respect to academic training programs, interdisciplinary university centres and national/international collaboration networks.
Next to these conceptual developments, there is now a wide range of activities throughout the world of rehabilitation in the development of practice tools and applications of the ICF. First of all, the ICF can serve as reference for the comparison, selection and further development of existing measures of human functioning. The mapping of the world of measures can now rely on established linkage rules. The development of

Introduction
The International Classification of Functioning, Disability and Health (ICF) is the basis for the conceptualization of the rehabilitation strategy and is of relevance for the curative, preventive and supportive health strategies. The ICF and the ICF-based conceptualization of the rehabilitation strategy are again the basis for the organization of human functioning and rehabilitation research in distinct scientific fields and the development of research capacity with respect to academic training programs, interdisciplinary university centres and national/international collaboration networks.

Results
Next to these conceptual developments, there is now a wide range of activities throughout the world of rehabilitation in the development of practice tools and applications of the ICF. First of all, the ICF can serve as reference for the comparison, selection and further development of existing measures of human functioning. The mapping of the world of measures can now rely on established linkage rules. The development of minimal standards for the assessment and reporting of functioning based on the ICF as a reference has made progress over the last years in cooperation between ISPRM, the ICF Research Branch WHO CC FIC (DIMDI), and WHO. The Brief ICF Core Sets are the standards for reporting and planning of studies as well as for clinical encounters. The Comprehensive ICF Core Sets are the standards for multi-disciplinary assessments for example in the context of rehabilitation medicine. Another important development in relation to the ICF in clinical practice and research is the operationalization of the ICF qualifiers as a means to directly apply the ICF in practice and research.

Conclusion
Under the leadership of the Functioning and Disability Reference Group (FDRG) of the WHO Family of International Classification (WHO-FIC) network, a task force is therefore coordinating the further development of coding rules and specific measurements in relation to one ICF or more ICF categories.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70973/cg71105

Symposium: ICF (International Classification of Functioning, Disability and Health)
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3585-829]

Development of ICF Core Sets for Persons Following Amputation

Author
Kohler, Friedbert (Sydney AU) | Associate Professor
Sydney South West Area Health Service

Introduction

Amputation is common in industrialised and in non industrialised nations, with a prevalence of 17 to 30 per 100000 in Europe and as high as 67 per 100000 in Africa (1). Incidence of amputations has increased in line with the continued prevalence of the main aetiological factors of diabetes, motorised transport use and conflicts in particular the use of the land mines. A challenge is to develop an internationally standardized instrument to use in the setting of the patient with an amputation. ICF Core Sets are a practical solution in many chronic conditions and may be a solution for the patients with amputations as well. ICF Core sets can also be utilised as outcome measures (2). This could contribute significantly to standardisation of treatment outcomes for patients with an amputation.

Methods

The development of ICF Core Sets can be considered in three phases: preparatory phase, ICF core set development and testing and evaluation (3). In the preparatory phase all relevant perspectives are addressed. (a) A systematic broad-based literature review identifies and quantifies the concepts underpinning the published and developed outcome measurements. The underlying concepts are linked to ICF categories. (b) Patient interviews, either individually or in focus groups, explore the concepts of functioning and health important from the perspective of a patient with an amputation. The underlying concepts are linked to ICF categories. (c) An electronic survey of clinical experts identifies the perspective of relevant professionals regarding the problems for an individual with an amputation. The survey includes experts from all WHO regions and all health professional groups involved in the treatment of amputees.

Results

(d) An empirical cross sectional multi-centre study using an extensive ICF check list identifies the most common problems and describes function and health in an amputee population. The final result of the preparatory phase is an extensive and all inclusive list of ICF categories. In the Core Set development phase the ICF categories derived from the preparatory phase are discussed and refined in detail over numerous iterations until consensus is reached about which categories should be included in the Core Sets. The final iterations take place in a consensus conference attended by a broad range of international representatives. The final phase of the development of initial ICF Core Sets is the testing and validation phase which is carried out as international multi-centre study.
Results: ICF Core Set(s) have been developed for numerous chronic conditions and are being integrated into clinical practice. The development of Core Sets for amputees has commenced. A steering group with representation from the major collaborating partners WHO, ISPMR, ISPO and representatives of the WHO health regions has been formed. A scoping paper has been published (4). Funding is being sought to support the development costs.

Conclusion

Over the next few years the Core Set will be developed and everyone is invited to contribute to the process.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70973/cg71152

Symposium: ICF (International Classification of Functioning, Disability and Health)
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3586-909]

The ICF in Prosthetics and Orthotics

Author
Burger, Helena (Ljubljana, Slovenia SI)
Institute for Rehabilitation, Republic of Slovenia - Centre for P&O

Abstract
Limb amputation and other health conditions due to which persons need orthoses results in significant alterations of Body Functions and Body structures. These people also experience a wide range of activity limitations and participation restrictions. Their problems also depend on the environment.

Introduction
The current outcome measurements are useful but are not comprehensive and do not fully encapsulate human functioning. The problem is also that in different countries and rehabilitation facilities in Europe they use over fifty different outcome measures, so it is very difficult or almost impossible to compare data and different rehabilitation procedures. The International Classification of Functioning, disability and health (ICF covers all aspects and levels of human functioning but was not developed for measurement. It has many codes and is difficult to use in every day clinical practice. Several tools have already been developed and some, as core sets for persons following amputation are in development. The two chairs of the steering committee are Friedbert Kohler and Gerold Stucki.

Methods
We try the use of ICF at our outpatient clinic for P&O. Forty (40) patients, 24 men and 16 women were coded with both ICD-10 and ICF by a medical doctor trained in ICF coding. The patients were 57 years old on average. Ten had lower limb amputation, 7 upper limb amputation, 8 foot or lower limb problems, 7 poliomyelitis, 7 other paralysis and 1 multiple congenital limb deficiencies.
From 1 to 7 ICD diagnoses were coded and 12 ICF codes were used on average per patient. More ICD and ICF codes were used in patients with more devices. No environmental codes were used in 5 patients who did not have any devices, in others the number used was from 1 to 3. The more devices used by the patient, the more environmental codes were applied. The devices also improved the patient’s performance in many activities.
It can be concluded that ICF offers additional information about an individuals health and shows the impact of P&O devices on the functioning of individuals.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70973/cg71199

Symposium: ICF (International Classification of Functioning, Disability and Health)
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3587-921]

Outcome Measures Based on the ICF

Author
Rauch, Alexandra (Nottwil CH)
Schweizer Paraplegiker-Forschung

Coauthors
Alarcos Cieza

Introduction
The approval of the new international classification of functioning, disability and health (ICF) by the World Health Assembly in May 2001 is a landmark event for medicine and society. Based on this classification, functioning, with its components body functions and structures and activities and participation, is now seen not only in relation to the health condition under consideration, but also in relation to personal and environmental factors. The ICF marks the beginning of a new era of patient-oriented clinical practice, research, and teaching. All member states of the World Health Organization are now called upon to implement the ICF in education, insurance, labor, health and disability policy, health statistics, and, last but not least,
medicine.

Methods
The ICF is not an outcome measure but a classification. However, health-status measures, which are frequently used in outcome research, have been developed based on the ICF. In addition, the ICF can be used as an external and independent reference to which health-status
measures can be linked and by which they can be compared. Linking rules developed to link the concepts contained in health-status measures to the ICF are thereby applied. The ICF-based comparison provides information about the contents addressed in the different health-status measures as well as interesting insights into their differences with respect to the breadth and precision of their coverage of specific concepts. This information can be useful when selecting specific health-status measures for a study and when developing new instruments. Additionally, it can also be used to study which categories or domains of the ICF require more specification.

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Symposium: ICF (International Classification of Functioning, Disability and Health)
Wednesday 2010/05/12 | 17:00 - 18:30 | Subtopic/Track: Miscellaneous

Congress Lecture [3588-800]

The Use of the ICF in the Non-industrialized World

Author
Zhang, Xia (CN) | Dr.

Abstract
The International Classification of Functioning, Disability and Health (ICF) was approved by the World Health Organization in May 2001 and has been introduced into China for 8 years. To investigate the literature on use of the ICF in China, with regard to type of use, aims and implementation problems.

Methods
Publicly available information to describe the use of the ICF in China was obtained from the following sources: the English international databases (Medline, Pubmed and Embase) and Chinese local journal full-text databases#Chinese Journal Full-text Database (CJFD) and Wangfang Database.

Results
A sample of 53 papers written in Chinese were found, with 11 (21%) of which were translated from English. Authors from major cities (Beijing and Wuhan) of China accounted for 79% of the papers (71% and 8% respectively). The papers were published in 12 journals, of which 58% were concerned with rehabilitation medicine. The most common aims were to explain the conceptual framework and/or structure of the ICF (51%) and to apply the ICF concepts to either discipline or condition-specific management (21%). There were 6 (14%) papers on specific diseases of stroke, spinal cord injury (SCI) and chronic ischemic heart disease (CIHD), among which 4 (10%) papers dealing with the development or identification and validation of brief ICF core sets for Chinese patients with stroke and CIHD respectively. There was no paper on the psychometric issues of the classification. Problems involved overlapping codes and codes that were inappropriately applied in China due to different systems and policies compared to other industrialized countries. Non-standard use of the qualifiers was reported.

Conclusion
The use of ICF in China is still localized, therefore need to be further facilitated. There is an urgent need for a standard utilization guideline to allow for the development of brief ICF core sets in China adequately.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg70973/cg71293

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3678-None]

Foot & Shoe - Deformities

Session Chair
Matussek, Jan (Bad Abbach DE) | Dr.
Asklepios Klinikum Bad Abbach

Session Chair
Yazdani, Meria (tehran IR)
Iran Medical science University - orthosis & prosthesis

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg230579

Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3025-223]

Wedge High Heel Effect on Pressure in Forefoot

Author
Štajer, Tomaž (SI)
Institute for Rehabiltiation, Republic of Slovenia - Centre for P&O

Coauthors
Burger H, Vidmar G, Cergol S

Abstract
We measured pressure in forefoot with wedge high heel using the F-scan system. Fifteen female students participated in the study, wearing shoes with no high heel, 2 cm and 5 cm wedge high heel. We found increase in pressures under the big toe on both sides and under the first methatarsal head.

Introduction
Nowadays, many females regularly wear shoes with high heels. It is common knowledge that walking with high heels is different from walking barefoot or in flat shoes (1). The possible negative effect of high-heeled shoes has also been reported (2). High-heeled shoes cause development of degenerative joint disease and have negative effect on comfort. Increased heel height increases impact force and medial forefoot pressure during walking (2). Not only during walking but also during standing, vertical forces applied to the forefoot increase with increased heel height (3). However, there are only two published studies about the effects of high heels on foot pressures, both studying the effects of insoles. All articles also used shoes with high heels and there is no study on whether wedge heel that may be used in patients with plantarflexion contracture has the same effect. Hence, the aim of our study was to measure how the foot pressures changes with the wedge heel height.

Methods
The study included 15 female students aged between 20 and 23 years without any foot deformities who agreed to participate. We made wedge cork soles of 2 cm and 5 cm height under the calcaneus decreasing to zero height under MT joints, covered with leather.
Plantar pressures were measured using the F-Scan System (Tekscan, Boston, MA). The system consists of 0.18 mm thick sensor insoles, which have 960 pressure-sensitive, resistive and conductive sensors. These insoles are connected to cuff units and cuff units to a computer. The data were collected at 50 Hz. F-Scan has excellent resolution and provides reliable measures of relative pressure values (4).
The first measurement was performed with measuring insoles within the socks. The second (third) was done with specially made socks in which we put 2 cm (5cm) high wedge heel and fixed it on the foot with adhesive tape. The subject had to walk 10 meters in each condition.

Results
The results are presented in Table 1, whereby only the locations with noteworthy effect of wedge heel are reported. The data were summarised as mean and standard deviation; means were compared between conditions using paired t-test.
Table 1. Comparison of plantar pressures between wedge heights.
Descriptive statistics P-value for wedge comparison
no wedge 2 cm wedge 5 cm wedge no vs. 2 cm no vs. 5 cm 2 vs. 5 cm
Left foot Toe 7.3 (5.1) 12.4 (6.0) 13.3 (8.6) 0.009 0.015 0.098

2nd MT joint 11.1 (4.8) 10.1 (3.7) 8.3 (3.9) 0.173 0.076 0.465
3rd-4th MT joint 9.8 (4.0) 9.9 (3.5) 4.7 (3.9) 0.154 0.057 0.199
5th MT joint 5.1 (2.8) 4.2 (2.3) 2.8 (1.4) 0.076 0.046 0.028
Heel 27.1 (8.8) 27.2 (9.2) 22.3 (9.7) <0.001 0.006 0.001
Right foot Toe 8.5 (5.0) 11.7 (6.3) 11.6 (7.7) 0.011 0.002 0.001
1st MT joint 4.4 (1.6) 5.3 (3.0) 6.0 (2.5) 0.010 0.001 0.010
2nd MT joint 12.5 (7.3) 10.9 (7.8) 8.8 (4.3) 0.002 0.044 0.001
3rd-4th MT joint 11.2 (6.6) 8.3 (3.5) 7.5 (4.5) 0.076 0.096 0.001
5th MT joint 5.5 (3.4) 3.8 (1.7) 3.0 (2.0) 0.015 <0.001 0.009
Values are reported as Mean (Standard Deviation); means were compared using paired t-test.

Conclusion

We found significant increase in pressures under the big toe on both sides and a slight increase under the first methatarsal head (statistically significant only on the right foot). Pressures under the second to fifth methatarsal heads slightly but significantly decreased. A slight significant decrease has been observed also under the left heel.

It is difficult to compare our results with results of others, because we used different systems and different areas under which pressures were measured. Hong et al. (2) also found that high heels increased pressures under the big toe and decreased it under lateral part of forefoot. Their study also reported on an increase under the medial part of the forefoot, where we did not observed any notable increase.

The differences we observed may be due to the fact that we did not measure in the shoes, but in socks only, which may allow distribution of pressures over larger areas, or because of the use of wedge heels instead of conventional heels.

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Image: Stajer Table 1_None.doc (see online)

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Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3418-593]

The Effect of Shoe Sole Thickness on In-shoe Plantar Pressure and Perceived Comfort for Patient with Metatarsalgia

Author
Chan, Wilson Y K (HK)
The Hong Kong Polytechnic University - Health Technology & Informatics

Coauthors
Leung AKL, Lui TH

Abstract
Metatarsalgia is a common problem causing forefoot pain. The sole thickness is an important characteristic of a shoe especially for the patient with metatarsalgia of biomechanical cause. The effect of shoe sole thickness on in-shoe plantar pressure and the perceived shoe comfort will be reported.

Introduction
Metatarsalgia may involve a component of mechanical overload causing forefoot pain. The biomechanical interventions for these conditions incorporate some form of off-loading through the use of shoe modifications, metatarsal pads and orthoses. Previous studies concentrated in the effectiveness of orthoses in term of the off-loading capability. Advice on proper shoes to patient with metatarsalgia is important in the treatment regime and cannot be ignored. Except the heel height, other characteristics of off-the-shelf shoes are of minor concern in the management of metatarsalgia. The shoe sole thickness may affect those patients with metatarsalgia of biomechanical causes. The correlation between shoe sole thickness, in-shoe plantar pressure and perceived shoe comfort is still unclear. The objective of this study is to determine whether different sole thickness will result in changes in plantar pressure distribution and perceived comfort during walking for patient with metatarsalgia.

Methods
Fifteen female subjects with metatarsalgia volunteered for the study. All subjects had experience of wearing thin-soled shoes (less than 5mm) and were free from other problems that prevented the subject making a judgment of foot pain severity and perceived shoe comfort. Three types of off-the-shelf shoes with different sole thickness (4mm, 8mm, 12mm) were compared. The F-Scan System (Tekscan, USA) was used to measure the in-shoe plantar pressure during three trials of comfortable cadence along a 15 meters long indoor level walkway. The peak pressures were measured at the forefoot, midfoot and hindfoot regions of subject's right feet when the subjects walked with the three types of shoes. The middle ten steps were used for analysis. The subjects also rated the perceived comfort and pain during the walking trials by Visual Analogue Scales (VAS). Analysis of variance tests were used to determine differences in perceived comfort and pressure variables between the three types of shoes.

Results
The result indicated that increasing shoe sole thickness decreased significantly the peak pressure in the forefoot and hindfoot ($P<0.05$). In particular, comparing the Leather Sneaker (12mm sole thickness) with the Ballet Flat (4mm sole thickness), thick-soled shoes reduced forefoot peak pressure by 26.9% and hindfoot peak pressure by 19.5%. Thicker sole also reduced the forefoot plantar force and forefoot force-time integral by 4.8% and 15.7% respectively. The comfort rating was significantly increased in all foot

regions with increasing of shoe sole thickness (P<0.05). In contrary, the forefoot pain score decreased with an increase of sole thickness. There was a significance difference (P<0.001) in walking pain score between Ballet Flat and Leather Sneaker. The overall comfort rating was positively correlated with peak pressure in the hindfoot (r=0.646, P<0.001) and mean peak pressure in the midfoot (r=0.577, P<0.05), but not correlated with the peak pressure in the forefoot. The forefoot comfort rating has the highest correlation with the overall comfort rating (r=0.825, P<0.01). There was no significant difference in the cadence and duration of stance in all foot regions between the three types of shoes.

Conclusion

The findings suggested that thin-soled shoes resulted in increased plantar pressure and decreased plantar comfort, which can be reflected by both the subjective rating scale and biomechanical variables. Increased forefoot pain was resulted when walking with thin-soled shoes. For the shoes compared in this study, peak plantar pressure and the force-time integral in the forefoot did not appear to be correlated to the perceived plantar comfort. For patient with metatarsalgia, the perceived comfort at the forefoot contributed a major role in rating the overall comfort of the shoes. The result of this study served as a simple guide to advice patient with metatarsalgia for the selection of appropriate off-the-shelf shoes. The correct choice of shoes may help to relieve forefoot pain with or without fitting of other orthotic devices.

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Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2991-189]

A Prospective Dynamic Pedobarographic Study of Indirect Kinematic Changes in the Roll-over Process of Valgus Foot Deformities Pre/Post Surgery in CP

Author
Matussek, Jan (Bad Abbach DE) | Dr.
Asklepios Klinikum Bad Abbach

Coauthors
Weingaertner J, Stemper W, Hofbauer R, Grifka J

Abstract
Pre and post-surgical evaluation of indirect kinematics with dynamic pedobarography helps to finetune surgical interventions in CP valgus feet.

Introduction
3-D dynamic kinematic data aquisition in the child´s foot is difficult as marker positioning is challenging and the process of a full gait analysis time consuming and costly. Especially the evaluation of dynamic foot kinematics when in ankle-foot-orthotics is hardly possible Readily available pedobarographic insoles to measure rapid pressure changes during gait possibly give sufficient indirect kinematic data to characterize relative pressure changes during the foot´s roll-over process. This enables the clinician to prospectively compare a baseline of dynamic pedobarographic and indirect kinematic data of pre- and postoperative gait in valgus feet with data acquired from healthy subjects.

Methods
19 children and adolescents (GMFCS I-III) between 9 and 12 yrs.(f: 8/m:11) with severe flexible valgus foot deformities due to CP (Tetraplegic n: 2; Diplegic n: 14; Hemiplegic n:3) who underwent bony subtalar fusion and calf tendon lengthening procedures were studied pre and postoperatively with and without orthotics. Of the tetraplegic / diplegic group n: 8 needed bilateral subtalar fusion treatment. 9 children had previous bony and/or other SEML surgery before addressing the foot problem, 10 children qualified for SEML surgery with the subtalar fusion procedure. Outcome measurements were done between 12 and 18 months postsurgery.
These children underwent video and pedobarographic gait analysis with a wireless 64-pressure-sensor 60-Hz system (capacitive pressure measurement system Medilogic®). All had standardized foot x-ray. A control group of 20 clinically healthy feet rendered so-called normal pressure distribution data. Gait parameters included speed, stride length, effective

Results
CoP line, effective foot length and foot pronation indexes significantly improved in n:14 (n: 3 hemiplegic, n: 11 diplegic patients) already without bracing, whereas an additional AFO adjusted measurements close to those of the control group. In n:5 children, AFO bracing was compulsory to stabilize gait, but was done more comfortably postsurgically than before. Data from the control group surprised with a high degree of variation and although clinically normal, foot pressure patterns from highly inverted to plano-valgus were observed.

Conclusion
Insights into the indirect kinematics of valgus foot deformities are easily available with dynamic pedobarography; functional evaluation with and without AFO bracing is possible giving valuable information into whether longterm postsurgical bracing is necessary.

References
See Lecture

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg230579/cg35044

Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3391-566]

Rate of Development of Medial Longitudinal Arch for Obese Children with Flexible Flatfoot Treated with Insole

Author
Law, Sam YC (None HK) | Mr.
North District Hospital - Prosthetics- Orthotics

Coauthors
Law SYC

Abstract
A longitudinal study was launched to compare the rate of development of medial longitudinal arch (MLA) for obese children, with flexible flatfoot. Results showed that medial longitudinal arch has a slow rate of development for obese children, compared with normal control group.

Introduction
PURPOSE: To compare the rate of development of medial longitudinal arch (MLA) for obese children, with flexible flatfoot, with gender, age, and height matched normal body size children.
STUDY DESIGN: A gender, age, and height-matched comparison between obese and normal body size children, who diagnosed with flexible flatfoot treated with orthopaedic insole in North District Hospital. Obese was defined as body weight 20% higher than median body weight for height of Hong Kong children (Leung, 1993)

Methods
METHOD: Ink-footprint was taken during regular follow-up. Staheli arch index (AI) is extracted from each footprint. (Staheli, 1987) The rate of change of AI for each subject was calculated. The foot with higher AI at the first pair of footprint was used for analysis. t-test ($p<.05$) was used to test the null hypothesis.

Results
RESULT: 9 pairs of children (In each group: 4 boys & 5 girls), satisfied the inclusion and exclusion criteria were matched. Average duration of follow-up is 3.3 years. (min. 0.8 years; max. 5.9 years)
Rate of improvement of AI for obese children is 68% ($p<.005$) lower than normal children.

Conclusion
DISCUSSION & CONCLUSION: From the result, slower rate of improvement of medial longitudinal arch is expected for obese children under non-surgical insole treatment. Other treatment options, e.g. surgical intervention or UCBL type arch support, can be considered in an earlier stage for those patients who expected to have a slow development of the foot arch.

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Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3051-249]

Treatment of Internally Rotated Gait with the Pomarino® Torqheel Insoles

Author
Zörnig, Laura (DE)

Coauthors
Stock S, Kühl F, Klawonn M, Walther C

Abstract
Im PTZ wurde der herkömmliche zur Therapie eingesetzte Torqueel-Absatz durch „Rotations-Korrektureinlagen nach Pomarino®“ ersetzt. Die Ergebnisse zu Therapieverlauf, -dauer und –trend zeigen, dass den IR-Gängern mit dem neuartigen Hilfsmittel eine optimale Behandlung zur Verfügung steht.

Introduction
The internally rotation gait is an infantile gait pattern without any data about incidence. Up to the age of 4 years this gait is physiological. If the child is limping, tripping or falling or if it has foot or leg pain and the feet are rotated different or the gait abnormality is getting worse a doctor should be consulted. Between the age of 3 and 4 years the external rotation starts. Without a malposition the rotation is minimised because of the strenghts at walking. If there is still an internal rotation gait at elementary school age, a treatment of this gait is necessary. Without treatment hip joint, knee joint and lumbar spine are extremly stressed. This leads to dysbalances of the skeleton and the muscles and to preterm tribological.

Methods
At every examination (initial or follow-up examination) the anamnesis, consisting of parents´ anamnesis, physical examination, gait analysis and eventual 3D imaging, is practiced. The results of the anamnesis are documented and are available for statistic analysis. Every follow-up examination includes:
• comparison of the results of the latest and the previous examinations,
• documentation of the effects of the rotations- and correcting insoles and
• checking of the prescription
The results of the examination determine if the patient is treated with Torqheel
Insoles and/ or physiotherapy. If it is necessary, a follow-up examination is accomplished every 8 till 12 weeks. To provide an optimal therapy with Torqheel Insoles for the child the following two symptoms are substantial:
• strong internal rotation gait,
• frequently tripping and/ or falling because of the internal rotation gait

Results
The benefits of the innovative treatment concept (Pomarino® Torqheel Insoles, gait analysis, 3D imaging to judge statics of the mechanical axis) against a common therapy are:
• the therapy can geared optimal and individual to the internally rotated walkers,
• an early prognosis is possible,
• the therapy duration is much shorter and
• the accruing costs are much lower.

These benefits result from the high reliability of the used technology and the standardised evaluation of gait and statics of the mechanical axis.

Conclusion

The treatment with Pomarino® Torqheel Insoles (arch support) is both for patients and for service provider more favourable than the common Torqheel (heel under the shoe). Both varieties are basically- related to the treatment of the internally rotated gait- effective. The important fact und difference is that Pomarino® Torqheel Insoles can be worn in different shoes and because of this the daily wearing time is much longer and a therapy success is faster possible.

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Session: Foot & Shoe - Deformities
Wednesday 2010/05/12 | 17:00 - 18:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2927-125]

How Do We Analyse Ground Reaction Forces Patterns to Insole Prescription in Structural Leg Lenght Discrepancy

Author
Yazdani, Meria (tehran IR)
Iran Medical science University - orthosis & prosthesis

Coauthors
Mohammad sadegh Ghasemi, Sanjari Mohammad Ali

Abstract
This study aims were to compare the GRF patterns and gait asymmetry in three types of insole for structural LLD patients and compare with barefoot walking

Introduction
Leg length discrepancy (LLD) is defined as a condition in which lower limbs are noticeably unequal. Ground reaction force (GRF) during locomotion have been examined by several authors; while a normal gait has been shown to have equal GRF for both limbs, in a series of papers, authors reported that LLD causes an asymmetry in GRF and this asymmetry is a major etiological factor in the development of degenerative joint disease or pain.The type of insoles footwear is known to have considerable effect on heel lift and correction of GRF in LLD patient with special insoles may turn out to be an effective tool for managing the naturopathic foot. Data from randomized trials on the usefulness of therapeutic footwear in preventing foot problems, with insoles studies showing benefits .This study aims were to compare the GRF patterns and gait asymmetry in three types of insole for structural LLD patients and compare with barefoot walking.

Methods
Fifteen subjects with a mean age of 39 years with no sign of neuromuscular disease, who had previously been diagnosed as having LLD functional nstability, were selected from orthopedic centers were participated in this study.
Each subjects performed 20 walking trial at a self-selected speed over two Bertec force plates; capable of measuring forces in the x, y, and z direction over the time of foot contact (Figure 1) and GRF vectors of both limbs were recorded for all subject with following conditions: Ethylene Vinyl Acetate (EVA) insole, Closed Cell Plastazote (Pl) insole, RTV Silicon or two-layer (hb) insole and barefoot (ba) walking. The analysis method was with spss and force graph soft wares.

Results
The finding shows that in barefoot walking, vertical GRF in shorter side was higher and stance phase time was greater in longer side. After using insoles, bilateral comparison showed that EVA insole increased the second peak of vertical GRF (fz2) and anterior-posterior GRF in longer limb. EVA had maximum of anterior- posterior (A-P) balance in longer limb, but A-P balance with this insole was less than two-layer insoles. Two-layer insole had maximum increasing fz2 in shorter side. Plastazote increased medio-lateral balance in shorter side but it shifted weight bearing to longer limb (30%).

Conclusion

The result of this study shows potential clinical implications of insoles in the patient with LLD and conservative rehabilitation for each individual demonstrated that proper selection of insoles material ensures the improvement in gait functions in the patients with LLD. Insole material reduces the initial peak force, force-loading rate. The tested insoles demonstrated that increases the vertical GRF in longer limb, decrease the GRF in the shorter side and improve the symmetry in weight bearing on both limbs, which these means a better gait and stability.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3747-None]

Open Forum 4

Session Chair
Franke, Jens (Dortmund DE)
Bundesinnungsverband für Orthopädie-Technik

Session Chair
Yadav, Shiv L. (New Delhi IN) | Dr
All India Institute of Medical Sciences - Physical Medicine & Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg348531

Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [3309-484]

Transfemoral and Transtibial Prosthesis: A Study on the Feasibility of Design Modification in Rural Setting in India

Author
Yadav, Shiv L. (New Delhi IN) | Dr
All India Institute of Medical Sciences - Physical Medicine & Rehabilitation

Coauthors
Biswas MM, Wadhwa S, Singh U

Abstract
In this paper we are going to discuss the outcome of questionnaire based survey on rejection/acceptability of the present prosthetic design used by them and with suggested modification contributed in improvement of day to day activities and participation in real life situations i.e.work or leisure.

Introduction
The problem of prostheses rejection among the rural disabled in India is very common. The designing of prosthesis is a very complex issue as varied life styles and cultures across the country. This study was done with the aim to find out prosthetic acceptability and causes for its rejection, flaws in the existing design and need of modification & feasibility of impleting the modified design.

Methods
One hundred and seventy cases of amputation(transfemoral and transtibial)residing in adjacent rural areas of Delhi and Jaipur were included in the study. Patients who had been using a prosthesis for at least the past three months were contacted, interviewed and detailed data were collected through questionnaire.

Results
The suggestions made by the user and their subsequent perceived prosthetic design modifications will be discussed in detail.

Conclusion
The study clearly indicated the dire need of modifications in the design of most of the lower limb prosthetic aids in the various domain of life pertaining to Indian culture such as squatting and cross-legged sitting and need for relacement of existing prosthetic foot, shin piece, socket. The modification to reduce down breakage, mechanical noise, pain, excessive stump perspiration and care of vascular copromised stump was also warrented.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [3053-251]

Users Satisfaction with Orthoses and Prostheses: An Iranian Experience

Author
Bahramian, Hooman (Tehran IR) | M.Sc.
Ortopede Fanee Andamkar Shargh - Orthotics and Prosthetics

Coauthors
Ghoseiri K

Abstract
For the first time, the evaluation of consumers satisfaction with orthoses / prostheses performed in Iran.

Introduction
The need for prostheses and orthoses has increased due to the large amount of industrial and traffic accidents and congenital, neuromuscular complication and sequelae of other diseases. (1) The rapid growth in the number of the prosthetic and orthotic consumers has improved the healthcare personnel and policies toward better services regarding the consumers interests and demands.(2) The evaluation of users satisfaction improves the quality of facility services. The aim of this study was to assess the patients satisfaction with orthoses and prostheses and also with services of the prosthetic and orthotic facility in Iran.

Methods
In this survey study, 144 patients who were all had orthotic treatment in an Iranian private facility participated. 144 patients (85 women, 59 men) with mean age 29.3±21.3 years were participated in this study. Consumers of a private P&O facility who were fitted with prosthesis, orthopaedic shoes, an orthosis, or another device, were asked to rate the overall services provided and whether they were satisfied with the device provided and its delivery time. Table 1, shows the frequency of orthosis/prosthesis type in participants. Each participant filled out all questions of the OPUS.

Results
In satisfaction with device, our subjects rated the highest satisfaction to the fourth question about comfortably putting on orthosis/prosthesis and the lowest satisfaction to the ninth question about pain free wearing of the orthosis/prosthesis. In satisfaction with services, our subjects rated the highest satisfaction to the thirteenth question about the proper level of courtesy and respect by the staff and the lowest satisfaction to the twentieth question about coordination of staff with therapist and doctors to offer services.

Conclusion
The most subjects were satisfied with the devices. The most of them were dissatisfied with the questions 7 and 9. They stated that the devices wear and tear their cloths and cause pain when wearing. The most of them stated that they were treated with the high level of courtesy and respect by the staff. The most of them reported dissatisfaction regarding the issues of the final two questions of satisfaction with services evaluation. Most of them stated that they think the staff was not coordinated with their therapists and doctors to serve them and also the staff had not participated them in their decisions regarding their care and equipment. In this study we have not found any significant correlation between age and sex of our subjects with their satisfaction scores in both disciplines of with device and with services.

For the first time, the evaluation of consumers satisfaction with orthoses / prostheses performed in Iran.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [2986-184]

The Effect of Electrical Passive Pedal Cycling on the Joints' Range of Motion of Lower Limbs in Iranian Spinal Cord Injured Veterans

Author
Shojaei, Hadi (Tehran IR) | DR
Janbazan medical and engineering research center - rehabilitation research

Coauthors
Shojaee H , Rayegani SM, Soroush MR,Baghbani M, Haghani H, Allami M.

Abstract
The purpose of this clinical trial was to evaluate the effects of electrical passive cycling usage on lower limb's joints' range of motion amongst spinal cord injured veterans.Findings suggest that it can causes improving hip, knee and ankle range of motions according to the intensity of exercise.

Introduction
SCI causes widespread disability and dysfunction.As a consequence of the related sedentary or complete inactivity life style, these patients encounter muscle dystrophy, stiffness of the joints and deformity.It is considered that physical exercises on a continuous and precise basis maintains muscle tone both in trunks and the limbs, leading to prevention of joint contracture, maintenance of flexibility in joints and muscles.In recent years new methods are introduced to help patients conduct physical exercises independently at home and this has been an evolution and a great progress. Electrical Passive Pedal Cycling (EPPC) machine is one of those innovated rehabilitation technologies by which the handicapped patients practice physical exercises independently.The EPPC has also been employed for Iranian Veterans exercise therapy but its effect on joints is not yet defined. This is the motivation for the present study to assess and evaluate the physical effects of EPPC on SCIed Veteranss in

Methods
The upcoming trial is a prospective clinical research performed on 64 Iranian SCI veterans.The subjects were divided and compared in three different groups according to the cycling protocol usage, 1) Control group included 21 subjects who did not use the cycling equipment, 2) Intervention group1 comprised of 13 veterans who used the equipment at the moderate intensity but less than the ideal, 3) Intervention group 2 with 29 veteran who used the cycling equipment according to the ideal protocol with high intensity of exercise.The investigated variables in this study include Hip , knee and ankle passive range of motions The variables mentioned above have been measured twice during the trial: First when the subjects underwent the passive cycling, and then after one year passed since that period of passive cycling.The Passive Pedal Cycling Machines were Therlive 2003 and German made. In order to measure the passive range of motion in joints, Goniameter was utilized by the PM&R MD

Results
According to the result of this study, most patients in this study were between 40-44 years of age (39.1%). While most of the cases (21 persons=32.8%) have become SCIed during 1985 to 1986.
The mean spasticity scale in Veterans and mean proximal muscle force among all three groups of study were have been matched and they had no statistical difference about these conflicting variables.

In the group who did not use EPPS at all (Group 1) there was found no significant difference in average and mean ROM of hip (Add., Abd., Flex., Ext.,) , knee flexion, ankle dorsiflexion and plantar flexion.
In group 2 who used EPPC on an moderate level of exercise (not optimum),ROM of Hip only in direction of flexion was significant (P= 0.023)and also it was for Knee flexion(P= 0.041),Ankle dorsiflexion(P= 0.026) ,and plantarflexion(P= 0.054).
Finally, in Group 3 who used EPPS on an optimal basis, regardless of Knee flexion ROM (P= 0.111), in other cases i.e. ROM of hip (Abd, Add., Flex, and Ext), ankle dorsiflexion and plantar flexion, there was shown significant increase for ROM which is due to the significant role of EPPC on ROM of joints. (Table 2).
According to the table mentioned above (Table 2) , apart from knee flexion ROM of which mean difference before and after EPPC application, no significant differences (P=0.111) in the rest of the cases mean difference in Veterans who have optimally exercised with EPPC shows significant difference (P<0.05)

Conclusion

Passive rhythmic movements with electrical stable pedal cycling can cause improving hip, knee and ankle range of motion according to the intensity of exercise. So it can play an important role in prevention of joints contractures.It is interesting that the ROM of Hip Joint in abduction and extension ,which may seem to be irrelevant to pedal cycling exercise, improved remarkably in group of optimum level of exercise.
The suitable reason for no improvement of the knee flexion ROM in group 3 may be that the patients with optimum knee flexion from the very beginning of the trial, there was seen no alteration in ROM values and it is due to their original proper flexion which means the participants could use the best of EPPC, while those without proper knee flexion probably could not obtain the best result from exercising with EPPC.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [3441-616]

Impact of Wheelchair Service Provision for Wheelchair Users Living in Urban and Semi Urban Slum - A study

Author
Ghosh, Ritu (Bangalore IN) | Impact of wheelchair service provision for wheelchair users livi
Mobility India - Training

Coauthors
Mr Anil Singh

Abstract
People with a disability have the right to good quality assistive devices and equipment to assist them to increase the level of independence in daily life. In low income countries, professional wheelchair service provision is an area of concern due to many challenges. In this paper, the purpose o

Introduction
10% of the global population that is, about 650million people are with disabilities. About 10% of this disabled population need wheelchairs, which translates to about 65 million people worldwide (World Health Organization, 2008). Importantly, disability is both a cause and a consequence of poverty (Department for International Development, 2000). People with mobility disabilities are confined to their homes due to a complete absence of suitable wheelchairs and hostile terrain. Main source of provision of wheelchairs in India is through mass distribution and to date professional service provision has not been addressed and developed and therefore hinders any other form of development for people with mobility disabilities. There is little data regarding the impact of professional wheelchair service.

Methods
Thirty three wheelchair users participated in study. All the users are using the wheelchair at least for 6 months or more and the service has been provided by trained professionals. All users are from urban and semi urban slums of Bangalore and falls in the project area of Mobility India, where community based rehabilitation programme is running. Users were selected for study irrespective of cast, creed, age and gender. Wheelchair users are having disabling conditions like Cerebral Palsy, Post Polio Residual Paralysis, Spina Bifida, Stroke, Spinal Cord Injury, Amputation, Hydrocephalus, Muscular Dystrophy, Brain Tumour , Wilson Disease and Congenital Deficiency.
In thirty-three subject's ratio of female and male is 14:19 with age ranging from 4 years to 85 years. 7 users are aged below 10 years, 11 users aged 11 – 20, 11 users aged 21 - 30 and only 4 users aged over 31 years.
Structured interview was done by the team of Prosthetist & Orthotist, therapist and Community workers

Results
The study showed that 56% of the users do not have enough money to meet the basic needs. Among them only 30% users are satisfied with their living place as they have lot of constraint in the physical environment. 45% are able to manage or have improved in managing their daily living skills and 33% thus have reduced dependency. 42% are able to move around with wheelchairs and 45% children are able to attend school. 33% people enjoy their life. 72% of the people were satisfied with wheelchair service provision however they have expressed many problems /challenges which they face in day to day life due to many constraints.

Conclusion

The result clearly reflects that even though professional service was provided through monitored programme, there are many constraints reducing the effectiveness of wheelchair service provision. The main challenges identified are poverty, living environment, limited product choices and awareness. It also stresses the fact that professional approach could be encouraged so that services are made available and provided by trained manpower and thus people are able to exercise their rights.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [3405-580]

A Historical Review of P&O and allied P&O profession in Japan ; the Kobe Model

Author
Uchida, Mitsuhiko (Sanda JP)
Kobe College of Medical Welfare - Course of P&O

Coauthors
Kazuhiko Sasaki,
Masanori Shimamura
Tadasuke Onishi

Abstract
The education of the P&O is spreading to all over the world to all over Japan. But there aren't enough discussions about allied P&O professions such like an orthopedic shoe technologist and a technical aid technologist. Kobe College has developed a P&O course in1997, and then a curse for orthopedic

Introduction
Prosthetics and Orthotics education in Japan was begun as 3 year course at National Rehabilitation Center for the Disabled in 1982.All of other after P&O schools were directed in establishments by the graduates, it contributed to the popularization and the standardization of the P&O education. In 1987, the prosthetist and orthotist law was established and the P&O became the medical care type state qualification of the Ministry of Health and Welfare. As of 2009, there are 9 schools in various parts of Japan. On the other hand, the education of theP&O is spreading to all over the world and being more clinical and going to upgrade to obtain higher degree/diploma by each country. But there are not enough discussions about allied P&O professions such like an orthopedic shoe technologist and a technical aid technologist.
Kobe College of Medical Welfare has been established in 1997 as a P&O 3 year's course. Following this, a 2 year's course for orthopedic shoe technologists in 1999 and a upgr

Methods
The orthopedic footwear course has started by installing German orthopedic footwear system looking at a curriculum of German OSM school. It is 2 years course and has 40 student yearly. As of 2009, the No. of graduates is 237. A half of them got a employment opportunities in P&O companies and 20# is in "Comfort shoes shop", and 20 is in shoes manufacturers. In 2003,Kobe College has established upgrade course to upgrade our student into Bachelor of P&O of La Trobe University. Students undertake one year full time study at LaTrobe University. The curriculum is consist complementary of the subject which has not operated or been weak in Japanese schools, such like Research Method, Patient Evaluation, Fracture Management, Advanced prostheses and advanced orthoses. As a course progress in this 5 years,11 students completed course.5 working in Australia ,New Zealand and Jakarta,6 have returned to Japan.8 currently enrolled will graduate on June 2010. Students not only from Kobe,from other P&O

Results
In 2004, The Ministry of health made a change of the regulation for P&O schools. It came from The significant amendment of education laws in 1991.This was undertaken in order to make existing systems

more flexible, thereby enabling each schools to develop its distinctiveness under its missions and objectives
Kobe has established additional a new 4 year's course in 2008.The graduate will obtain the advance diploma. It's equivalent with Bachelor degree. Now Kobe has 2 P&O classes of total 60 students yearly. Receiving it, in 2004-2007, Kobe College innovated the own curriculum in collaborated with La Trobe University.
We install "Patient Evaluation" using Web CT delivery. Guest Lecture programs from La Trobe to cover the advanced P&O. While this process we have learnt the advanced teaching skills such like Tutorial lesson, Problem based Learning, Web CT
In 2005-2008,a rush of the P&O school establishment happened. New 4 school,5 courses came in. Three 4 years course is included.

Conclusion
Kobe has established additional a new 4 year's course in 2008.The graduate will obtain the advance diploma It# equivalent with Bachelor degree. Now Kobe has 2 P&O classes of total 60 students yearly.4 years curriculum has additional subject in the fields of R&D, Orthopedic footwear technique, Assistive devices, and more clinical practices.
There are no ISPO recognized school in Japan. When we discuss why ISPO Cat1 is needed for Japanese P&O schools? There are negative cements that ".It is difficult because of Language barrier"," we already have the national exam"," cost for accreditation procedures".
Otherwise There are positive comments that "Yes! It is necessary for us because our student want international activities", "It would be a guideline for development 4 years course"," Developing the international network of schools"," Getting international accreditation.". Kobe college take a forward-looking stance to applying ISPO Cat 1 accreditation.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [3021-219]

Limb Amputation and Limb Prosthetic Repair in West Siberia: A Population-based Study

Author
Vasilchenko, Elena (Nowokuznetsk RU)
Federal Centre for medical and social evaluation and rehabilitation of people with disabilities

Coauthors
Sytin L, Vasilchenko E, Chechenin G

Abstract
We performed an analysis of the number and outcomes of major amputations for vascular disease or complications of diabetes mellitus and of the outcomes of subsequent limb prosthetic repair in the population of one of the regions of West Siberia.

Introduction
Limb loss is a dramatic consequence of a number of disease processes and it leads to marked limitations of mobility and self-service and to social insufficiency of this patient population. The number of patients with lower limb amputations is still large [1,2], mortality remains high [3] and the quality of life of the patients is reduced [1]. The main method of rehabilitation of people with limb stumps is prosthetic repair. However, not all patients who lost a limb apply for prosthetic and orthotic care. The objective of this study was to analyze the number and outcomes of major amputations for vascular disease or complications of diabetes mellitus and to analyze the outcomes of subsequent limb prosthetic repair in the population of one of the regions of West Siberia.

Methods
Using the database of the local system of personified registration of patients, we studied the information about the cases of major limb amputation among the inhabitants of the city of Novokuznetsk (West Siberia) performed for vascular disease and complications of diabetes mellitus in the time periods 1993 to 1997 (Period 1), 1998 to 2002 (Period 2) and 2003 to 2007 (Period 3). We analyzed the number of hip-level or shin-level amputations and the number of people who had undergone limb amputation (amputees), including separate analyses in the age groups younger than 60, 60 to 69 years old and 70 years old and older, as well as among men and women; we also studied patient survival and prosthetic and orthotic care appealability.

Results
The total number of amputees increased by 14% in Period 3. But this number did not change in patients aged 60 to 69 while it increased 2.7-fold in patients aged 70 and older and decreased 1.6-fold in those younger than 60. Similar changes were seen also in the number of limb amputations, with an increase in the shin/hip ratio from 0.13 (in Period 1) to 0.40 (in Period 3). Men had amputation twice as often as women but the proportion of amputations in women increased from 29.6% (in Period 1) to 38.0% (in Period 3). Survival was 51% (95% CI, 47-55%) 2 years after amputation and 36% (95% CI, 32-40%) 5 years after amputation. Female patients are 25 to 30% less likely to survive after limb amputation than males. The analysis of prosthetic care appealability showed that prosthetic care was administered to 28.9% of patients (95% CI, 23-34.8%) 2 years after amputation. One of the major factors influencing appealability is the

high mortality among these patients during the first few months after amputation. After shin amputations, prosthetic repair appealability was 52% (95% CI, 40.2-63.8%) 2 years after amputation. Hip amputation considerably reduced the likelihood of prosthetic repair and appealability was 22.0% (95% CI, 16.1-27.9%). Prosthetic repair appealability 2 years after limb loss was 33.0% (95% CI, 27.1-38.9%) among men and 15.0% (95% CI, 7.8-22.8%) among women. Of the patients with limb loss aged 70 and older, only 13.0% (95% CI, 5.4-20.9%) received prosthetic repair.

Conclusion

We found that the total number of people who underwent major amputation and the number of limb amputations increased in the period 1993 to 2007 due to patients aged 70 and older while these numbers decreased among patients younger than 60, which seems to be associated with an improvement in angiosurgical care and a simultaneous increase in elderly patients with vascular disease and diabetes mellitus [4]. Prosthetic repair appealability remains low, with the ageing of the population further aggravating this factor. But a higher ratio towards the number of shin amputations may contribute to an improvement in rehabilitation outcomes in the population.

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Session: Open Forum 4
Wednesday 2010/05/12 | 17:00 - 18:30

Congress Lecture [2844-60]

Challenges Faced by Prosthetist in the Management of Trans Tibial Amputee, Prosthetist Perspective

Author
Aziz, Ahmad (Peshawar-Pakistan PK) | Mr
PIPOS - Prosthetic

Abstract
This study was conducted in PIPOS (Pakistan Institute of Prosthetic and Orthotic Sciences Peshawar Pakistan) in 2008.

Introduction
Half of the lower limb amputations are performed at the transtibial level. Patients with trans tibial amputation experience problems with pain, edema, knee flexion contractures, wound healing, reconstruction surgeries, limited returned to function and high rehabilitation cost. Prosthetist faces problems in the rehabilitation of transtibial amputees (TTA) which needs to be investigated.

Methods
A survey questionnaire was distributed among the Prosthetist and Orthotist, with a minimum of 01 years clinical experience with prosthetic fittings. The return time was 02 weeks. The questionnaire was used with the four point likert scale as Agree, Strongly Agree, Disagree and Strongly Disagree options.
The data collected via a survey questionnaire was analyzed with 95% confidence interval. Descriptive statistical analysis method was used.

Results
A survey questionnaire was distributed among the Prosthetist and Orthotist, with a minimum of 01 years clinical experience with prosthetic fittings. The return time was 02 weeks. The questionnaire was used with the four point likert scale as Agree, Strongly Agree, Disagree and Strongly Disagree options.
The data collected via a survey questionnaire was analyzed with 95% confidence interval. Descriptive statistical analysis method was used.

Conclusion
Problems in the residual limb like volume fluctuation, bony sharp ends, redundant tissues etc, cause of amputation as DM and trauma along with the age, health and gender difference can directly challenge Prosthetist professional abilities. Psychological issues like anxiety, depression etc with the socioeconomic conditions makes the rehabilitation process with prosthetic fitting more complicated and time consuming. These potential problems can be minimized with standards surgical procedures such as posterior long flap and properly beveled anterior distal tibial end with shorter fibula than tibia in transtibial amputations.

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Image: Problems faced by prothetist_60.PNG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg348531/cg31052

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3556-None]

Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation

Session Chair
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615

Basic Instructional Course: Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3557-705]

Motivations and Barriers to Participation in Physical Activity and Exercise

Author
Deans, Sarah (Glasgow UK)
University of Strathclyde - National Centre for Prosthetics and Orthotics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615/cg58749

Basic Instructional Course: Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3558-None]

Enhancing Athletic Performance by Maximizing Prosthetic Capabilities

Author
Gailey, Robert (Miami US) | PhD, PT
University of Miami Miller School of Medicine - Department of Physical Therapy

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615/cg58790

Basic Instructional Course: Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3559-None]

The Role of Fitness Training in Prosthetic Rehabilitation

Author
Hirons, Carolyn (Cheadle GB)
Pace Rehabilitation Limited

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615/cg58871

Basic Instructional Course: Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3560-None]

Prosthetic Considerations for Improving Athletic Performance

Author
Harsch, Peter (San Diego US)
Naval Medical Centre

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615/cg58929

Basic Instructional Course: Physical Activity, Exercise and Sports: the Bar is being Raised in Prosthetic Rehabilitation
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3718-821]

An overview of two United Kingdom Exercise Master Classes for Prosthesis Users

Author
Deans, Sarah (Glasgow UK)
University of Strathclyde - National Centre for Prosthetics and Orthotics

Author
Sexton, Sandra (Glasgow UK)
University of Strathclyde - National Centre for Training and Education in P & O

Coauthors
Deans SA, Gailey R, Harsch PD, Hirons C, Sexton S

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg58615/cg280923

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3739-None]

e-Learning Applications for Prosthetic and Orthotic Care

Session Chair
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Abstract
This e-Learning instructional course will be provided by the ISPO International e-Learning Working Group and will cover information and examples for practical applications for three learning aspects:
1) e-Learning for Students and Continuing Education
2) Using Desktop Conferencing for Mentoring and Peer-to-Peer learning
3) Web resources for continuing education
The participants will leave this course with an understanding of the currently available resources for e-Learning in the prosthetics and orthotics field, an expanded perception of how e-Learning could be used for continuous learning in their practice, data security considerations when using e-Learning in a peer-to-peer setting, and the future direction for e-Learning within ISPO. Participants will also become knowledgeable about the various contacts and institutions that can be approached for more advanced information on these topics.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg321172

Basic Instructional Course: e-Learning Applications for Prosthetic and Orthotic Care
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Education

Congress Lecture [3740-836]

e-Learning Resources and Opportunities in P&O Education

Author
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Author
Wong, Man-Sang (Hong Kong HK) | PhD
The Hong Kong Polytechnic University - Department of Health Technology & Informatics, ST418,

Abstract
This section of the Instructional Course will present current and future e-Learning resources and opportunities for course-based learning and new practitioner education. The focus will be on e-Learning used by education institutions for undergraduate students and the support of those currently in the field who require ongoing education at an ever-increasing level.

Introduction
Over the recent years there has been a growth in the available resources that facilitate and enhance the delivery of educational content at various levels. Coupled with this is the ever-increasing need and demand for educational programs to deliver their curriculum in more creative and flexible ways and in turn be more effective and efficient. Added to this, is the fact that most students (undergraduate and post-graduate) are able to receive and consume information with varying technical modalities and for the most part have the available internet and telecommunication infrastructure to facilitate such modes of information delivery.

Methods
Currently, there are many modes of delivering educational content to the consumer be it an undergraduate student or professional in the field. In terms of what is available, there are more or less various levels of how e-learing in itself can take place.
Firstly, there are many systems that facilitate information and file sharing of various kinds and promote the experience of on-line collaboration and communication. These systems can be implemented within educational programs but also can be utilized to allow for information sharing and collaboration at the post-graduate level. For the most part, such systems are not expensive to implement.

Results
There also a number of course management systems that allow for full delivery of courses in a blended or on-line method. These course management systems are normally housed within a educational program which take care of not only the delivery of content but also allow other functionality in terms of testing, mark management, scheduling and so on. Often such systems are adopted by larger educational institutions or by larger corporations to facilitate in-house training programs. Over the years, these systems continue to develop allowing more integration of other levels of e-learning and bringing about a more modular approach where other e-learning modalities can be brought into such systems. This gives such systems a much more dynamic “feel” to the delivery of on-line courses.What is even more interesting when it comes to the support of education around the field of prosthetics and orthotics, is the every increasing ability to interact, collaborate, and deliver educational content over the internet in a “live” or synchronous way.

Conclusion

There are a number of e-learning systems developed that allow for this mode of delivery. This brings huge possibilities to our field in terms of not only delivering lectures and seminars to the undergraduate student in a more convenient way but also allows for more collaboration and sharing between schools and also enables the delivery of larger seminars and workshops to the professional in the field on a global basis.

The desire for this segment of the instructional course is to leave the participants with a better understanding of the currently available resources for e-Learning in the prosthetics and orthotics field. In addition, it will offer the participants an expanded perception of how e-Learning could be used within professional undergraduate programs and also at the level of the professional in the field who requires continuous learning in their daily practice at an ever
increasing level.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg321172/cg321664

Basic Instructional Course: e-Learning Applications for Prosthetic and Orthotic Care
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Education

Congress Lecture [3741-843]

Using Desktop Conferencing for Mentoring and Peer-to-Peer Learning

Author
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Author
Schlierf, Christian (Nürnberg DE)
Human Study e.V. - Balkan Program

Coauthors
Christian Schlierf

Abstract
This section will present methods for using accessible and low-cost multimedia communication technology for continuous learning. Topics will include available technologies for internet-based audio-visual-data communication, peer-to-peer learning applications, and information security considerations.

Introduction
Internet-based communication technology is globally integrated into our technological sphere and culture. In the past, obstacles such as lack of appropriate Internet connections, technology costs, and training inhibited the use of multimedia communication to assist with continuous learning. Over the past decade, most of these obstacles have been removed so that individuals are empowered to create “personal learning networks” that can maintain and enhance their clinical and technical competencies. eLearning technologies are ideal tools for removing distance issues from personal learning networks and integrating continuous learning into everyday life.

Methods
Critical review of commercial products, open source products, and literature related to eLearning, desktop conferencing, and small group collaboration.

Results
A wide variety of options are available for personal learning networks and continuing education for prosthetic and orthotic care. These include computing platform independent options (across desktop computers, cell phones, and television boxes) for audio conferencing, video conferencing, data conferencing, and messanging. For prosthetics and orthotics, a combination of voice and image communication is essential to ensure accurate and timely interactions concerning clinical practice and technical issues. A continuum of communication options can be used to select the most appropriate eLearning technology for the application and type of interaction (small group work, person-to-person, lecture, etc.).

Conclusion
Desktop conferencing technologies are important tools to allow prosthetic and orthotic professionals to maintain personal learning networks and integrate continuous learning into their professional lives.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg321172/cg321831

Basic Instructional Course: e-Learning Applications for Prosthetic and Orthotic Care
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Education

Congress Lecture [3743-914]

Web Resources for Continuing Education

Author
Pryor, Wesley (New Delhi IN)
Handicap International

Author
Boone, David (Washington, D.C US)
OrthoCare Innovations

Abstract
This section will present prosthetic and orthotic related learning opportunities and consideration for web-based learning. This includes the full range from information web sites to interactive web-based learning.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg321172/cg322165

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3507-None]

Partial Hand Prostheses – Functional Demands and Constructional Innovations

Session Chair
Schäfer, Michael (Traunstein DE)
Pohlig GmbH

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg51836

Advanced Instructional Course: Partial Hand Prostheses – Functional Demands and Constructional Innovations
Thursday 2010/05/13 | 08:00 - 09:15 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3508-850]

Introduction and Overview

Author
Schäfer, Michael (Traunstein DE)
Pohlig GmbH

Abstract
Through the use of modern materials, i. e. silicone(1), the quality of the stump embedding and the resulting options of a functional fitting have been significantly improved. The following lecture shall, besides an introducing overview, show the possibilities of applying and integrating new mechanical joint constructions as well as finger systems driven by an external power.

Introduction
Depending on the amputation level we have to adequately handle low alignment levels as well as remaining functions of the amputation stump in order to achieve, besides the restoration of the physical shape, a fitting result that is as functional as possible. Similar to the armprosthetic fitting, we have to make a difference between passive function, systems driven by the patients own power and partial hand prostheses driven by an external power (4). The basic division into transversal and longitudinal partial hand defects has proven itself as useful in view of the structural alignment of the hand prosthesis to be chosen.

Methods
The use of silicone allows a very differenciated and individual embedding which is adapted to the stump. In this procedure even very sensitive areas can be embedded in a pressure-tolerant way through the integration of gels. The really good adhesion properties of the silicone on the amputation stump make a more functional use of the partial hand prosthesis possible as compared to traditional prosthetic systems. More and more demands on the functional components of the prosthesis result from this development. In all variants of control (passive, patient´s own power, external power) further developments have been reached during these last few years, which improve the functional use of partial hand prostheses. Among them are passively adjustable and lockable joints, pull-controlled finger systems as well as the latest development in active myoelectric single finger systems.

Results
More and more we receive requirements for adjustable finger positions also in passive hand prostheses, which support and stabilize the function of the passive hand prothesis in different activities.
These new passive joint systems make the application of further working techniques as well as the integration of lever-stabilizing reinforcements necessary. These are supposed to distribute the forces working on the stump and thus make a more functional use of the prosthesis possible. These systems are applied if the user of the prosthesis defines the primary demands on the prosthetic fitting as the best possible restoration of physical shape and aesthetics.
The last and still unreached variant in partial hand prosthetics is the integration of finger components controlled by an external power (2,3,4). New product variants allow the active control of the finger systems through pressure-controlled touch-pads or myoelectrical sensors. First experiences with the fitting show that especially in the fitting of partial hand prostheses the technical demands like installation criteria, grip force and control options have a decisive influence on the result of the fitting.

Conclusion

The movement of active finger components alone does not necessarily mean a gain of function. Also the cosmetic design and integration of technical components in the construction place high demands on the orthopaedic technologist as well as the manufacturing industry. The first step is taken, but we can already say that this highly demanding technology will need many refinements and further developments for an adequate application in every-day life.

The long-term aim of the fitting with partial hand prostheses must be to fulfill the range of different demands of the patients concerned. A large choice of different ways of fitting will expand the “keyboard“ of the orthopaedic technologist and on a long-term basis will ensure an individual management which will be oriented on the demands of the patient.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg51836/cg51940

Advanced Instructional Course: Partial Hand Prostheses – Functional Demands and Constructional Innovations
Thursday 2010/05/13 | 08:00 - 09:15 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3509-793]

Use of Rapid Prototyping in Producing Partial Silicone Hand Prostheses

Author
Maver, Tomaz (Ljubljana SI) | dipl. ing. for Prosthetics and Orthotics
University Rehabilitation Institute, Republic of Slovenia - Centre for Prosthetics and Orthotics, Silicone department

Abstract
Todays technological procedures involved in the fabrication of prostheses following partial amputation of the hand require a lot of time and modelling by hand. Using the Rapid Prototyping technology enables the making of a mirror image of the healthy hand and reduces the time necessary to model a prosthesis.

Introduction
After a partial amputation of the hand, patients want a high-quality prosthesis that visually matches the shape of the healthy hand (1). Todays technological procedures involved in the fabrication of prostheses after partial hand amputation require a lot of time, modelling by
hand, and artistic abilities when fabricating a prosthesis (2). In the 1980s, computer-supported technologies (CAD-CAM) also began to be used in the field of medicine and in prosthetics for making positive models (3,4). The RP technology has recently been developed to a great extent. It is being used in the process of making pre-models, tools as well as end products(4,5). This technology offers a broader selection of materials and greater precision.
The University Rehabilitation Institute in Ljubljana (Slovenia) linked up with partners in the field of industry with a common goal of making an aesthetic prosthesis that is required after partial amputation of the hand, a mirror image of the healthy hand.

Methods
The development comprised three areas:
- scanning system,
- digitalised model modelling and correction technology,
- tool manufacturing technology.

We have digitalised the stumps and healthy hands of five patients after partial hand amputation. We have tested three 3D scanners: the CAPOD CAD-CAM system manual laser scanner, the ATOS II 400 optical scanner and the Z-corporation Zscanner 700. Due to the
high precision and skin print recognition requirements, we have scanned the plaster models.
The precision of scanning a “living” hand is namely decreased by nearly imperceptible tremors of the hand during the scanning process. The TEBIS CAD 3D modelling computer programme was used for the computer processing of scanned models. The data was processed by means of the TEBIS-CAD 3D modelling programme. In order to make positive models of the stump and to make tools, we have used the Direct Metal Laser Sintering technology (DMLS) for sintering metal dust, the Selective Laser Sintering technology (SLS) for sin

Results
After carrying out the first digitalising tests on patients, we found that slight tremors of the patients hand were disruptive and that they reduced the precision of the model’s (hand) skin

detail detection. ATOS II 400 proved best at detecting skin prints. The Capod freescanner did not detect skin prints, while Zscanners detection ability was inferior to that of ATOS II 400. The digitalising time with the tested scanners ranged from 30 to 60 minutes.
The Tebis Cad programme was successful in performing the mirroring of the digitalised stump model and of the healthy hand model. During corrections in the sense of expanding or shrinking the digitalised point cloud data in the process of mutual adjustment of both models (the healthy hand and the stump), we noticed a decrease in the recognisability of skin prints. The best recognition of skin prints occurred in the tool made by means of the DMLS technology where the layer of material applied was only 0.04 mm thick. Both technologies using an artificial material dust are characterised by slightly poorer recognisability of skin prints because the application layer is 0.1 mm thick. The SLS technology is more suitable for making the tools, as the material is tougher in comparison to the 3D print technology and because it is less expensive than the DMLS technology. The above-referenced technology method enables the creation of a tool for the fabrication of a prosthesis which is, in terms of shape, a mirror image of the healthy hand (Figure 1).

Conclusion
By using the RP technology, we can make a prosthesis that looks more similar to the healthy hand. High-precision scanners must be used in the process (6). Up until now, we have not found a scanner which would enable high-precision digitalisation of the patients hand in a matter of seconds. Such a scanner would reduce both the scanning time as well as the cost of this service.
The procedures of digitalisation, computer modelling and tool making are all technologically accessible, but still expensive. Further development of a computer programme with functions adapted for making hand pre-models or tools would be necessary. The technological principle may be used only up to the pre-model fabrication phase, after which a tool is made by following the classic method. Due to restrictions with regard to material, we are as yet unable to make prostheses as end products with the using of this technology. We are convinced that RP technology development will lead to even greater precision in the fabrication pr

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Image: DSCF7553_793.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg51836/cg51965

Advanced Instructional Course: Partial Hand Prostheses – Functional Demands and Constructional Innovations
Thursday 2010/05/13 | 08:00 - 09:15 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3510-714]

Experiences with ProDigits

Author
Gill, Hugh (Livingston UK)
Touch Bionics

Abstract
ProDigits by Touch Bionics is the world's first commercially available powered bionic finger solution for patients with missing fingers (partial hand). This presentation paper will address the experience garnered through over 35 patient fittings.

Introduction
The articulating digit underpins much of ProDigits Partial Hand Prostheses' technical advantage and it is this articulation that provides the biggest benefit to the patient or user. With the ability to bend, touch, pick-up and point – the ProDigits used within an overall prosthesis reflect the function of a natural hand. The modular nature of the ProDigit finger design and the individually powered motor located within each digit means that a clinician can build replacement fingers to an accurate anatomical length – matching the patient's opposite hand size if the patient is unilateral. If a user has remaining fingers, the socket solution can be built to accommodate the remaining fingers and thumb.

Methods
Thumb solutions can be built using either powered or non-powered options. Socket design and interface materials examples will demonstrate how every effort to preserve the critical functional elements of the hand, as well as to protect compromised skin, have been made through alpha and beta patient stages. Although electrodes are regularly used to activate the opening and closing of the fingers of the ProDigits system, the development team expanded the input options to include force sensing resistors (FSR or touch pad) and linear transducers, which allowed patients to initiate movement in the fingers even if muscles in the affected area were absent, burned or otherwise unable to generate an electromyographic signal strong enough to create movement.

Results
This presentation paper will share the successful patient outcomes and explore the work of the various experts that have contributed to the first protocols for control mounting, power and coverings for this new powered solution for partial hand amputees.

Conclusion
Vocational and social reengagement is a very important to patients' rehabilitation after a traumatic event. Partial hand injuries are, by their nature, challenging aesthetically and therefore all that can be done to reinstate a patients function and interaction other people within their chosen lifestyle and career is the ultimate goal for creating successful patient outcomes.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg51836/cg52026

Advanced Instructional Course: Partial Hand Prostheses – Functional Demands and Constructional Innovations
Thursday 2010/05/13 | 08:00 - 09:15 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3511-832]

Anatomical Socket Interface Fitting for Partial Hand Amputations

Author
Lake, Chris (Irving, TX US)
Advanced Arm Dynamics

Introduction

Limb deficiency distal to the wrist is common (1), yet proves to be a difficult level to treat with a functional prosthesis. With the growing attention to the partial hand level, variables such as residual limb presentation, surgical results, and anatomical stability point to the need for concise treatment parameters. A new research focus on upper limb prostheses is accelerating the transfer of technological advances from the research laboratory to the real world.
Silicone prostheses have been recommended (2, 3) for partial hand prosthetic management. The challenge of this application is that many times the silicone covers the entire residual hand and transitions proximal to the wrist to some extent. This can lead to excessive heat build-up as well as skin irritation in respect to the integrity differences between the skin of the dorsal and palmar surfaces. Clinical experience suggests avoiding this extensive encapsulation of the residual hand whenever possible. (4, 5)

Results

Several ongoing patient cases will be discussed to illustrate the principles of an anatomical socket interface for the partial hand level patient. These principles can be integrated into different designs including those that utilize HTV silicone for enhanced stability. The basis for utilizing the anatomical socket interface designs will be discussed further.

Conclusion

Partial hand prosthetic management represents an exciting new frontier in the specialty of upper limb prosthetics. The application and benefit of treating this level are apparent. Currently this level is very difficult due to the vast surgical presentations, traumatic nature of the resultant limb difference, as well as the complicated biomechanics present as a result of the aforementioned two issues. As fitting techniques and componentry evolve, so will the clinical protocols and socket interface design.

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Congress: 13th ISPO World Congress
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Advanced Instructional Course [3478-None]

Orthotic Stance Control

Session Chair
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Session Chair
Kaufman, Kenton (Rochester US) | Dr.
Mayo Clinic - Department of Orthopedic Surgery

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45725

Advanced Instructional Course: Orthotic Stance Control
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3479-None]

Stance Control Orthoses: Research Results

Author
Kaufman, Kenton (Rochester US) | Dr.
Mayo Clinic - Department of Orthopedic Surgery

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45725/cg45768

Advanced Instructional Course: Orthotic Stance Control
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3481-None]

Biomechanical Principles and Functional Deficits

Author
Campbell, James (San Mateo US) | Ph.D.
Becker Orthopedic Company

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45725/cg45808

Advanced Instructional Course: Orthotic Stance Control
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3480-None]

Stance Control Orthoses: Clinical Applications

Author
Michael, John (Portage, IN US)
CPO Services, Inc.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45725/cg45788

Advanced Instructional Course: Orthotic Stance Control
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3482-None]

Stance Control Better Than a Locked KAFO?

Author
Nollet, Frans (Amsterdam NL) | Prof. Dr.
Academic Medical Center University of Amsterdam - Dept. of Rehabiliation Medicine

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg45725/cg45823

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3173-None]

Spinal Muscular Atrophy (SMA)

Session Chair
Fujak, Albert (Erlangen DE) | Dr. med.
Orthopädische Universitätsklinik der Friedrich-Alexander-Universität Erlangen-Nürnberg

Session Chair
Wollinsky, Kurt Hannes (Ulm DE) | Dr. med.
Orthopädische und Neurologische Klinik der Universität Ulm - Klinik für Anästhesiologie/Intensivmedizin

Abstract
The spinal muscular atrophy (SMA) is a genetically and clinically heterogeneous group of hereditary diseases mostly with symmetrical weakness and atrophy of the skeletal muscles. Though up to now no causal treatment for SMA is available, their disease process and above all the quality of life of these patients can be decisively improved by established medical procedures, specialist provision of orthoses and assistive devices.
The fundamental orthopaedic problems for SMA patients are contractures in the lower and upper extremities and sitting instability caused by progressive scoliosis with increasing pelvic obliquity. The orthopaedic treatment includes conservative methods, e.g. physiotherapy, orthotic devices and aids as well as surgical spine stabilisation and correction of the contractures of the lower extremities.
Very important are the early prophylaxis and treatment of the respiratory insufficiency by regularly respiratory therapy to learn breath and cough techniques and self-exercises as well as th

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Advanced Instructional Course: Spinal Muscular Atrophy (SMA)
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3174-719]

Introduction, Classification, Diagnosis and Therapy of SMA

Author
Hirsch, Almut (Erlangen DE) | Dr. med.
Sozialpädiatrisches Zentrum (SPZ), Kinder- und Jugendklinik, Universitätsklinik Erlangen

Introduction
Spinal muscular atrophies are hereditary diseases. They are characterized by degeneration of the alpha-motoneuron predominantely located in the anterior horn of the spinal cord and in fewer cases in the bulbar nucleus of the brainstem.

Results
The SMA are classified according to the time of first symptom's discovery, the heaviness of the disease as well as the presence of additional symptoms. The incidence of SMA is 1 : 6.000-10.000 births. The clinical symptoms of SMA are characterized by generalized muscular hypothony and symmetric proximally indicated muscular weakness with preference of the upper extremities and atrophies. Typical are lingual fasciculation and/or tremor of the hands. During the progression of the disease the patients develop scoliosis depending of the type of SMA as well as progressing respiratory insufficiency. About 90% of SMA cases are proximal germs of tue disease. The distal SMA forms accompanied by weakness of distal musculature or of the diaphragm are rare.

Conclusion
The disease can only be treated symptomatically. This includes continuos neuropaediatric, orthopaedic and physiotherapetic treatment. In some cases assisted ventilation is required. The activity of drugs such as gabapentin, clenbuterol, albuterol and valproat are currently investigated in clinical studies.

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Advanced Instructional Course: Spinal Muscular Atrophy (SMA)
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3175-707]

Orthopaedic Problems and Orthopaedic Treatment in SMA Patients

Author
Fujak, Albert (Erlangen DE) | Dr. med.
Orthopädische Universitätsklinik der Friedrich-Alexander-Universität Erlangen-Nürnberg

Introduction
Although to date there is no causal therapy for SMA, the course of the disease and, above all, the patient's quality of life can be greatly improved by established medical procedures.
The fundamental orthopaedic problems for SMA patients are contractures in the lower and upper extremities and sitting instability and discomfort, caused by progressive scoliosis with increasing pelvic obliquity.
Orthopaedic treatment includes conservative methods, such as physiotherapy, orthoses and assistive devices, as well as surgery to stabilise the spine and treatment for contractures in the lower extremities. Competent and expert provision of orthoses and assistive devices is crucial for the patients' ability to participate in family and social life and for their quality of life.

Results
Progressive scoliosis with increasing pelvic obliquity in childhood of SMA patients is a common feature in this disease. Conservative treatment of scoliosis in SMA is ineffective. Spinal surgery should be carried out as soon as a progressive curve of more then 20° Cobb and a preserved FVC of 20-30% is proved. For SMA patients younger than 10 years our therapeutic recommendation is a corset until the age of 10-12 years followed by definitive surgical correction.
Restrictions of movement occur more frequently and usually with greater severity in the lower extremities than in the upper extremities. Daily activities for the upper extremities are made easier by the development of compensatory and adaptive techniques so that operations are only very seldom indicated.
Surgical treatment of the contractures of the lower extremities is indicated to improve the sitting position and ability to stand, to enable the fitting of shoes, to relieve pain and to enable easier care. The indications and timing of surgery vary from individual to individual.
Fractures are a common problem for SMA patients and frequently occur spontaneously or during trivial activities. Distal fractures of the femur are observed most often. The majority of fractures can be treated conservatively.
Imbalanced proximal muscle weakness leads in some of children with SMA to coxa valga with hip subluxation and dislocation. Surgical reconstruction of subluxated or dislocated hip in non-ambulatory patients is very controversially discussed.

Conclusion
The conservative and operative management of SMA patients requires competent planning and experience and should take place only in specialised departments with experienced and competent team.

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Advanced Instructional Course: Spinal Muscular Atrophy (SMA)
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3176-834]

Orthoses and Orthopaedic Technical Devices in SMA

Author
Fuchs, Markus (Erlangen DE)
Völk-Orthopädie

Introduction
The manufacturing of corsets for SMA-patients compared to idiopathic Scoliosis is not carried out in the well-known classical construction.

Methods
At the beginning of the corset treatment it is necessary to determine the patients instantaneous ability for upright seating. The patients must sit in an upright position for the plaster cast under consideration of a moderate not a maximum correction. One has to look out for scoliotic pelvis, the position of the spinal column and the head but also considerate the prevention of thorax distortion or pressure marks. One also has to keep in mind the cut-out for a PEG-probe. The brace has to be built under consideration of the pelvis for an optimal seat-stabilisation in a maximum lightweight construction. The construction of each corset is individually made for each patient.

Results
Preservation of abdominal respiration, the full flexibility of the arms, the achievement of self-contained of the head or adjustment.

Conclusion
Delay of surgical stabilisation of the spinal column and preservation of the vital functions.

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Advanced Instructional Course: Spinal Muscular Atrophy (SMA)
Thursday 2010/05/13 | 08:00 - 09:15 | Subtopic/Track: Back Trouble

Congress Lecture [3177-858]

Treatment of Respiratory Insufficiency in SMA

Author
Wollinsky, Kurt Hannes (Ulm DE) | Dr. med.
Orthopädische und Neurologische Klinik der Universität Ulm - Klinik für Anästhesiologie/Intensivmedizin

Introduction
SMA patients are characterized by motoric weakness. Scoliosis, atrophic rip cage and intercostal muscles reduce the cough flow. By elevated respiratory rates and diaphragmatic activity SMA children may compensate over longer periods. Chronic sleep related disorder may occur accompanied by desaturation and respiratory fatigue. Viral or bacterial respiratory tract infections (RTI) then lead to drainage problems of secrets, atelectasis and pneumonia.
SMA I infants decompensate earlier due to swallowing problems even of oral secretions,
aspiration and malnutrution. Noninvasive ventilation (NIV) is effective to treat hypoventilating neuromuscular patients (SMA II). Treatment of SMA I infants however was under controversial ethical debate and Bach et al. demonstrated effectivity of NIV. We ventilated our first SMA I infant end of the 80th.

Methods
38 children suffering from SMA Type II and 10 infants from Type I, were admitted electively or during pneumonia to the ICU. After successful extubation a noninvasive ventilation with nasal masks (Respironics ®) was initiated (overnight 6-9 hrs. and partially also daytime max. 20-22 h /d). We used mobile respirators with volume preset in the past (EV 800®, Dräger, PV 501®, BREAS) later with pressure preset (PV 403 ®, BREAS) and actually modern turbine driven ventilators (Legendair®, Covedian, Clevair plus®, Versamed). Essential are possible high respiration rates (80/min), low tidal volumes, and low trigger and easy exhale functions. Assisted coughing was performed using Cough Assist ®,Emerson and Pegaso®, Dima. Enteral feeding was applied in all SMA I children and in some SMA II children.

Results
Only one SMA I infant with diaphragmatic weakness was tracheostomized primarily and one SMA II intermediate type children secondarily. All other children accepted NIV, their pulmonary situation stabilized. No severe adverse reactions (i.e. aspiration) were observed. Some developed mild midface hypoplasy. Essential was the change to tight fitted individual masks (Typ Mindé Bemetec®). Controls (ideally every 3months) were performed and aggressive intervention in case of RTI with a low threshold for antibiotic drugs. Drainage of secretions was managed after inhalation of drugs (salbutamol, corticosteroids, a-dornase) with an IPPB (intermittent positive pressure breathing) device or inhalation system, physiotherapy and assisted coughing techniques (Cough assist®, Pegaso®).

Conclusion
NIV is suitable for SMA children for longterm (SMA I infants > 8yrs., SMA II > 15 yrs.) and enables them to visit kindergarten, school and even university (2/38). Ethic debates about initiating such intensive treatments are no longer justified. Technical orthopaedic support using i.e. wheelchairs, eye sensors, laptop-technology for communication, mobile small portable ventilators and assisted coughing device enables them to participate in social and daily activities.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3787-870]

A Review of Orthotic Management to Patients with Adolescent Idiopathic Scoliosis – Past, Present and Future

Keynote Author
Wong, Man-Sang (Hong Kong HK) | PhD
The Hong Kong Polytechnic University - Department of Health Technology & Informatics, ST418,

Abstract
Scoliosis is a three-dimensional spinal deformity usually with lateral curvature of the spine and vertebral rotation. Most cases are with unknown cause and found in adolescence, therefore, it is termed as adolescent idiopathic scoliosis (AIS). Generally, regular observation is suggested for mild cases and surgery will be considered for severe cases. For patients with moderate AIS, the conventional treatment method is to apply rigid spinal orthoses to patients during their puberty to mechanically support the spine and prevent further deterioration. A review of the orthotic management to AIS from the past interventions to the future possibilities will be discussed in the keynote speech.

Introduction
Scoliosis is a three-dimensional spinal deformity usually with lateral curvature of the spine and vertebral rotation. Most cases are with unknown cause and found in adolescence, therefore, it is termed as adolescent idiopathic scoliosis. Generally, regular observation is suggested for mild cases and surgery will be considered for severe cases. For patients with moderate AIS, the generally accepted treatment method is to apply rigid spinal orthoses to patients during their puberty to mechanically support the spine and prevent further deterioration. With the advancement of technology, the past method of putting patients in a plaster cast for months of correction has no longer been used. The development of various orthotic treatment methods has been evolved rapidly. The clinical efficacy of treatment intervention together with the patients' physical and psychological acceptance to the treatment is equally important.

Methods
In parallel with the development of various treatment methods, the relevant assessment methods/tools are also advanced to better assess, monitor and evaluate the treatment outcome. These methods include realtime ultrasound assessments and use of computational methods for 3-D reconstruction of spine from 2-D X-ray images and estimation of curve correction after orthotic treatment. A review of the orthotic management to AIS from the past interventions to the future possibilities will be discussed in the keynote speech.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3614-None]

Osseointegration Technique - Surgical Procedures, Postoperative Management

Session Chair
Branemark, Rickard (Göteborg SE) | MD PhD
Sahlgrenska University Hospital - Centre of Orthopaedic Oesseointegration, Dept. Orthopaedics

Session Chair
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

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Symposium: Osseointegration Technique - Surgical Procedures, Postoperative Management
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3810-898]

Development of Surgical Procedures and Postoperative Management of Transfemoral Amputees (TFA) with Osseointegration (OI) in Sweden

Author
Berlin, Örjan (Gothenburg SE) | MD PhD
Sahlgrenska University Hospital - Centre of Orthopeadic Osseointegration, Dept Orthopaedics

Abstract
The development of TFA-OI procedures has been a stepwise introduction from custom-made design to standardized equipment, surgical technique and postoperative care and rehabilitation.

Introduction
Transfemoral amputations due to trauma or tumour surgery often result in a high amputation with or without soft tissue problems. These patients are frequently difficult to rehabilitate optimally with conventional socket prostheses. Boneanchored amputation prostheses (BAAP) might be a functionally good solution for these patients and our present surgical procedure and postoperative management is reported in this study. The first osseointegrated (OI) transfemoral amputation (TFA) prosthesis operation was performed in Sweden in May 1990. As in the following 8 years it had a custom made design and postoperative management was individualised. The Centre for Orthopaedic Osseointegration (COO) was inagurated in 1999,
and the prospective OPRA-study (Osseointegrated Prosthesis for Rehabiliation of Amputees) was initiated the same year. It introduced standardized procedures for the manufacturing of the surgical components, surgical technique, postoperative management and rehabilitation.

Methods
The surgery consist of a two-stage procedure. At the primary surgery (S1), a titanium screw (the fixture) is inserted into the remaining diaphyseal bone. A 3-dimensional guide instrument has been developed to ascertain central positioning. The fixture, countersunk by 20mm from the end of the remaining femur, is 80 mm long with a standard diameter of 16–20mm with stepwise increase by +0.5mm. The distal 20mm is thoroughly bone-packed. The patient is hospitalized for 5-7 days. At the secondary surgery (S2) six months later, when bony ingrowth has occurred, an abutment is inserted into the fixture allowing it to penetrate the skin. The abutment has a hexagonal press-fitting into the fixture and is secured by an abutment screw with a 10mm long thread into the fixture. Optimally the skin should adhere to the end of the bone and for that reason a hockey-puck like polyethylene ring compresses the skin against the underlying bone. The patient remain hospitalized for 10–12days with changing of draping every 3rd-4th day

Results
The preliminary results of the OPRA study are beyond the scoop of this technical presentation and will be presented in another part of this session. Postoperatively, local skin and flap problems can occur. The surgical armament to solve these problems may include extensive revision, split skin grafts and VAC treatment. Furthermore we have seen overloading of the system with metal fatigue problems and bending of the abutment and abutment screw, but problems with the fixtures are rare.

Conclusion
All prosthetic implant surgery is at risk of complications, and so is this technique. Development of a new concept like orthopaedic osseointegration in TFA patients is a tedious and time-consuming process, which have to be carefully monitored and controlled. Once a standard technique has been developed a drop in the complication rate can be noted. Surgical complications and early postoperative complications are few and can be managed in most instances without implant removal.
Information: www.integrum.se, www.sahlgrenska.se/su/osseointegration.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg101577/cg487037

Symposium: Osseointegration Technique - Surgical Procedures, Postoperative Management
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3726-871]

Endo-Exo-Prostheses - Improving Rehabilitation for Amputees - the Lübeck Approach

Author
Aschoff, Horst-Heinrich (Lübeck DE) | Dr. med.
Klinik für Plastische, Hand- und Rekonstruktive Chirurgie

Coauthors
John M. Keggi

Abstract
Endo-Exo-Prostheses are all about the improvement of gait following amputation upon an intramedullar, osseointegrated, percutaneous conducted implant as a hard point for the Exoprosthesis. The so called Endo-Exo-Femoral-Prosthesis (EEFP)is for above knee amputees (AKA), for below knee amputees (BKA) an Endo-Exo-Tibial-Prosthesis is available. It will be reported about 39 EEFP-patie

Introduction
Patients with above knee amputation (AKA) face many challenges to mobility including difficulty with socket fit and fatigue due to high energy consumption. Poor socket fit is a common problem and can be exacerbated by minor weight changes, sweating and skin problems.
In 1999 we began using a transcutaneous, press-fit distal femoral intra-medullary device whose most distal external aspect serves as a hard point for AKA prosthesis attachment.

Methods
The Endo-Exo Femoral Prosthesis (EEFP) is a cobalt-chrome alloy device covered with spongiosa metal (Eska Implants, Germany) which creates a deep porous surface and favorable modulus for bone formation. The EEFP is implanted in retrograde fashion as a first stage, followed some weeks later by stomatization whereby the distal aspect of the implant is exposed and an extension added for fixation of the AKA prosthesis. The stoma matures and epithelializes while solid bony ingrowth inhibits ascending infection.

Results
The first Endo-Exo-Femoral prosthesis (EEFP) was performed in 1999. Until December 2009, 39 cases were operated in Luebeck. Their indication for surgery was persistent AKA prosthesis difficulties with a history of AKA for trauma. Early serosanguinous drainage, soft tissue problems at the stoma and ascending infections after mobilisation of the patients could be minimised by developing the design of EEFP. Intramedullary infections were exceptions (1 of 39). 4 Explantations had to be performed (3 due to infection and 1 due to prosthetic failure). Two patients sustained traumatic, peri-trochanteric fractures treated operatively with retention of the implant.EEFP led to a better gait pattern because of the bone guided transmission of muscle power, the increased osseoperception and the improved economical energy balance.
37 of 39 Patients would accept the operation again.

Conclusion
The intramedullar, percutaneous Endo-Exo-Prosthesis

is warranting a secure Osseointegration, leads to an improved Gait which comes along with a physiological Osseoperception and a comparatively lesser energy consumption. The procedure may lead to soft-tissue problems at the Stoma that can be managed or even be avoided and does not necessarily lead to an intramedullar infection of the bone. The Lübeck approach presents further patient data regarding the biology of the implant interface, patient satisfaction, graded improvements in mobility and function, pain scores and oxygen consumption.

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Symposium: Osseointegration Technique - Surgical Procedures, Postoperative Management
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3727-None]

Development of an Intraosseous Transcutaneous Amputation Prostheses

Author
Blunn, Gordon (Stanmore UK) | Prof.
University College London, Royal National Orthopaedic Hospital - Musculo-Skeletal Science, John Scales Centre for Biomedical Engineering

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg101577/cg291088

Symposium: Osseointegration Technique - Surgical Procedures, Postoperative Management
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3728-820]

Where Are the Limits - Surgical Approach and Case Reports from Sweden

Author
Branemark, Rickard (Göteborg SE) | MD PhD
Sahlgrenska University Hospital - Centre of Orthopaedic Oesseointegration, Dept. Orthopaedics

Abstract
When can bone anchored amputation prostheses be considered? This presentation will report on some cases illustrating possibilities and limitations.

Introduction
Treatment with osseointegrated transfemoral prostheses (OI-prosthesis) has been performed in Sweden since 1990. It comprises two surgery sessions (S1 and S2) and rehabilitation. But this technique can also be used for patients with other amputation levels as well as for patients with very short stumps.

Results
This presentation will focus on case reports in the treatment of the patients with very short transfemoral stumps or other amputation levels such as thumb, transradial and transhumeral.

Conclusion
Today we have not explored the limitations with bone anchored amputation prostheses. This presentation will illustrate some possibilities and limitations with the current approaches.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg101577/cg291249

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3204-None]

Assistive Devices for Children with Cerebral Palsy - How to Get the Whole Picture?

Session Chair

Kraus de Camargo, Olaf (Hamilton CA) | Dr. med.
McMaster University, McMaster Childrens Hospital, McMaster Child Health Research Institute - Paediatrics/Developmental Paediatrics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg40048

Symposium: Assistive Devices for Children with Cerebral Palsy - How to Get the Whole Picture?
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Children

Congress Lecture [3209-732]

The Non Ambulant Child, Options in the Treatment with Wheelchair and Seat-support-orthoses

Author
Stockmann, Norbert (Dortmund DE)
Bundesfachschule für Orthopädie-Technik

Abstract
According to international and national legal norms an individual right to participate in community life as well as to ensure personal mobility is accepted. CP-children, especially when they are non ambulant, are greatly aggrieved in this. It will be shown in which way concerned children benefit from mobility aids.

Introduction
Looking for experiences in independent mobility the non ambulant CP-child requires solutions alternative to the human-gait. This is preconditioning for taking part in age-based activities as well as for discovering its own environment.
Meeting mobility claims concerned children usually get wheelchairs respectively seat-support-orthosis attached to wheel bases.

Methods
It will be shown why independent mobility is important for the non ambulant CP-child.
In respect to different indications a differentiation will be made between wheelchair and seat-support-orthoses.
Requirements for positioning in seating will be given.
Aspects of wheelchair-dynamics will be discussed.

Results
The viability of the approach will be illustrated by examples.

Conclusion
Compared to non-disabled children of the same age the CP-children suffer from motor impairments, and often also in their intellectual development. Immobility, due to a lack of ability to walk, also reduces the chance of age-based activities and environmental experiences. The offer of assistive devices for independent mobility helps to keep looming deficits to a minimum.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg40048/cg40412

Symposium: Assistive Devices for Children with Cerebral Palsy - How to Get the Whole Picture?
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Children

Congress Lecture [3210-815]

Surgical and Conservative Methods in the Treatment of Children with CP

Author
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

Coauthors
F. Braatz, C. Weichold, T. Dreher, S.I. Wolf, M. Alimusaj

Abstract
For the management of children with cerebral palsy (CP) a team is necessary since there are different treatment aspects during the development of the child. With age there are both operative and conservative treatment options. For the conservative treatment, orthoses, Botulinum-toxin and casts are used. The surgical options vary with the degree of involvement. In mild cases only isolated calf muscle lengthenings are needed whereas in more severe cases multi-level soft tissue procedures often including bony procedures are indicated. In every case an interdisciplinary postoperative management is required. The gross motor function classification scale (GMFCS) hereby serves as a reliable tool for treatment planning and control.

Introduction
Patients with CP and spastic diplegia show different disturbances of the musculoskeletal system. The common classification is done with respect to the GMFCS. During the last years this scale turned out to be a helpful tool in the therapy process for describing and understanding functional deficits. Both conservative and surgical treatments have to be planned with respect to the patients' functional deficits. The conservative treatment with orthotic devices should be preferred. Non ambulant patients and short distance walkers (GMFCS IV-V) need aids for sitting e.g. in the wheel-chair and for the night time. Other conservative options in the treatment of patients with CP are casting and Botulinum-toxin.
Surgical interventions are an option when conservative methods are not feasible but should be planned carefully. Instrumented three-dimensional gait analysis is the appropriate method in this process of treatment planning. This contribution presents the surgical techniques, indications for hip reconstruction an

Methods
3-D gait analysis including dynamic EMG was used to document the effect of Botulinum toxin and of orthotic devices. 16 patients were therefore monitored before and 6 and 18 weeks after the start of treatment. For comparison the surgical outcome of treatment with FDO is presented on the data basis of 48 patients which underwent 3D-gait analysis before and 1.6 years (mean) after surgical intervention

Results
In the Botox versus casting study all of the three (Btx, cast, cast +Btx) groups showed relevant benefits. 18 weeks after the intervention the interventional effects were not longer present and the patients reached the same functional level they had before.
The EMG showed the local Botulinum toxin effects. During the cast-treatment EMG analysis showed a more physiological timing of the m. tib. ant.

Results of the FDO study showed a mean hip internal rotation in stance of 18° before the operation. 1 year after surgical intervention the mean inernal hip rotation in stance was 0,2 °. The long-term results showed no significant changes (Tab.1).

Conclusion

The treatment of CP patients during adolescences requires a interdisciplinary therapeutically team. The choice of the correct therapy out of the large bandwidth of the therapeutic options has to be chosen with respect to the patients' functional capability. Individually manufactured orthotic devices are the guarantee for success in post-surgical interventions and conservative treatment. The treatment includes a team of different professions, CPO´s , Physical therapists, occupational therapists and medical doctors.
The above mentioned treatment concepts should be used at right time. Patience is one of the most important key factors for the success.

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Symposium: Assistive Devices for Children with Cerebral Palsy - How to Get the Whole Picture?
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Children

Congress Lecture [3211-794]

The Model of the International Classification of Functioning, Disability and Health - Its Importance for Providing Assistive Devices

Author
Kraus de Camargo, Olaf (Hamilton CA) | Dr. med.
McMaster University, McMaster Childrens Hospital, McMaster Child Health Research Institute - Paediatrics/Developmental Paediatrics

Abstract
This presentation will demonstrate how the framework of the ICF-CY allows to describe the functioning and the needs of children with cerebral palsy and how this can be used to communicate with the different stakeholders in order to provide the best fit between patients/family needs and the assistive devices that are chosen.

Introduction
The International Classification of Functioning, Disability and Health - Children and Youth (ICFCY) can be used as a tool to collaborate between clients, clinicians, service providers and policy makers.

Methods
Functioning of children is determined with regard to the context in which they are living (Concept of Environmental Factors), to which degree their Body Functions and Structures correspond to general accepted norms (Concept of Body Functions and Structures) and, if they are able to perform the type of activities in the same way as a person without a health problem (Concept of Activities) developing their existence in all domains that are important to them in the same way and the same extent as it would be expected to be by a person without impairments of body functions or structures or restrictions in activities (Concept of Participation).

Results
The planning of interventions and goal setting should focus on how the functioning of a patient can be improved. Adressing structure and functions can be one way to approach these goals, but identifying barriers and facilitators in the environment can be equally important and effective in increasing the participation of the patient. The ICF can be quite helpful in providing a common language for professionals of different areas to communicate and collaborate about the functioning of a patient in a certain environment and to identify the different needs, barriers and facilitators. This can be used in the analysis and the choice of the assistive devices. From the perspective of service providers and policy makers it is important to understand, that within this framework, children with the same diagnosis might have quite different needs of assistive devices, depending on their functioning.

Conclusion
The use of the ICF-CY can assist in communicating these needs in a standardized way.

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Symposium: Assistive Devices for Children with Cerebral Palsy - How to Get the Whole Picture?
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Children

Congress Lecture [3212-809]

Orthotic Concepts in Children with CP: From Conventional up to Soft-Orthotics

Author
Weichold, Claudia (Heidelberg DE)
Orthopädische Uniklinik Heidelberg - Orthetik

Coauthors
M. Alimusaj, F. Braatz

Abstract
There are many appearances of Patients with Cerebral Palsy (CP). Therefore a wide bandwidth of orthosis is needed that fits to the different requirements. An overview of these concepts will be shown by taking the issues into account that have to be included into the design of the orthotic treatment.

Introduction
There are a lot of different orthotic concepts for the treatment of patients with cerebral palsy available (1). The variety of those is based on the different requirements on the orthosis which are not only defined by the medical indications and diagnosis but also by further important aspects. In the past having a good fitting of an orthosis to the anatomical structure of an extremity was sufficient. Nowadays, orthosis must also fit to activities of daily life with respect to different tasks of these activities and to the therapeutically treatment plan.

Methods
An overview of the different orthotic concepts in the treatment of children with cerebral palsy will be given. Orthosis for the lower and the upper Limb will be discussed based on clinical experiences and medical indication. The classification of orthosis is additionally assisted by functional aspects defined by Gross-Motor-Function-Classification-System GMFCS (4).

Results
The orthotic concept is particularly influenced by the therapeutically target, the patient's age, his motor function and the mental capability (2). Additionally the patient's environment has to be taken into account, i.e. parents, teacher, therapist and the carer. For a good compliance and a successful treatment attention has to be paid to all these factors and special requirements have to be transferred into the orthotic design. Fortunately, functional and therefore biomechanical designs are getting more in the spotlight. Orthosis are getting smaller, lighter and cosmetically appealing by being more robust than they were in former times. Orthotic supplies with adaptive systems are getting more suitable for daily use with increasing the handling(3, 5).

Conclusion
Orthosis are part of the predefined treatment concept and have to be adjusted to the patient's development. There are manifold opportunities for the treatment of patients with CP and it is important to find the right one that meets the individual needs of each of these patients. This leads to the most beneficial outcome and to the most efficient treatment. Taking all these issues into account in the treatment plan leads therefore to the most important target – a satisfied patient.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3662-None]

Lower Limb Prosthetics - Socket Technology

Session Chair
Guenther, Michael (Parey DE) | Dipl.-Ing. (FH)
Guenther Bionics GmbH

Session Chair
Solomonidis, Stephan (Glasgow GB)
University of Strathclyde - Bioengineering Unit

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Session: Lower Limb Prosthetics - Socket Technology
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3343-518]

CIR TF Casting System for Making Transfemoral Sockets

Author
Wu, Yeongchi (US)
Northwestern University - Dept of Physical Medicine and Rehabilitation

Coauthors
Casanova HR, Brncick MD, Karolewski TP

Abstract
This paper presents a plaster-less casting system for forming of transfemoral sockets. With a polystyrene-beads-filled casting bag and adjustable vacuum pressure, one can rapidly form the negative mold for making positive sand model, minimal modification and vacuum forming the transfemoral socket.

Introduction
Currently, there are two common approaches for transfemoral socket fabrication: plaster-based and CAD-CAM-based techniques.
Plaster is a casting material that requires high energy to produce and transport. The approach is a slow process and creates non-recycled waste that has to be collected and disposed. When not produced locally, plaster has to be imported or replaced with other alternative materials or methods.
The CAD-CAM technology, although used in some developed countries, is still too costly for low-income countries to set up and maintain.
The CIR Casting System for transtibial socket fabrication was developed to meet the needs of low-income countries. Since 2008, more than 2,000 transtibial prostheses have been fabricated and delivered using the new casting system by two organizations, in India and in Thailand. A re-designed casting bag and a modified fabrication procedure has allowed for the fabrication of transfemoral sockets.

Methods
The socket fabrication process using CIR TF Casting System includes four steps: 1) casting the residual limb using a large plastic bag to seal the polystyrene-beads-filled casting bag after it is rolled over the residual limb. Once sealed, the air inside the casting bag is evacuated via the vacuum connector. In less than a minute, the soft casting bag becomes a solid negative mold, which can be used as a check socket to determine the fitting comfort; 2) converting the negative mold into a positive sand model by filling the cavity of the formed negative mold with silica sand, inserting the mandrel into the sand, sealing the large plastic bag to the mandrel, and evacuating the air from inside the sand to form the solid positive sand model, 3) modification of the positive sand model using water-based clay for build-ups, and, 4) vacuum forming a socket. Demolding of the formed socket is done by cutting open the plastic bag to drain the sand inside the positive sand model.

Results
The progress from initial CIR Sand Casting System to the CIR TF Casting System for transfemoral socket fabrication required a number of modifications. The following improvement made the fabrication technique a potential useful clinical procedure:
- Changing the casting material from heavy silica sand to lightweight polystyrene beads reduced the set up cost, and simplified the process of casting transfemoral residual limb.
- Use of two plastic bags in the procedure made the surface of positive sand model smoother.

- With adjustable vacuum pressure, one can form at will areas of increased pressure bearing during casting or after the negative mold is removed from the residual limb. Being able to re-shape the negative mold during or after casting, it is possible to achieve an impression with compression of the soft tissues that minimizes extensive modification as routinely done in a plaster-based approach.
- Similar to pressure casting, the elastic properties of the casting bag provides an impression of an evenly compressed yet un-deformed residual limb.
- If preferred, the formed negative mold can be filled with plaster to form a positive plaster model for traditional plaster model modification.
- Unlike plaster bandages, the new casting system has almost an unlimited working time. If not satisfied with the formed negative mold, one can repeat the entire process without wasting any casting materials, allowing new users to practice the procedure to gain experience.

Conclusion

The CIR TF Casting System is a new casting system evolved from the CIR Casting System initially developed for transtibial socket fabrication. This new casting system uses a redesigned polystyrene-beads-filled casting bag and a modified procedure for making the negative mold of the transfemoral residual limb. The formed negative mold can be rapidly converted into a positive sand model for modification and vacuum forming of a check socket. With application of controlled vacuum casting, the formed positive sand model requires minimal modification.
- The setup and maintenance costs for this environmentally friendly reusable casting system are minimal. Elimination of plaster bandages or Plaster-of-Paris from the fabrication process can be a significant cost saving for many low-income countries. It reduces the need for collecting and disposing plaster waste. With further field evaluation and refinement, it can be a potential “green” prosthetic technology for many parts of the world.

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Session: Lower Limb Prosthetics - Socket Technology
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3118-316]

The Milwaukee - Socket: Scientific Findings as the Foundation of an Improved General Trans-Femoral Socket Design Concept

Author
Guenther, Michael (Parey DE) | Dipl.-Ing. (FH)
Guenther Bionics GmbH

Coauthors
Fiedler G

Abstract
Experimental assessment of isometric hip moment in amputees, as well as biplanar fluoroscopy studies provided the basis for several conceptual modifications of current trans-femoral socket designs. The developing of the theoretical framework was followed by a first practical trial of the new socket.

Introduction
Recent designs for trans-femoral sockets, starting with Long's NSNA [1], Sabolich's CAT/CAM socket [2], and not ending with Ortiz' MAS system [3, 4], although based on biomechanic reasoning and proven in everyday's practice, have generally evolved over considerable time spans and mainly as a product of the inventor's personal experience.
To thoroughly understand the situation in the trans-femoral stump and the functioning of current socket designs, was topic of a range of studies, including gait analyses, electro-myography, and isometric force measurements[6], the latter being a well defined criterion to estimate the effectiveness of a stump bedding design. The information which muscles experience the greatest restrictions gives a hint what section of the socket may be improved.
DRSA (Dynamic Roentgen Stereogrammetric Analysis) has recently been adopted for in-vivo assessment of prosthesis [5]. Findings suggest that the general concept of trans-femoral sockets can be improved.

Methods
The results of isometric force measurement in above knee amputees and previously published findings from DRSA studies on the stump/socket interaction during gait were combined to establish the theoretical foundation of an optimized fitting concept. Consideration of changes in isometric stump forces inside the socket and observations from the relative motion of the stump with respect to the socket during walking, led to three major deviations from traditional designs (CAT/CAM or MAS):
- Abdication of the super trochanteric lateral socket wall component
- Abolition of rigid ramus containment and "bony lock" in favor of a "muscular lock"
- Addition of an L-shaped lateral posterior support structure to stabilize the femur
A prototype was manufactured and fitted to a 21 year old volunteer for first practical tests. Function and comfort was assessed by the subjective feedback of the amputee, and the judgment of a certified prosthetist.

Results
The upper lateral part of the socket wall has been shown to have no beneficiary effect for prosthesis stability or muscle force exertion. It can even impair the walking pattern and subjective perception of the

prosthesis, why it was removed. Welcome side effects of this modification include better range of motion and less restricted muscle play, as well as cosmetic advantages.
For the ramus pubicus, riddance from the medially applied pressure results in a substantially reduced inconvenience level. The (distally) surrounding muscle tissue is capable of providing the required load bearing, as long as it is properly embedded. By including the hip extensors, which are tensed at heel strike, in the equation, the bony support can be entirely abandoned. The wedge blocking then takes place between hip extensors and the subtrochanteric parts of the femur bone in one direction and between the hamstrings and the rectus femoris muscle in the other direction. The glutes can be spared from rigid containment in the interest of free extension movability. Also no structural stability for the ramus “dent” is required anymore.
DRSA tests of MAS prosthesis walking revealed that upon heal contact the femur tip moves towards distal and lateral – resulting in Duchene-limp. An L-shaped guidance structure lateral posterior is to better this unwanted excursion. The change in insertion angle of the remaining abductor and extensor muscles is expected to reduce callus exostoses and related problems.

Conclusion
After years long experience with modern socket designs, extensive studies of isometric stump forces, and the chance to participate in the first DRSA tests of trans-femoral prosthesis walking, our proposed new socket concept includes the quintessence of various lessons learned. While first practical trials have been promising, it remains subject to further work, to investigate the clinical viability of our findings. Provided that clinical trials will be successful, it is suggested to name the design “Milwaukee-Socket” in recognition of the city of its first realization.

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Session: Lower Limb Prosthetics - Socket Technology
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3325-500]

Improved Technologies and Procedures for Custom Made Prosthesis Transfemoral Sockets

Author
Hamoui, Giovanni (Vigorso di Budrio (BO) IT) | Eng.
Centro Protesi INAIL - Production

Coauthors
Sacchetti R, Boccafogli E

Abstract
INAIL Centro Protesi, as partner of European Project Custom-Fit, in order to improve transfemoral socket design and manufacturing, developed and tested with good results a productive process based on 3D modelling and RM manufacturing.

Introduction
Custom-Fit is an EU sponsored consortium of universities, companies, and research institutes working together with an aim: increase the quality of life of European citizen developing customized products procedures through integration of human body geometry scanning, advanced 3D computer design and Rapid Manufacturing process. Prosthesis transfemoral socket was one of the demo-cases chosen to test the integration of these technologies, leading to a new automated 3D design, with added socket features enabled by RM manufacturing procedure, and new manufacturing process, different from the traditional one based on positive models.
The aim of this work was:
- verify the feasibility of the new procedure;
- assess the design improvements;
- test RM materials in socket application;
- compare time to market and costs of the new process and the traditional one.

Methods
RM materials samples (75 mm square, thickness varying from 4-6 mm) were tested in order to verify their suitability for RM of the prosthetic socket. These tests simulated the operation during socket testing and modification, according to the adjustments of a check socket made during fitting tests.
The input data for the modelling was the inner surface of the socket, obtained using OssurCad, a specialized CAD program that generates the socket surface with the input of patient geometry data. The file of inner socket surface was processed in Materialize 3-matic software. Was developed a variable thickness socket structure in order to increase mechanical properties and to reduce weight and manufacturing costs. The air valve housing was added in the selected position, obtaining the model (fig.1) to RM with SLA technology.
Two socket were made (fig.2), each assembled with a complete transfemoral prosthesis (fig.3) and tested on two patients in Centro Protesi training route (fig.4).

Results

The materials test results are reported in tab.a. The material DMX-SL™ 100, with good mechanical properties but lower thermoformability compared to the traditional one, showed the best overall performances and was used to RM the two check sockets.
Compared to the traditional technology these are the main benefits of CF procedure:
- reduction of number of positive models, with less human operations and less material waste;
- automation of socket design and manufacturing;
- addiction of new socket features (variable thickness, valve housing, reinforcement ribs).

Main disadvantages are related to SLA manufacturing technology:
- 150% increase of manufacturing costs;
- 100% increase of manufacturing process time;
- lower thermoformability of the socket.

Conclusion

The Custom Fit project has been a laboratory where develop new ideas and test new procedures and technologies. The two transfemoral check sockets produced with Custom-Fit procedure and tested on patients showed that the CF procedure is feasible. Main drawbacks are related to RM manufacturing time and costs. The major improvements of the prosthesis demo-case are connected to the 3D socket design with added socket features and the production process without positive models.

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Image: INAIL_abstract_Hamoui_None.jpg (see online)

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Session: Lower Limb Prosthetics - Socket Technology
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3433-608]

An Advanced Method for the Characterisation of the Biomechanical Properties of the Living Tissues of an Amputee's Residual Limb

Author
Solomonidis, Stephan (Glasgow GB)
University of Strathclyde - Bioengineering Unit

Coauthors
Solomonidis SE, Spence WD, Sandham WA.

Abstract
The P&O group of the University of Strathclyde, have developed a system which takes in account the external and internal geometry of a residual limb, the biomechanical properties of each tissue layer and the boundary conditions of the prosthesis to produce a functional prosthetic socket.

Introduction
Traditional methods of design, manufacture and fitting of a prosthetic socket are typically carried out by "artisan" techniques and often result in ill-fitting devices. Many prosthetists, (if not all), are frustrated by the lack of an objective method that would ensure an optimum fit of the socket. This 'need' for assistance instigated the advent of industrial sector technologies to be taken up in the field, even though these systems, in reality, lack the necessary "ingredient" to allow the optimum socket to be produced. They merely attempt to replicate current practices in a digital manner (CAD/CAM), without taking into account the biomechanical or anatomical characteristics of the residual limb. The introduction of a system that is capable of providing the prosthetist with on-line information concerning a detailed mapping of the residual limb and the pressure distribution at the stump/socket interface, as well as the maximum stresses in the tissue, is an innovation in the field.

Methods
Our group have carried out extensive research in designing a new system to aid the creation of prosthetic sockets. This research differes from other research as it aimed to acquire and utilise not only the external shape of a residual limb but also: 1.The internal anatomy of the stump. 2.Biomechanical properties of each tissue layer of the stump. 3.Established boundary conditions. This existing prototype system is named Intellisoc. It offers key advantages over existing techniques: 1.Provides optimally fitted prosthesis. 2.Provides the prosthetist with on-line information concerning the detailed mapping of the residual limb (external and internal geometry). 3.Real time diagnosis of residual limb problems. 4.Accelerates the rehabilitation of the patient. 5.Reduces costs by reducing the number of visits to the prosthetist as well as by reducing materials and time wastage due to poor fittings.

Results
Intellisoc consists out of three modules (figure 1): 1.A device to scan the residual limb internaly and expernaly and export data. 2.Data Tools - software to analyse and collate the data into intelligible information. 3.Socket Modelling - FEA simulation procedures that combine scanned information with known boundary conditions to create a model of a socket for the specific amputee. The system consists of an array of sensors which continuously record position, pressure, depth and stress propagation data; the external

geometry of the medium under examination is acquired by the position data and the internal geometry is acquired with the use of the on-board ultrasound transducers. Information on the bio-mechanical properties of the tissues are also captured. All the data are sent to a PC. Software generates a 3-D image of the stump's external and internal geometry. FEA and optimisation software generate the optimum design for the socket in order to obtain the best pressure distribution, and therefore the most comfortable prosthesis for the amputee. Tests of the System have already been pefrormed on tissue mimiking media as well as on porcine tissue speciments, in-vitro. Also, the system has already been awarded ethical aproval to be tested with human amputees and it has passed all the required safety tests.

Conclusion

The Intellisoc system aims to introduce a simple, scientific, repeatable and reliable way to produce prosthetic sockets. Amputees and prosthetists alike will benefit from the system. The SocketFit approach to the problem is multi-directional, unique and the only comprehensive solution ever to incorporate in-vivo external and internal geometrical and anatomical mapping, biomechanical properties, FEA and customised socket production. Innovations: 1.The use of Biomechanical Properties of the residual limbs. 2. Use of FEA in socket production; Though FEA has been used to analyse the stresses and strains in the amputee/ socket system in academic research, it has never been implemented into assisting actual socket design and creation. The incorporation of biomechanical properties and FEA which enable this system to largely automate the creation of prosthetic sockets is the "Holy Grail" of the p&o field. A patent application has been filed at the US and EU Patent Offices.

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Session: Lower Limb Prosthetics - Socket Technology
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3456-631]

Computer Aided Fabrication of a Carbon Fiber Prosthetic Limb Socket

Author
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Coauthors
Brad Mate, Mentis Sciences Inc., Manchester, NH
Ellenor Brown, Robert Kistenberg,
Georgia Tech School of Applied Physiology, Atlanta, GA
Samer Tawfik, Georgia Tech School of Aerospace Engineering, Atlanta, GA

Abstract
A prosthetic limb socket was fabricated using a process solely based on computer aided design/ manufacturing. The socket was designed from MRI data and fabricated using automated milling and fiber braiding devices. It was tested on a trans-tibial amputee, exhibiting good fit and excellent strength.

Introduction
Fitting of a prosthetic limb is a critical part of the rehabilitation of a lower limb amputee. Often the fitting process is a manually intensive, trial and error process, with the outcome dependant on the skill and experience of a particular prosthetist. Typically a composite socket is fabricated by hand layup, with the end result highly dependant on the skill and experience of the prosthetist or technician. Thus, the typical socket is a custom crafted item, not a precisely manufactured item. A new fabrication process is described which employs precise computer numerical control fabrication methods, driven by a digital model of the socket. This fabrication process gives control over the socket shape and the carbon fiber layup, whereby socket shape and structural characterisitcs can be repeatably reproduced. Furthermore, an automatied carbon fiber braiding process is employed which yields superior mechanical properties in comparison to hand lay-up.

Methods
The patient's residual limb is modeled from Magnetic Resonance Imagery data using Materialise MIMICS®; critical anatomical strustures are separated into distinct digital models, and the limb surface is extracted. These models are imported into Materialise 3matic® CAD design software, in their spatial relationship within the limb. Internal anatomical landmarks are used to position reliefs, builds, and trim-lines on the external surface of the limb. This model is used to mill a mandrel in the shape of the socket's interior surface.
An IGES model of the socket's inner surface is used to create a G-code program for a 4-axis CNC milling machine using CamWorks®. A mold blank, made from a special washout core material, is machined into mandrel for the automated composite lay-up. Carbon fiber strands are tightly wound over the mandrel using a mechanized braider, as a thermoset resin is added. The socket is vacuum bagged until the resin is cured, then the socket is cut along the trim-lines.

Results

The fabrication process was demonstrated on a trans-tibial amputee subject. A model of the subject's residual limb was generated from an MRI, and 3-D model of the limb shape was created and rectified. A patella tendon bar was carved into the limb surface using the internal position of the Patella as a reference. Likewise, trim lines were marked using the internal anatomy, defining the shape of the mandrel. Two identical mandrels were carved on the CNC mill, one was used for a thermoformed check socket and one to produce a carbon fiber socket on the mechanized braider.

The check socket was test fit to the subject, and with minor adjustments to leg height and liner thickness, the subject was able to walk using the prosthesis, successfully demonstrating the design process. An identical carbon fiber socket was fabricated on the mechanized braider. The braiding process insured intmate contact of the fiber strands to the mandrel surface. This socket exhibited a superior strength to weight ratio compared to conventional sockets due to the high volumetric fraction of carbon fiber to resin achived by the braiding process.

Successful modeling of the residual limb from MRI images took significant development for the pilot subject. However, once the model was obtained, a socket was designed and fabricated by the CNC processes in less than two working days.

Conclusion

A carbon fiber prosthetic limb socket can be successfully, repeatable fabricated using computer aided design and manufacturing processes. Furthermore, the automated carbon fiber lay-up process produces a socket with excellent shape fidelity and mechanical strength. Test fitting of a socket on a trans-tibial subject verified that the external shape of the limb was adequately captured and replicated in the fabrication process. Manufacturing turnaround time for a carbon fiber socket using this process is comparable to existing processes, and the mechanical properties of the carbon fiber socket appear superior.

Image: braided_socket_None.JPG (see online)

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3637-None]

Biomechanics in P&O Training: The Realities and Issues

Session Chair
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Session Chair
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg150972

Symposium: Biomechanics in P&O Training: The Realities and Issues
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3638-695]

Introductory Presentation: The Importance of Addressing this Topic

Author
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Introduction
Over the past decade, I have had been highly involved in the area of international standards as it relates to Prosthetic and Orthotic professionals and also in the development of Prosthetic and Orthotic professional education. Along with this, I have had the opportunity to travel around the globe and visit most Prosthetic and Orthotic educational related institutions. This has given me the unique chance to observe the methods used to develop Prosthetic and Orthotic professionals in many national settings.
The one clear and consistent issue observed, is the lack of ability within students and graduates to comprehend and apply the necessary biomechanical principles to clinical practice. Even though there are internationally defined standards in this subject area, often they are not met to the level expected. These standards are outlined within the ISPO/WHO standards in both the Category I and II professional profiles and learning objectives.
Further to this, there is a consistent lack of standardization

Results
No results - not applicable.

Conclusion
As a result of these identified issues and observed problems, it was felt important to address them within a symposia focused on the subject of Biomechanics as it relates directly to the training and development of Prosthetic and Orthotics professionals. Three esteemed and highly qualified colleagues have been invited to present and discuss their views on the topic from their professional perspectives.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg150972/cg151462

Symposium: Biomechanics in P&O Training: The Realities and Issues
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3639-846]

The Views from the Educator & Prosthetic/Orthotic Practitioner

Author
Ruder, Gordon (Toronto CA)
George Brown College - Prosthetic & Orthotic Programs

Coauthors
Dan Blocka (Chair), Gordon Ruder, Siegmar Blummentritt, and Stefania Fatone

Introduction

In the classroom, if I were to ask my students of the importance of biomechanics to them as aspiring clinicians, they would all emphatically answer, “yes!”. Many can’t even comprehend how one could become a good clinician without a sound understanding of biomechanics and gait.
In a clinical setting, we rely on gait and biomechanical knowledge to assist us in designing new devices, and critiquing current/previous ones. We use this knowledge to help determine casting alignment, materials and components to order, and how the device is to be fabricated. An understanding of biomechanics and gait is also necessary in trying to communicate with colleagues, presenting a case study, or conducting a clinical workshop at a conference.

Results

However, if you were to ask a student to use their classroom understanding of biomechanics and apply it to a technical or clinical scenario, most struggle and are unable to do so. Many experienced and well established practitioners similarly avoid biomechanical assessments altogether, or only describe kinematic aspects of it. Students, practitioners, and even educators themselves have variable, personal, and inconsistent biomechanical language. Not all believe that biomechanic training is even that important when providing prosthetic/orthotic care for our patients.
The purpose of this symposia is to discuss the realities & issues of biomechanical training in Prosthetics and Orthotics. There are some things we do know, that will help this discussion begin. There are significant gaps between biomechanics education, research and prosthetic & orthotic industry. In addition, there is no single standardized approach to how biomechanics is taught, there is limited prosthetics & orthotics biomechanical reference material to draw from. Those that are strong biomechanists tend not to also be educators or clinicians.

Conclusion

It is the hope that from this symposia, the gaps between biomechanical education, research, and the industry can begin to close and some strategies on how we could deal with the issues raised can be developed. If this can happen then we as P&O professionals can continue to improve our level of care for our patients.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg150972/cg151742

Symposium: Biomechanics in P&O Training: The Realities and Issues
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3640-803]

Biomechanics in P&O Training: the Realities & Issues From the Perspective of Industrial Research

Author
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Abstract
The support and locomotion organs represent the largest organ system of the human organism. These organs fulfil primarily mechanical tasks such as posture and movement. Many people are in need of orthopaedic aids because the function of this system is limited.

Introduction
The importance of biomechanics for Technical Orthopaedics is described in the following definition: “Biomechanics within the scope of orthopaedic technology means the science of the influence of technical aids on living tissue and their effect on human posture and locomotor functions" (R. Uhlig). Thus biomechanics deals with a wide range of ideas such as the understanding of shape and function of locomotion organs (e.g. when treating hip dysplasia), the effect of insoles or prosthetic alignment, and the analysis of finger movement when gripping with modern prosthetic hands.

Methods
By providing materials, technologies and products that compensate for physical disabilities, the industry becomes a partner with the rehabilitation team. Product developments are frequently based on biomechanical considerations and knowledge that are absolutely essential for a high standard of care.

Results
Within this framework, objective data for static standing and motion gain increased significance. For example, laser-based alignment systems containing a force plate allow for precise and bio-functional integration of the lower limb orthosis with the support and locomotor organs. Movement can be objectively assessed using gait analysis technology. These methods are easily justified in research as they provide scientific knowledge, but they are also justified with respect to clinical diagnostics and therapy, particularly with regard to objectively assessing static standing.

Conclusion
The primary basis for prescription of orthopaedic treatment that offers the most consensus is the biomechanical requirements for achieving specific rehabilitation goals. Thus biomechanics should focus on treatment. It should provide the scientific basis for interdisciplinary activities in prosthetics and orthotics. A clinical practice-orientated university education and training are therefore required. The necessity for this type of education for the future of P&O will be explained through examples.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg150972/cg152022

Symposium: Biomechanics in P&O Training: The Realities and Issues
Thursday 2010/05/13 | 10:30 - 12:00 | Subtopic/Track: Education

Congress Lecture [3641-785]

The Views from the Researcher

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Abstract
The National Commission on Prosthetic and Orthotic Education (NCOPE) defines an entry-level prosthetist-orthotist as someone who has achieved entry-level competence through a combination of academic and clinical experience education; who upholds the clinical standards and values of the prosthetics-orthotics profession; and who is an effective consumer of research

Introduction
and knowledge to support clinical practice and contribute to the growth and development of the profession. The NCOPE Core Curriculum Guide for Orthotists and Prosthetists states that the “professional curriculum portion” is designed to provide the student with the knowledge, skill and behaviors required for entry into the clinical practice of orthotics-prosthetics. Included as basic sciences are biomechanics/pathomechanics, gait analysis (normal and pathological gait), and kinesiology. In 2005, NCOPE voted to move the prosthetics and orthotics entry-level education to a Master’s degree by 2010 for new programs and 2012 for existing programs. In the Core Curriculum Guide:
•Biomechanics is defined as “the application of mechanical principles on living organisms. It includes research and analysis of the mechanics of living organisms and the application of engineering principles to and from biological systems.”

Methods
•Gait Analysis/Pathomechanics is defined as “the study of locomotion in humans.”
•Kinesiology is defined as “the study of the mechanics of body movement.”
Orthotists and prosthetists must be able to explain the biomechanical mechanism for development of deformity, describe the forces between the patient and the device during functional activities, and compare and contrast the biomechanical differences between different device designs. More specifically, an orthotist should be able to apply knowledge of normal anatomy and normal and abnormal biomechanics of the lower limb, upper limb and spine in combination with patient assessment to develop an appropriate orthotic treatment plan. While a prosthetist should be able to apply knowledge of kinesiology, biomechanics and pathomechanics to describe the biomechanical rational for bench alignment and the effect of alignment on forces placed on the residual limb, joint moments and stance and swing stability

Results
in lower limb prosthesis and for upper limb prostheses, describe how changes in the working environment are affected by component control availability. Furthermore, both orthotist and prosthetists must be able to apply information from research to their clinical practice, evaluate the outcome of their interventions, and contribute where possible to the growth of prosthetic and orthotic knowledge and research. A search of Pubmed (National Library of Medicine) conducted in November 2009 shows that a third of all prosthetics and orthotics citations focus on gait or biomechanics. Search terms used were “(orthotic devices OR braces) AND (gait OR biomech* OR kinesiology OR movement OR locomotion OR motion)” and “artificial limbs AND (gait OR biomech* OR kinesiology OR movement OR locomotion OR motion).”

In order to do this an entry level biomechanics course should introduce Newtons Laws of Mechanics and applications of those laws to human motion as well as prosthetic and orthotic situations. At the Masters level students should develop competency in the mechanics of human motion including knowing how to compute the values of a variety of mechanical parameters, with an emphasis on those relevant for the analysis of human movement and use of prosthetic/orthotic devices.

Conclusion

Additionally, graduate level students must be engaged in critical evaluation and application of current research, which requires that research methods, including basic statistical concepts, be taught alongside biomechanics as foundation knowledge. As in clinical practice, it also requires that the evidence used in the education setting be current and interwoven through all aspects of the curriculum providing constant reinforcement of the use and application of evidence. This requires substantial depth of knowledge among teaching faculty as well as the resources and opportunity for students to engage with researchers and research experiences. Without these skills, prosthetists and orthotists cannot provide a competent and safe level of clinical care based on the most current knowledge, nor can they contribute to the continued growth of the profession.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3674-None]

Orthotics - AFO

Session Chair
Alexander, Michael (zvia IL) | CO Ped.
stride Orthopedics Ltd. - orthotics

Session Chair
Bregman, Daan J.J. (Amsterdam NL) | Drs.
VU University Medical Center - Rehabilitation Medicine

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228362

Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3034-232]

The Effect of Two Types of Ankle-Foot Orthosis on EMG Activity of Peroneus Longus Muscle in Athletes with Functional Ankle Instability

Author
Sohrab, Marjaneh (Tehran IR)
Iran university of Medical Science - Orthotics and Prosthetics

Coauthors
Sarrafzadeh J,Saeedi H,Sanjari MA,Keyhani MR

Abstract
The purpose of this study was to determine whether there was a difference in latency of the peroneus longus muscle using two types of ankle orthoses in response to sudden ankle inversion perturbation.

Introduction
Ankle sprain is such a common sports injury that it constitutes 10% to 25% of all sports injuries .On the other hand 70% to 80% of individuals who experienced a sprain may suffer from another ankle sprain at least once more, which results in chronic ankle instability. Thus,many studies investigated the role of orthosis in reducing the incidence of sprain,constricting the range of motion and improving neuromuscular function. The purpose of this study was to evaluate the influence of orthosis on peroneus longus muscle reaction time in response to sudden perturbation in athletes with functional ankle instability.

Methods
12 female athletes(volleyball and basketball alite player) with functional ankle instability(age=21.5 ±2.9 years,range:17 to 27 years ;BMI=23.26±3 kg/m2) participated in this study.Repeated ankle inversion sprains and a self-reported feeling of instability was used as inclusion criteria.The method of testing dynamic staility with a tilting platform was approved by the local human ethics committee.Prior to participation,all subjects were informed about the procedures and signed a consent form. Unexpected perturbation in frontal plane was exerted by using ankle perturbation system(APS-I.R. Patent 31901) and simultaneous recording of electrical activity of peroneus longus muscle was performed with surface electromyography.The trapdoor was released up to 300 by a pneumatic switch through a control panel not observable to the subjects.Participants were tested under 3 conditions:without orthosis,using elastic orthosis and semirigid stirrup-Type Ankle-Foot orthosis.

Results
The results of kolmogorov –Smirnov test showed the normal distribution of variants(P>0.05).The mean of peroneus longus muscle latency was reduced using elastic orthosis(mean diffrence: 12.49 ms) and semirigid stirrup-Type Ankle-Foot orthosis(mean diffrence: 8.40 ms) in comparison with no orthosis condition.However these differences were not significant.(P>0.05)

Conclusion
The results of present investigation indicate that immediate effect of wearing elastic and semirigid orthoses in athletes with functional ankle instability does not leed to change in peroneus longus latency and refute

the theory that using ankle braces may results in delay of peroneus longus reaction time and will augment the risk of injury.
On the other hand, perceiving the mean differences of these three conditions shows that using both orthoses may attenuate the reaction time of peroneus longus muscle.Since elastic support had more effects on diminishing the latency,the hypothesis that using elastic supports stimulates the cutaneus mechanoreceptors and improves proprioception was intensified.
Our findings suggest that elastic and semirigid stirrup-type ankle-foot orthosis did not have an excitory or inhibitory effect on reflexive ankle muscle activity and prevention of ankle injuries may be accomplished by limiting ankle motion not by affecting ankle muscle latencies.

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Image: chart1_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228362/cg35377

Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3113-311]

A Systematic Review to Determine Best Practice Reporting Guidelines for AFO Interventions in Studies Involving Children with CP

Author
Ridgewell, Emily (Bundoora AU)
La Trobe University - National Centre for Prosthetics and Orthotics

Coauthors
Dobson, F
Bach, TM
Baker, R

Abstract
This review used a customised data extraction and quality checklist to evaluate the level and quality of detail reported about the AFO intervention, participants and testing protocol in AFO intervention studies. Best practice reporting guidelines were developed.

Introduction
The evidence-base for the use of AFOs in children with cerebral palsy (CP) has been repeatedly described as low quality 1-3. These conclusions are largely based on assessment of general methodological construct and minimisation of study bias 4,5.
However, assessment of the quality with which the intervention (the AFO) was administered is also crucial6. This requires reporting of sufficient detail and transparency6 which is often lacking in this literature1,2. There are currently no guidelines recommending the level of detail and transparency required in AFO intervention studies.
This is the first review to focus specifically on the level and quality of detail reported by AFO intervention studies on children with CP. It was anticipated that by focussing on examples of good practice within the literature, it would be possible to derive best practice guidelines for reporting research in this area.

Methods
An electronic database search was conducted to identify all studies that evaluated AFO use in children or adolescents (aged 6-18 years) with a primary diagnosis of CP. Abstracts and case studies, opinion pieces and systematic reviews were excluded. No date limits applied.
As no quality checklists were available for this type of review, a new data extraction and quality assessment checklist was designed. This focussed on detail regarding the participants (topographical diagnosis, age, joint ranges of motion, common ankle, knee or hip movement or abnormality); the AFO intervention (description of the orthotic aim, of the construction, action and alignment of the device); and the testing protocol (control and test conditions, randomisation and acclimatisation).
The checklist was piloted on a sub-group of papers. Two reviewers independently assessed all papers. Full consensus was reached on all items.

Results
Forty-one full papers were included in the review.

Topographical diagnosis and participant age were well reported. Very few studies clearly described a homogenous gait characteristic demonstrated by all participants. However, in several studies participants were subdivided according to gait pattern and differences in outcomes between the sub-divisions were observed. Given these differences future studies should focus on participant groups exhibiting some degree of homogeneity, or should sub-divide groups to investigate the possibility that heterogeneity might affect results.
A clear description of the general type of AFO was provided by most studies. However, few studies clearly described the physical design, construction and alignment of the AFO or provided a clear orthotic aim. Clear reporting of this information is essential as differences between AFO designs may produce difference in outcomes in several gait parameters.
Only one study included both shod and barefoot control conditions. Footwear has been shown to influence gait7, and thus future work should consider including both of these control conditions wherever possible. Several studies used a non-randomised order of testing and many did not report this information. Acclimatisation times were reported by the majority of papers which ranged from less than one day to greater than 4 weeks.

Conclusion

Assessing the quality of individual studies and using results in quantitative research synthesis requires transparent reporting6. There was considerable variety in level and quality of detail provided by these studies. There were however, sufficient good examples to enable the generation of guidelines for reporting of detail in AFO intervention studies. These guidelines should also direct the design of future investigations in this area which will improve the synthesis of quantitative research and therefore the quality of this evidence-base.
Several avenues of research have been identified which could benefit from focussed attention. For example, what is the most appropriate control condition for comparison with an AFO intervention? What is the minimum acclimatisation required for an unfamiliar device? Do small differences in AFO design and alignment have a significant effect on AFO effectiveness? Answering these questions might facilitate comparison across studies already published.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228362/cg38287

Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3222-404]

Quantification of the Path of the Center of Pressure (COP) after Application of an Ankle Brace during Daily Activities

Author
Werner, Simone (DE) | Dipl. Ing. (FH)
Orthopädieschuhtechnik Möller - Kundenbetreuung

Coauthors
Peikenkamp K, Thorwesten L

Abstract
On the basis of plantar pressure meassurement the influence of an ankle brace on the path of the center of pressure (COP) was studied.

Introduction
This paper extends recent studies [1, 2, 3], which examine the influence of an ankle brace on activity and motion. The influence of an ankle brace on the path of the COP is analyzed and a detailed and quantifiable discription of the path of the COP is developed.

Methods
For this paper the plantar pressure of 14 healthy adult test subjects was measured to determine the path of the COP. The test subjects had to walk along a straight path, to go upstairs and downstairs with and without the U-shaped ankle brace for the measurements with insole plantar measurement.
With the help of a spreadsheet program a mask is developed which analyses the measured values of the measurement system. The calculated parameters are the length of the path of the COP, the first and the last coordinates of the path of the COP, the period of the stance phase, maximum and minimum laterally deviation of the path of the COP at forefoot, midfoot and hindfoot. The results are presented with tables and charts.
The significance of the results was proven with a three-factorial analysis of variance.The level of significance was determined at 5%.

Results
The measured values are automatically analysed after data import into the masks of the spredsheet program. You can modify the masks and adapt them to changed test conditions.
Because of the analysis of the measurements the path of the COP is quantifiable spatially and temporally described.
You can see a significant influence of the ankle brace on the parameters length of the path of the COP and period of stance phase which also means an influence on the rolling action of the feet.
The interaction between side and treatment shows reduced length of the path of the COP and period of stance phase because of application of the ankle brace to the right ankle. At the same time these parameters increase on the collateral side which means an increased rolling action and an increased stress on the native foot.
The interaction motion and treatment shows a significance, too. The period of stance phase increases because of the ankle brace while going upstairs. While walking along a straight path and going downstairs

with the ankle brace the period of stance phase decreases. That means that not only the brace but also the kind of motion influences the path of the COP. You can see this correlation in recent studies, too [1, 2]. The results of the single test subjects shows that the influence of the ankle brace also depends on the individual itself. So you can find different influences on the individual. Recent studies document this kind of influence [3].

Conclusion

The stress on the native foot is stronger than on the supported foot which is shown by the interaction of side and support.
Because of the interaction of motion and support we can see that not only the ankle brace influences the path of the COP but also the kind of motion. This kind of influence is also described in literature [1, 2].
The type of influence of the ankle brace depends on interaction between motion and the individual itself. This phenomenon is also discribed in literature [3].
Because of the mask on the basis of the plantar pressure messurement we can get a detailed discription of the path of the COP and the roll motion of the feet.
The masks are adaptable on changed test conditions.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228362/cg40488

Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3351-526]

Evaluation of Functional Parameters of Ankle Foot Orthoses for Different Materials and Design Characteristics

Author
Creylman, Veerle (Geel BE)
KHKempen University College - mobilab

Coauthors
Muraru L, Creylman V Palari J2, Willemsen R, Vander Sloten J, Peeraer L
Central Research Laboratory for Biomedical and Rehabilitation Technology (MOBILAB), K.H.Kempen University College, Belgium
Materialise, Haasrode, Belgium
Centrum Technische Orthopedie Division Pellenberg, Belgium
Division of Biomechanics and Engineering Design, K.U.Leuven, Belgium
Faculty of Movement Sciences and Rehabilitation, K.U.Leuven, Belgium

Abstract
This study investigates the effect of different materials and different design characteristics on functional parameters of ankle foot orthosis (AFO). Preliminary results of finite element (FE) simulations are presented.

Introduction
Patients with various lower limb muscle and joint weaknesses and instabilities are widely prescribed to wear an ankle-foot orthotic device (Halar and Cardenas, 1987). Functional requirements of AFO are customized depending on patients' pathology. The materials and the design parameters determine the mechanical characteristics of AFOs. Traditionally, AFOs are made of polypropylene (PP) and polyethylene (PE) (Chu, 2001). Recent studies have proved the feasibility of using selective laser sintering (SLS) techniques to manufacture passive dynamics AFO with shape and mechanical damping properties similar to carbon fiber AFO (Faustini et al., 2008). This study investigates the effect of AFO material (PP vs. SLS Nylon-12) and AFO thickness on AFO functional parameters. Preliminary results of finite element (FE) simulations involving different design characteristics and different materials are presented.

Methods
A patient-specific AFO was designed for a healthy test subject (female, 25). FE models of different thicknesses (4mm, 5mm) were defined. Boundary conditions simulating dorsiflexion movement were implemented in the numerical model (Creylman et al., 2009). Isotropic PP (VINK) and Nylon-12 (EOS PA 2200) material characteristics were taken from literature (Syngellakis et al., 2000; Amando-Beker et al., 2008) and employed in the numerical models. Transversally isotropic material properties (Amando-Beker et al., 2008) were also considered for the Nylon-12 material to simulate different material orientations (flat vs. upright) introduced by means of SLS technique. A sensitive study regarding the effect of AFO thickness and material on AFO functional parameters was conducted. Maximum deflection values, maximum rotational angle, compressive stress values in the ankle region were calculated for each model.

Results

The key results of the FE simulations are listed in Table 1. Increasing the thickness with 1mm had a large effect on all considered parameters: AFO deflection and rotational angle decreased with approximately 22% (Nylon-12), 34% (PP) and 40-44% (SLS Nylon-12 flat and upright, respectively). For the PP and Nylon-12 models, stress contours had similar patterns. For the 4 mm thickness, stress contours revealed compressive stress concentrations at the ankle radius on the medial side. For the 5 mm thickness, the highest compressive stress values were predicted at the trim line ankle on both medial and lateral edges. Peak compressive stress values are shown in Table 1. The PP orthoses showed to be more rigid than the Nylon-12 ones, while the SLS Nylon-12 orthoses were found the most flexible ones. Although elastic material properties were considered in the FE simulations, the non-linear behaviour of AFOs was regarded by means of large deformation effects. Significant lower stress values were obtained with a non-linear material model and large deformation effects compared to a linear analysis (linear elastic material and large deformations not incorporated) (Syngellakis et al., 2000). If the numerical implementation of non-linear properties of PP is documented for specific applications (Lobo, 2006), determining and implementing the non-linear properties of SLS Nylon-12 is still ongoing research.

Conclusion

A FE model of a patient-specific AFO was used to investigate the influence of different materials and different thicknesses on AFO functional parameters. Both elastic properties and material orientation have influenced the flexibility of the device. The non-linear behaviour of the AFO was considered by means of large deformation effects.

The FE method allowed direct comparison of AFO characteristics when different materials and designs were evaluated. The results presented in here will help understand the complex non-linear behaviour of AFOs before device manufacturing.

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Image: table1_None.jpg (see online)

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Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3124-322]

Observations of Peroneal Functional Electrical Stimulation (FES) with CP Pediatric Population

Author
Alexander, Michael (zvia IL) | CO Ped.
stride Orthopedics Ltd. - orthotics

Coauthors
Michael Alexander CO. Ped.
Vivian Alexander MA Bpt CO

Abstract
1961 Liberson published the first study of FES. 2 computerized FES devises were introduced lately. Few researches have been published about the use of FES, less were published about FES in pediatrics. We will show examples of FES with CP children, report our observations and describe the potential

Introduction
Functional Electrical Stimulation – FES for the treatment of drop foot externally induces dosiflextion by electrical stimulation to the peroneal nerve. It will help in the swing phase with patients who suffer from central nerve system injury such as CP, CVA, incomplete spinal cord injury, MS, etc. FES was first used in the beginning of the 60s. In the pre-computer era, FES was cumbersome and not user friendly. There are today two orthotic computerized FES devises available. The WalkAide and Ness L300. Both are computerized and use Blue Tooth technology. We use the WalkAide system and have been working with it since 2007. The FES orthosis is an active orthosis whereas the traditional AFO or its different variations, are more passive orthotics. We have observed improvement in clearance, heel strike, and overall gait quality. FES is still in its infancy and so its potential in the rehabilitation of the pediatric population with CP is yet to be discovered.

Methods
Since 2007 we have been using the WalkAide as a peroneal FES devise. Children with spastic hemiplegia, spastic diplegia and spastic quadriplegia have been observed in clinics and videoed for future follow-up. The children chosen were in GMFCS category II and III.
Clinical observations were made with the FES device on and without any device for observational comparison. Most of the patients we examined have used, or are currently using conventional orthotics.

Results
Since 2007 we have seen 124 patients that were suitable and tried walking with the WalkAide system. Forty two of these patients had CP. The CP pediatric population examined have hemiplegia or diplegia. Of this group 29 patients ranged from age 6 to 13 years old (23%). Thirteen were between 14 to 18 years of age (10.5%). Five patients from the first group have been using FES - WalkAide for at least eight months. One patient from the second group has been using it for more then a year. There is one diplegic patient (9 years old) that is using FES WalkAide bilaterally. Usage rate with adults, (19 years or older) was 12.7%.
Immediate results were improvement in functional ankle ROM during FES stimulation. This improvement was observed via better clearance, and in the occurrence of heel strike. A decrease of the base of support was noted with the diplegic patient. The patients that used the FES for a month showed an even greater

improvement in dorsiflexion during gait. In the long term use neuroplasticity was evident in one case. This patient can now selectively dorsiflex his foot. With most pediatric patients (yet not so with adults) the improvement was evident within the first few minutes of use and therefore suggests a positive prognosis if FES WalkAide was used on a regular basis. We don't have long term use results as far as dorsiflexion ROM preservation or increase is concerned, yet with two users the Achilles tendon lengthening operation was reconsidered and postponed.

Conclusion

FES is in its infancy. We have observed benefits in the use of peroneal FES WalkAide with pediatric CP patients. When first examining the children with electrical stimulation most responded positively but disliked the stimulation and therefore needed time to get accustomed to it. We think that peroneal FES is another orthotic solution to be considered in the pediatric population with CP. Even though we observed positive results with the suitable patient, statistics show it is not a magic bullet orthotic solution. Currently it is an expensive out of the pocket solution whereas the conventional orthotics are subsidized.We think that only 10% of the suitable population buy the computerized FES because of its high price. There is very little research of FES and a lot to be discovered. The exploration through wider use of FES will open a whole new variety of rehabilitation options. The innovative peroneal FES technology hopefully will be made more available and so will realize its potential

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Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3598-677]

The Effect of Ankle Foot Orhosis Stiffness in the Energy Cost of Walking: A Simulation Study

Author
Bregman, Daan J.J. (Amsterdam NL) | Drs.
VU University Medical Center - Rehabilitation Medicine

Coauthors
M.M. van der Krogt, V. de Groot, J.Harlaar, M. Wisse, S.H. Collins

Abstract
We used a computer simulation model to assess the influence of AFO stiffness on the energy cost of walking, and the amount of energy stored in the AFO. We found an optimal AFO stiffness, which was determined by the amount of energy stored and returned by the AFO, and by the timing of the energy retu

Introduction
In stroke and multiple Sclerosis (MS) patients gait is frequently hampered by a reduced ability to push off with the ankle, caused by weakness of the plantar flexor muscles [1]. To compensate for this weakness, carbon composite Ankle Foot Orthoses (AFO) are often prescribed [2]. These AFOs act like a spring; they store energy at the beginning of the stance phase and return energy at the end of the stance phase. It seems evident that when more energy is stored and released by the AFO, a higher functional benefit for the patient can be obtained. The functional benefit for the patient can be expressed as a decrease in Energy Cost (EC) of walking[3].
The aim of this study is to determine the effect of variation in AFO stiffness on the EC of walking and the amount of energy stored in the AFO.

Methods
We developed a conceptual, forward dynamical 7-segment model, analogous to previously developed conceptual walking models [4,5]. The model was composed of an upper body, two upper legs, two lower legs and two feet. The AFO was modelled as a passive linear spring acting on the ankle joint. To propel the model, a constant retroflexion torque was applied onto the upper leg during stance, and a constant anteflexion torque was applied onto the upper leg during swing.
We used a first order gradient search method to find cyclic walking motions at which the configuration of the model at the initiation of a step was identical to the configuration of the model after completion of the step. To enable comparisons between walking with different AFO stiffnesses, walking speed (0.70 m/s) and step length were kept constant by adapting the hip torques. For each AFO stiffness we calculated the amount energy required to propel the model, as well as the energy stored and returned by the AFO.

Results
AFO stiffness strongly effected the energy cost of walking. Optimal energy cost of walking(D) was found at an AFO stiffness of 41 Nm/rad. Higher(A) and lower(F) AFOstiffnesses resulted in higher energy cost (Fig. 1 top panel). Energy stored AFO was also strongly effected by AFO stiffness. Most energy storage in

the AFO(C) was found at AFO stiffness of 29 Nm/rad (Fig. 1 middle). Stiffness at which the lowest energy cost of walking was found(D), coincided with stiffness at which highest ankle push off velocity just before contralateral foot strike
was observed (Fig. 1 lowest). Stiffness at which most energy was returned before contralateral foot strike(E) led to a sub-optimal energy cost of walking.
The results indicate that besides the amount of energy returned by the AFO, the timing of energy return is an important factor determining the energy cost of walking. In the model, energy is lost when the contralateral foot collides with the ground. When the ipsilateral ankle plantar flexion velocity is highest, the impact between the contralateral foot and the ground is minimal, and consequently the model walks with the lowest energy cost. Most energy stored in the AFO(C), the energy release comes too late; the energy is not returned before contralateral heelstrike, therefore it can not be used to reduce the impact losses between the contralateral foot and the ground. When AFO is very stiff(E,F), most of engery is returned before contralateral heelstrike and counteracted by gravity

Conclusion

The aim of this study was to determine the effect of variation in AFO stiffness on the EC of walking and the amount of energy stored in the AFO. We found an optimum in the AFO stiffness in terms of EC of walking. Furthermore, we found that this optimal AFO stiffness did not coincide with stiffness at which most energy was stored in the AFO. This can be explained by our finding that not only the amount energy retuned by the AFO, but also the timing of the energy return determines the EC of walking. To be able to gain fundamental insights, and to lessen the burden for the patients, we choose to use a conceptual model to answer our research question. Despite its simplicity, valuable insights were obtained in the functioning of spring like AFOs. Our findings suggest the need to optimize AFO stiffness for each patient, as this may result in a large reduction of the EC of walking. Such approach will be validated in an experimental study in the patient population.

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Session: Orthotics - AFO
Thursday 2010/05/13 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2992-190]

A Follow-up Study of Simplified AFO by Minimum Invasive Surgery (MIS) to Spastic Foot Deformity for which Heavy Duty AFO had been Used

Author
Asayama, Ko (Fukuoka JP) | MD,PhD
Nagao Hospital - Rebabilitation

Coauthors
Murakami, Masaaki (CPO, Advanfit co.), Konishi, Ryo-hei (MD, Nagao Hosp.), Hattori, Fumitada (MD, Nagao Hosp), Endoh, Masao (RPT, Nagao Hosp)

Abstract
In order to adjust Japanese life style, we need simplified AFO for stroke patients with high degree of spastic foot deformity. Bare foot activities are also required in some moment. MIS were performed which didn't need post operative bed-rest. Successful results were obtained.

Introduction
Active ambulation should be one of the main goal for stroke rehabilitation. For patients with ability to walk, spastic foot deformity is one of the obstacle factors which use to require heavy duty AFO in ADL.
While on taking bath or other various activities, AFO has to be taken off temporarily that will face dangerous moments for disabled. Bare foot walking or doing with simple, light AFO are sometimes required in Japanese life style living on tatami mat.
We have been using MIS to those with spastic foot deformity to alleviate the spasticity which doesn't need post operative bed rest. Application of simple, light weight AFO was followed after these procedures.
Heavy duty AFO patients must be changed to simple style AFO models. For this purpose, our developed models (such as UD-AFO-long or short one) have been applied frequently. Patients ADL was expected to improve with the combination of MIS and using these simple orthotics afterward.

Methods
One hundred twenty patients were enrolled in present follow-up study for recent eight years since 2002. Old stroke hemiplegics with moderate to sever degree of spastic foot deformity were the subject ranged from 31 to 82 years old. Its cause by turns is 59 intracranial hemorrhage, 34 thrombosis, 10 emboli and so on. The factors responsible for foot deformity included mainly equinus, varus and hammer toe. Each of the factors has had different degree of spastic combination. Some other factors were also combined. Selected tendons for the reconstructive surgery (and its methods) included gastrocnemius (Vulpius), TP (tenotomy), FDL (tenotomy or lengthening), FHL(tenotomy), TA (intramuscular recession), FDB (tenotomies or lengthening) and so on. Patients were encouraged to walk in full weight bearing soon after the procedure (anesthesia:NLA). The cases of ten recurrent after nerve block and 16 reoperation were included.
. Functional gait evaluation before and after the procedure was accu

Results

The combination of operated tendons by turns was “V+TP+FDL+FHL+TA” ;31 cases out of 120, “V+TP +FDL+FHL”; 27 cases, “TP+FDL+FHL”; 10 cases, “FDB”;7 cases, “V” and “TP+FDL+FHL+TA”; 5 cases respectively and other combination of small tendons.

Before the MIS intervention all the ambulatory patients had used heavy AFO, such as two metal upright AFO, completely molded posterior leaf type AFO with straps. In some cases, patients had not given adequate orthosis due to severe deformity. Majority (53.3%) of the AFO before the MIS was plastic made posterior leaf type AFO, followed by metal upright Type, UD type anterior leaf plastic AFO, Rie strap and so on. After the correction of foot deformity, AFO types were changed to UD-S in 38.5%, UD-L in 34.0%, posterior leaf with open heel type in 15.1%, Rie-strap type in 7.5% and brace free in others, respectively.

All the main problems were solved as had been scheduled after these MIS except the cases for which another small operations were added later due to recurrent equinus and hammer toe of 2nd to 5th toes. Superficial infection in two cases developed postoperatively which healed soon. Peri-operative period (MIS) was uneventful in all cases. Simple, light weighted AFO were applied to all the cases adequately after the MIS.

Most of the cases became able to walk without orthotic following to corrected foot, but needed some kind of AFO due to somewhat flailed foot appearance or obtaining walking security especially in outdoor activ

Conclusion

Ambulation activity is one of the main goal in stroke rehabilitation. AFO is necessary in most of these patients who use to have various degree of spastic foot deformities. Its variability depends upon the combination of spastic tendons acting separately on the foot in dynamic phase resulting in certain types of foot deformities. For facilitating ambulation ability and ADL, simple and light weight type of AFO is preferable especially in Japanese life style. Since 1975 we have developed many anterior leaf type models to meet these purposes. For easy fitting to this type, MIS is imperative which do not need postoperative bed rest. 120 MIS cases in recent 7 years was overall evaluated regarding the selection combination of spastic tendons and end results of the orthotic changes.

Sixteen cases needed additional small procedure. Foot deformities corrected as expectedly (targeted responsible tendons varied case by case) which could be able to fit simple orthotic afterward.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Poster Session [3701-None]

Orthotics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg241774

Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3028-226]

Research and Development of a Flexor Hinge Splint Based on Ergonomics

Author
Urabe, Takahiro (Kobe JP)
Hyogo Prefectural Rehabilitation Center - Physical Therapy

Coauthors
Chin T, Otsuka A

Abstract
Trunk and arm movement was analyzed under restraint conditions to the wrists and thumbs to facilitate the rehabilitation of C6 patient. Results indicated that with the thumb pinching from the radial abduction position, the smaller the dorsi-flexion angle, the smaller the compensatory movement.

Introduction
Flexor hinge splints are often prescribed in the rehabilitation of patients with C6 cervical injury (C6 tetraplegia). The flexor hinge splints are those that use tenodesis. However, pinch function with a flexor hinge splint fitted causes compensatory movement around the shoulder joint. As a result, there are almost no examples of flexor hinge splints actually being fitted in practice.
The aim of this research is to propose a practically useful device for use in C6 tetraplegia, and thereby, to facilitate their rehabilitation. We hypothesized that when tenodesis is used, the thumb pinches from the radial abduction position, reducing the compensatory movement. As a result, when the wrist was moved, compensatory movement was lessened when the thumb pinched from the radial abduction position. Results indicated that the smaller the dorsi-flexion angle, the smaller the compensatory movement. We are now able to report on prototype production of a flexor hinge splint based on the above results.

Methods
For this research, we constructed a device to limit the motion of the wrist and thumb, to mimic pinching action. We then applied five restraint conditions on the wrists and fingers of experimental subjects. The method was to fit this device to able-bodied subjects, who were asked to grip a ball placed on a table, with a pinching grip, lift it vertically, and then put it back in the original position. The subject's movements in the process were subjected to three-dimensional video analysis and surface electromyography to analyze muscle action potential. The data obtained were used to find manipulability, which is an ergonomic analytical method in robotics. Thus, in order to clarify the roles of the wrist joint and thumb in pinching the target object, we applied right trunk and arm to an engineering model to calculate posture changes during execution of the task, and assess manipulability as an indicator of arm posture and hand tip movement.

Results
Analytical assessment results for arm posture were expressed using the manipulability ellipsoid, to calculate manipulability. We observed that, under conditions similar to normal use of a flexor hinge sprint, use of the whole body in pinching movements led to inefficient work and excessive muscle activity. Furthermore, the arm posture and hand manipulability were low under these conditions. This means that the manipulability of the tip of the hand during pinching movement had an impact on working efficiency. Next, we observed that restraint conditions with high manipulability were those in which the wrist joint was

at zero degrees and the thumb was free. This demonstrated that specifying wrist and thumb movements caused major changes in posture.
In conditions with the wrist joint angle fixed at 0 degrees and 30 degrees, the hand tip operability and working efficiency were affected by the movement of the thumb. The results were better under conditions with free thumb movement than under conditions with the thumb only able to perform opposition movements. Also, under conditions in which the movement of the wrist was free but the thumb could only able to perform opposition movements, the working efficiency of pinching movements was good, but manipulability was slightly lower. This indicates that, in pinching an object, the movement of the thumb has a more important role than the wrist joint.

Conclusion

In this research, we tested the hypothesis that compensatory movement during pinching could be reduced by pinching with the thumb from the radial abduction position. In conventional devices, the thumb was held in an entirely fixed position. Therefore, in the movement of pinching an object, users of flexor hinge splints exhibited compensatory motion of the trunk and arm when using tenodesis.
Our experimental results in this research suggest “a device capable of pinching movement with the wrist angle at 0 degrees, in which the thumb moves at the radial abduction position with palmar flexion of the wrist from 0 degrees” as an added function for a new flexor hinge splint.
We believe that addition of these new mechanisms would reduce compensatory motion in the arm, including the trunk and shoulder girdle, when using a flexor hinge splint to grip an object on a table. We intend to verify this through clinical testing.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3370-545]

Development of Wearable Powered Gait Orthosis Using Geared Motor

Author
Kang, Sungjae (Incheon KR) | Research of Hybrid Gait Orthosis Analysis for paraplegics
Korea Orthopedic and Rehabilitation Engineering Center - Research 1Team

Coauthors
Ryu JC, Kim GS, Mun MS

Abstract
This study of the paraplegic to walk on a walker to assist will be wearable.
90W motor on RGO at the hip and the knee was attached to control the gait.
Using EMG signals, walking speed and stride are controlled.
As a results, gait for paraplegic patients were possible stably.

Introduction
Apart from disorders in physical and sensory functions, most of the paraplegics have problems in the function of the autonomic nerves that control the bladder and the colon [1, 2]. The rehabilitation treatment for paraplegics consists of walk training using orthosis devices appropriate for the level of paralysis. The training is effective in preventing contracture in joints, decreasing rigidity, and protecting patients from complications [3]. However, as walking with orthosis requires a lot of energy and is not difficult, there have been many cases where its use was discontinued after the termination of the physical therapeutic walking [4]. Therefore there needs to be an orthosis effective for functional walking after therapeutic walking.
The objective of this study is to development of regular walking of the paraplegic using a RGO with motor .

Methods
The WPGO(Wearable Powered Gait Orthosis) with motor developed for this study adopted an Isocentric RGO (IRGO) structure in order to insure the stability of the balancing posture. The structure of the RGO was modified to accommodate geared motors as developed by Kang and Kim et al. [5] and was made in titanium alloy for rigidity [6]. Geared motor (90W, Hyundae, Korea) were installed from the points above and below therotating axes of the hip joint to enable flexion .Each geared motors the rotation of the body that rotates the pelvic band which brings corresponding leg forward alternately through a link mechanism. Therefore the patient consumes less energy. The control system is composed of a motor controller (24V ,eleparts ,Korea), battery (Li-ion, Samsung, Korea), and real-time controller(AVR, USA). The signals for gait are an EMG signal emitted from the electromyography sensor attached to both arms, and signal from foot sensor the insoles of both foot.

Results
In order to analyze the kinematic and clinical effects of the paraplegic wearing a WPGO under study, three participants were selected. In this study, parameters measured for the analysis were the gait speed, number of steps per minute, and the length of each step for Group (subjects A,B, and C). The measurements were done at the onset of, two months after and four months after the gait training. The number of steps for each participant was different, but it can be seen that they were all improved as the

training sessions continued. Subject B especially, showed improvement of about 59% at the end of training. Subject A showed improvement of by about 26%, and Subject C by about 56%.
Fig. 5. Comparison of gait parameters change in moveable joint knee for PGO: (A) Cadence (steps/min), (B) Velocity (cm/s), (C) Step length (cm). The gait speed also showed improvements over the course of training. Subject A was confirmed with about 82% improvement at the end of training compared to the initial stage. In the case of Subject C, there was no significant difference in the gait speed during the two months of training. These differences show that the training effects could vary according to personal traits such as age, physical condition or activeness.
The lengths of each step showed an increase among the participants as training progressed. Subject A improved by about 54% at the end, and Subject C by about 35%. On the other hand, while Subject B showed no big difference up to the t

Conclusion

In this study, to validate the effect of gait training from sustained functional training after training to acclimate to it.
A RGO with geared motors for paraplegics has greater kinematic effects than RGO, and showed improvements in gait speed, cadence, and step length after a long training period.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3262-440]

Adaptive Control System for Active Ankle-Foot Orthosis for Ankle Assisting and Rehabilitation

Author
Veneva, Ivanka (Sofia BG) | Dr
Institute of Mechanics, Bulgarian Academy of Sciences - Biomechanics and Technically Assisted Rehabilitation

Coauthors
Kiriazov PK, Boiadjiev GV

Abstract
An intelligent device for control of active ankle-foot orthosis (AAFO) composed by microcontroller, actuator and sensor system, and its application to actuation and position of the foot orthotic segment is presented. The system can be used for ankle assisting and rehabilitation and gait analysis.

Introduction
Orthotic treatment is the most common method for foot-drop cases. The standard ankle foot orthosis is a polypropylene structure intended to support the ankle, correct deformities, and prevent further injuries. The idea of an actively powered orthotic device has been explored since the early 1980's using hydraulic and pneumatic device. More recently, compressed gas and DC motors have been researched to provide active assistance to the individuals with paraplegia [2]. An active ankle-foot orthosis with a force-controllable series elastic actuator (SEA) was also designed [1] capable of controlling orthotic joint stiffness and damping for plantar and dorsiflexion ankle motions.
We propose an autonomous adaptive device for actuation, data acquisition and control of ankle-foot orthosis during normal level walking using tactile sensors and monitoring system for gait analysis. The device is used to help or rehabilitate persons with control disorders and weaknesses of ankle foot complex.

Methods
Proposed ankle-foot orthosis is with one degree of freedom which foot segment is connected to the shank segment by a rotational joint. The joint is fitted with direct drive actuator attached laterally. The position of the actuator is handled by a control module according the output from the rotational potentiometer RP in the ankle joint. The controller reads the angle, y, measured by a potentiometer and subtracts it from a desired reference, y0 to generate the error value, e. This error is used in PID control algorithm in order to adjust the desired position and maintain stability of the system when a foot load is applied. Control signals are received in real time from two tactile sensor arrays TR incorporated in the foot part of AFO and TL in the insole of the healthy leg which is the basement of the control algorithm. During walking the microcontroller estimates forward speed and modulates swing phase flexion and extension in order to assure automatic adaptation of the joint torque.

Results
The control module prototype has been realised using microcontroller ATmega128 (Atmel Co.) [3-6]. In order to test the control algorithm and system functionalities a laboratory model of orthosis with hinge joint and attached laterally direct drive actuator was designed.

A healthy subject equipped with sensors mounted under the heel and the toes part of the insole (TR1, TR2 for the right leg and TL1, TL2 for the left leg), performs different trials of slow and normal level walking. During walking the motion of the orthosis is observed - if the time and phase parameters of the orthosis coincide with these of the right leg.
Controlling the actuator movement during the swing phase (where the clearance of the toe is released) the system adjusts the flexion of the orthosis and keeps this position till the heel strike appears. Thus the ankle torque is modulated from cycle-to-cycle throughout the duration of a particular gait phase. The sensors work together to detect walking over one given interval of time and to collect the following parameters: ankle joint angles, foot (heel and toe) contacts and foot velocities. The microcontroller collects sensor data in four VS buffers, ADC buffer and PWM duty-cycle buffer. In monitoring mode the data acquired from the sensors during walking are transferred to a graphical user interface for visualization, interpretation and analysis.
The dynamic system simulation and analysis is done in Matlab Simulink and SimMechanics.

Conclusion

The presented device for control of active ankle-foot orthosis integrates biomechanics based algorithms with active control system. The autonomy of the developed system has been demonstrated presenting experimental data during walking. The system controls the orthosis functionalities, records the data received from sensors during the gait and transfers recorded data to graphical user interface for visualization and future analysis.
The developed device for control of AAFO provides broad information for both control and gait analysis. The data from the sensors are used in every step from the control algorithm. The actuator joint torque is automatically modulated in order to optimize the heel-to-forefoot transition during the stance or the swing phase of walking. The experimental data discussed in this paper can be used in cases of the drop foot treatment and lower limb rehabilitation to enhance the AAFO functional performance and to improve the patient gait.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3379-554]

Test Method for Mechanical Testing of Hip Orthoses

Author
Lindner, Tobias (Rostock DE) | Dipl.-Ing.
Orthopädische Klinik Universität Rostock - Forschungslabor FORBIOMIT

Coauthors
Lindner T, Kohn A, Liebau G, Fabry C, Mittelmeier W, Bader R

Abstract
An objective tool for evaluation of hip orthoses regarding their ability to prevent total hip dislocation is currently not available. Therefore, we developed a test device to analyse the mechanical capability of hip orthoses for preventing dislocation of total hip replacement.

Introduction
Dislocation of primary total hip replacement (THR) and after revision surgery continues to be a severe complication in the endoprosthetic treatment of osteoarthritis. This can be reduced in high risk patients by the use of a hip orthoses, which limits the range of motion including positions of the artificial hip joint, which are exposed to a high risk of dislocation. Studies about the clinical effectiveness of hip orthoses are rare and test methods are hardly described. Therefore, we developed a test device to analyse the mechanical capability of hip orthoses for preventing dislocation of total hip replacement.

Methods
The test device (Fig. 1) is based on a metallic frame in which an anthropometric test body consisting of a limb part and a trunk part on which the orthoses can be placed is mounted. At the pelvic and femoral site of the test body a total hip endoprosthesis is inserted. In the test device two leg positions associated with high risk of dislocation (90° flexion / 0° adduction and 10° extension / 15° adduction) can be arranged. Resulting hip forces are applied by a wire rope system. For testing, an electric motor turns the limb part in these positions to enable dislocation of the artificial joint mechanically. During the rotational movements the resisting moment against subluxation and dislocation provided by the artificial hip joint and the hip orthosis is measured by a torque sensor.

Results
First measurements were done with a commercially available standard hip orthosis (Newport). This orthosis were adapted to the dummy and tested in extension and flexion position. The resisting and dislocation moment of the hip joint were measured without and with application of the Newport orthosis. For the 90° flexion position we measured a 43 % higher dislocation moment with applied orthosis. In the extension position the moment was 165 % higher with the orthosis. However, in both positions the range of motion until dislocation of the artificial hip joint occurred did not differ with vs. without application of the hip orthosis.

Conclusion
Less effort has been undertaken onto hip orthosis testing and investigation of their effectiveness to prevent total hip dislocation so far. The new developed test device provides an method to evaluate the mechanical capability of hip orthoses. Hence different design features can be tested. The test results may help to refine existing orthosis designs and can lead to new developments in the field of hip orthosis.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3363-538]

A Cross-sectional Comparison Study of the Plantar Pressure and Gait Characteristic of Patient with Rheumatoid Arthritis

Author
Lau, Sze Man (HK)
Hospital Authority - Prosthetic-Orthotic Department

Abstract
A study to find out plantar pressure and gait characteristics of rheumatoid arthritic foot. From the information obtained, orthotic or footwear with definite function could be designed to alter the force on RA foot at weight bearing, thus modify walking biomechanics and prevent further deformities.

Introduction
Rheumatoid arthritis is a chronic disease which affects 0.3-1.5% of population worldwide. Due to its nature of joint inflammation, patient experience progressive joint destruction, together with the force acting on the joints during walking, further deformity may occur. Over 85% of RA develop foot and ankle symptoms that seriously affect their mobility.
To prevent impairment from foot deformities, nonpharmacological treatment such as insole is recommended to help with the symptoms. However, what type of foot orthosis should be used is still controversial because biomechanical data of the rheumatoid arthritis feet are still insufficient for the proper design of foot orthosis, the key gait and plantar pressure characteristic that contribute to foot pain and destruction of joint is not yet clearly known. The purpose of this study is to find out the pattern of the plantar pressure and gait characteristics of the RA foot and provide a reference for the design of orthosis in RA patient.

Methods
51 Rheumatoid arthritis subject and 51 normal subjects without any foot and ankle symptoms and deformity were recruited from local hospital and community respectively. The age, sex, body mass index, disease duration and disease activity were recorded. Foot functional impact caused by the foot and ankle symptoms were measured by Chinese version Foot Function Index which measure pain, activity limitation and disability. Physical parameters including barefoot regional peak plantar pressure and foot roll over time were measured by Matscan ® pressure mapping system (TekScan, Inc, South Boston, Massachusetts). Independent t-test was used to analyze the sample means of RA group and normal group. The correlation between subscale scores from the Foot Function Index and the plantar pressure were analyzed. Statistical Package for Social Science, version 13 (SPSS Inc., Chicago, Illinois) were used for all the statistical calculation and analysis. Statistical significance was set at $p<0.05$.

Results
The study is still in data collecting phase. Result will be available before May 2010.

Conclusion
The study is still in data collecting phase. Result will be available before May 2010 but it is expected that significant difference of peak regional plantar pressure of rheumatoid arthritis subjects compare to non-arthritis subjects and; between the weight transfer pattern of rheumatoid arthritis subjects compare to non-

arthritis subjects will be found out. Significant correlation between the subscale scores from Foot Funtion Index and plantar pressure of the rheumatoid arthritis subjects will also be noted.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3459-634]

Development of Multi-linkage Orthotic Knee Joint for Paralysis

Author
Kim, JangHwan (KR)
HanSeo univ. - prosthetics and orthotics

Coauthors
Lim KD, Yi JB

Abstract
We developed 4-bar linkage knee joint attachable to KAFO. This new knee joint flex freely at swing phase and lock geometrically at stance phase. There are no needs of any electric parts, sensors, and mechanical accessories. The operation reliability was successfully evaluated at 3D gait lab.

Introduction
KAFOs are used in patients with severe knee extensor and hamstring weakness, structural knee instability, etc. There are several types of orthotic knee joints. The single axis knee joint, straight-set knee joint, drop lock, ratchet lock, and bail lock, posterior offset knee joint, and so on. Recently stance control orthosis (SCO) was developed as an advanced orthotic joint. Stance control orthotic knee joints are designed to allow free flexion of the knee in swing, while providing full stability in stance by automatically locking on initiation of the stance phase of gait. We developed an orthotic knee joint using 4-bar linkage polycentric technique realizing SCO. The 4-bar linkage mechanism guarantees knee flexion at swing phase and stability at stance phase by geometric locking. It has been verified so far in prosthetics. There are no needs of electric power, sensor, connecting circuit, bulky upright, etc. The reliability of this function was evaluated in 3D gait lab.

Methods
The geometric locking mechanism has been designed with consideration of biomechanical aspects. We considered GRF, necessary moment at the knee, single equivalent force, etc. And the functional and safe 4-bar mechanism was designed by relevant software for dynamics. Both superior, inferior end for assembling upright was designed for compatibility with conventional upright parts. Two same but symmetric joint parts was necessary on each leg. Therefore locating those on precise symmetric position was very important. It was essential to confirm parallel between two joint parts, and coincidence with every match axis of links. For guarantee geometrical kinematics accurately, rigid cuff and secure bandage was applied to above and below knee. Full leg length casting was necessary for rigid cuff. Operation test was performed at 3D gait lab.

Results
Appropriate mechanical design was leaded by computing various biomechanical conditions. Four bar structure fulfilled given conditions. Smoothness of rotation at each joint between links is controlled by several steps. The range of motion goes through with normal range. The dimension of the developed joint part is small enough through all directions. Those are 15*4*1.2 #. Aluminum alloy was selected for material. Consequently this joint is lightweight enough.
In fabricating KAFO with these joint parts, full leg length casting was performed for rigid cuff forming. The rigid cuffs covered posterior half of circumference. The rigid cuffs were thermoformed by polypropylene and leather bands attached to those. The anatomical reference point to locate the joint part was apex of lateral epicondyle of femur and matching point of joint part was anterior-superior one of four axes. To

confirm coincidence of axes, long straight stick passed through reference axes of two symmetric parts, piercing plaster model. Rest parts of KAFO were conventional ones.
After fitting on subject with polio, no collapse was happening while wagging the CoG in standing. As protracting pelvis of affected side and starting swing the same side leg, knee joint of KAFO began flexion. As consummation of swing phase, orthotic knee joint was fully extended and got ready for stable initial contact. In stance phase, knee joint showed secure stability.

Conclusion
In the meantime many knee joint mechanisms have challenged natural and safe knee motion. With the posterior offset joint, it is difficult to balance stability and smooth swing. Horton's one has additional weight and decreased stability at initial contact. In the case of UTX, it is ankle dependent mechanism so additional cable is needed. SPL type requires enough hip extension muscle power. And it is inappropriate for full weight bearing. E-knee needs electric power so additional equipments that battery, circuit, clutch, sensor, etc. are required. Accurate operation is dependent on sensors at sole and logic algorithm.
This research has achieved lightweight, no bulky, no electric power, and reliably operated knee joint development using polycentric mechanism. 4-bar linkage design fulfilled the requirements of this development. However this specific design was for non-contracture knee. For various knee contracture aspect, additional designs using different dimensions are required.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3372-547]

The Development of Socks for Fall Prevention

Author
Maeoka, Hiroshi (Koryo-cho, Kitakatsuragi-gun, Nara JP) | The Development of Socks for Fall Prevention
Kio University - Department of Physical Terapy

Coauthors
Takahiko F,Kenji S, Toshio A

Abstract
We fabricated “Taping Socks” for the purpose of inducing tiptoe lift up. The purpose of this study was to verify the influence on hallux dorsi-flexion angles by the Taping Socks during gait. We confirmed that the Taping Socks were able to significantly induce tiptoe lift up even for normal adults.

Introduction
The effects of taping are braking of the joints and improve the stability of an injury joint, and prevention of disorder. However, anatomical and kinematical knowledge and skills are necessary for taping. We expected that taping is useful not only in sports scenes but also in daily life as preventive means of disorder insisted on today. Therefore, we examined an easier means to utilize the effects of taping in the daily life, and we focused on socks frequently wore. Additionally, we fabricated special socks with the taping function. Earlier, we showed that the special socks could induce the foot eversion to prevent ankle inversion sprain. Therefore, in this time, using similar processing technique, we fabricated socks for the purpose of inducing tiptoe lift up (prevention of tripping), and we call the socks “Taping Socks”. The purpose of this study was to verify the influence on hallux dorsi-flexion angles by the Taping Socks to induce of toe dorsi-flexion during gait.

Methods
Thirteen healthy volunteers (male, 3; female, 9; age, 24.0±6.3 years: mean ± standard deviation) participated in this study. All participants had no special physical problems. Informed consent was obtained in writing from all participants before the study. Participants were instructed to walk the distance of 7 meters with the free speed under two conditions: while wearing normal socks and the Taping Socks. Participants were measured in each condition three times. At the time of measurement, Reflection markers were fixed on the tip of the medial malleolus, the first metatarsal head, and the tip of hallux on the left lower extremity. The movements of hallux during the swing phase of gait were recorded at 300 frames per second by a high speed camera (CASIO Limited, Japan) from right sagital plane. We extracted the images before and after of mid-swing of gait. Subsequently, we measured hallux dorsi-flexion angles by ImageJ (the National Institute of Health) of the motion analysis software.

Results
There were significant differences in hallux dorsi-flexion angles between the Taping Socks and normal socks. As for the mean of hallux dorsi-flexion angles, it was 121.04 degrees while wearing the Taping Socks and 128.03 degrees while wearing normal socks just before mid-swing, and hallux dorsi-flexion angles increased significantly while wearing the Taping Socks ($p<0.010$). In addition, at just after mid-swing, it was 128.57 degrees while wearing the Taping Socks and 138.27 degrees while wearing normal socks, and hallux dorsi-flexion angle increased significantly while wearing the Taping Socks ($p<0.005$).

Conclusion

In an aged society, a lot of actions for the fall prevention are conducted now. The epidemiology of falls can be categorized as intrinsic and extrinsic risk factors. Tripping over an obstacle has been reported to be one of the main causes, accounting for up to 60% of all falls. Toe dorsi-flexion is usually important as well as ankle dorsi-flexion for acquisition of the foot clearance in the swing phase of gait. We think that tripping occurs for the body function such as the muscular strength decreasing associated with aging. In this study, we confirmed that the Taping Socks were able to significantly induce tiptoe lift up even for normal adults with a few decreases of the body function. Therefore, The Taping Socks have the possibility of the effect for elderly people. However, we think that further investigation is necessary to verify a long-term effect and the influence.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2922-120]

The Immediate Effect of UCBL Orthosis on Reducing Heel Pain for Plantar Fasciitis

Author
Chan, Lai On (HK)
Tuen Mun Hospital - Prosthetics and Orthotics Department

Coauthors
Dr. MS Wong

Abstract
Plantar fasciitis is one of the most common foot disorders.The treatment of UC-BL orthosis is not always prescribed.This study aims to investigate and evaluate the immediate effectiveness of the UC-BL orthosis in relieving pain for plantar fasciitis at different speeds.

Introduction
Plantar fasciitis is one of the most common causes of heel pain in adults and athletes. Orthotic interventions including over-the-counter or custom foot orthoses with arch supports and/or heel cushion, heel cups and night splint, are common conservative treatments with high successful rates. However, the treatment of UC-BL orthosis is not always prescribed as accommodative insoles are often preferred. Since UC-BL orthosis is made of semi-rigid material, its ability to control the foot in a position which is effective in relieving pain for plantar fasciitis is ignored nowadays.This is partly because the bulkiness of the UC-BL orthosis is not acceptable for everyone.Surprisingly, there is no recent published research studied about the effectiveness of UC-BL orthosis in treating plantar fasciitis.this study is going to investigate the influence of walking velocity on the effectiveness of UC-BL orthosis in reducing pain.

Methods
A total of 5 subjects diagnosed with chronic plantar fasciitis were recruited to this study. Each patient completed the whole process in 2 weeks. The experiment was carried out by recording the time to onset of pain during ambulation with and without the UC-BL orthosis at three different speeds. Besides, two questionnaires were administered to quantify the change of the degree of pain with and without treatment. For data analysis, One-way Repeated Measures Analysis of Variance was carried out to analyze the time to onset of pain at different speeds. Paired t-test was performed to analyze the time to onset of pain with and without treatment and the scores of the pain sub-scale of the two Foot Function Index questionnaires. Intraclass Correlation Coefficient was calculated to identify the relationship between the first and second trials of the experiment.

Results
In two and a half months time, 5 subjects (2 men and 3 women) aged 28 to 55, were recruited to voluntarily participate in this study. All the subjects completed all three sessions of the study.The results pointed out that there was significant increase in time to onset of pain with the use of UC-BL orthosis at medium and fast speeds. In addition, the time to onset of pain decreased with increasing speed. Also, the pain sub-scale scores of the Foot Function Index showed significant reduction after one week treatment.An extra question was asked in the questionnaire about how often they wore the UC-BL orthosis during the week. All the subjects wore the UC-BL orthosis for over 8 hours. This question ensured the subjects in this study

to have an adequate usage of the orthosis in order to execute its effect.The results of present study proved that the UC-BL orthosis is significantly effective as a treatment for plantar fasciitis in relieving heel pain.

Conclusion

The treatment of UCBL should be a good choice for the orthotists when considering treatment for patients with plantar fasciitis. However, the UC-BL orthosis might not be as comfortable as insoles made of soft material. And the UC-BL orthosis is relatively bulky. Although the UC-BL orthosis has its disadvantage, its effect and functions shouldn't be ignored. It was concluded that the UC-BL orthosis had immediate effect in reducing pain for plantar fasciitis. The effect of the UC-BL orthosis was influenced by walking speed. The faster the walking speed, the lesser the effect in relieving pain.
Consequently, the findings of this study have important implications for the patients suffering from plantar fasciitis that slow or medium walking speed should be preferred.
Also, the prescription of UC-BL orthosis for plantar fasciitis patients should be re-considered.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2903-101]

Portable Posture Monitoring System

Author
Wong, Wai Yin (HK) | Dr.
Tuen Mun Hospital - Department of Prosthetics & Orthotics

Coauthors
Wong MS

Abstract
The portable posture monitoring system has been developed, which consisted of 3 sensor modules, a data logging and feedback system and a garment. The system could provide posture information, including frequency distribution of the posture change and trunk orientationfor posture habit analysis.

Introduction
Spinal deviations including lateral curvature, rotational deformity, hyper/hypo-kyphosis and hyper/hypo-lordosis, could be associated with some spinal diseases such as idiopathic scoliosis, Scheuermann's disease, osteoporotic vertebral fractures or low back pain. Spinal diseases occur at different stages of life span from growing population to working population and then extending to aging population. These diseases might relate to physical and social problems of the patients and would impose a major burden to the society via work absenteeism and high health care costs. Therefore, an effective posture assessment and training would be helpful for improving a person's quality of life and reducing the social burden.

Methods
The posture monitoring system was developed for monitoring the trunk posture of the users and providing guidance to let them know how to use their back muscles to keep the spine in neutral spinal curvature. The system performed this by using 3 sensor modules, which were integrated into the tight fit garment, and micro-processors inside the data logging and feedback system to continuously measure the changes of the trunk posture (spinal surface curvature of the trunk) at the thoracic and lumbar regions in both the sagittal and coronal planes from those of the standard calibration posture, simultaneously. The measurements were then compared every second to the pre-set target range of trunk angle. The system would provide an audio-feedback, as a reminder, when the measurement is found out of the pre-set target range for longer than a pre-set tolerance time, to remind the user to keep their trunk posture within the target range.

Results
A reduction of approximately 26% of time which spent in "poor" posture of the thoracic spine is found in this current study. For the lumbar spine, the reduction could be up to approximately 65% depended on the level of threshold set.

Conclusion
The portable posture monitoring system has been developed, which consisted of 3 sensor modules, a data logging and feedback system and a garment. The whole system is easily hidden under clothing. The system could provide posture information, including frequency distribution of the posture change and trunk orientation, in an easy interpretation manner for posture habit analysis. The preliminary results of the posture monitoring during daily activities also demonstrated that the subjects could control their postures when feedback signals were provided. It is recommended that long-term clinical trials for evaluating

the effectiveness of the posture monitoring system on posture training should be arranged in further investigation.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3109-307]

The Biomechanical and Functional Effects of Ankle Foot Orthosis Shank-To-Vertical Angle in Children with Cerebral Palsy: A Pilot Study

Author
Ridgewell, Emily (Bundoora AU)
La Trobe University - National Centre for Prosthetics and Orthotics

Coauthors
Gibson S, Nguyen T, Walker L.

Abstract
Systematic alignment changes were made to the AFOs of 4 children (7 limbs) with CP. The effect on gait was dependent upon the ability to achieve foot-flat during stance phase. Increased shank inclination reduced the external knee extending moment and moment arm at mid-late stance.

Introduction
By adjusting the shank-to-vertical angle (SVA) of the ankle-foot orthosis (AFO) and footwear, the orientation of the ground reaction force (GRF) to the lower limb can be modified. Tuning of the AFO and footwear involves adjusting the SVA to normalise the orientation of the ground reaction force (GRF) vector to the proximal lower limb joints (1, 2). Although considered important in optimizing gait in children with cerebral palsy (CP) (Butler et al 2007; Owen, 2002), limited evidence exists to quantify the effect of AFO SVA on gait and function in this population.
The aim of this pilot study was to quantify and explore the effect of systematic AFO and footwear alignment changes on the gait and function of children with CP.

Methods
Four children with spastic hemiplegia or diplegia CP, aged 10.9 ± 3.6 years who wore solid AFOs and were classified as Level 1 or 11 on the Gross Motor Functional Classification Scale (GMFCS), participated in the study. An 8 camera Vicon Mx3 3-dimensional motion analysis system with 4 AMTI force plates was used for kinematic and kinetic data collection.
Participants walked in their baseline AFO and footwear and in 5° incremental increases in SVA up to a maximum of 15°. AFO and footwear SVA was measured using a modified long armed goniometer. Alignment changes were made by adding internal heel raises beneath the heel of the AFO.
Following data analysis, AFOs were altered to 10° SVA by adding a wedge of high density EVA foam to the underside of the AFO heel. The Timed Up and Go (TUG) Test, 6 Minute Walk Test (6MWT), Paediatric Balance Scale (PBS) and Canadian Occupational Performance Measure (COPM) were administered pre- and 4 months post- SVA modification.

Results
In all limbs, increased SVA reduced the peak external knee extending moment and moment arm at mid-late stance. In some cases these became flexion moments.
In three participants (1, 2 & 4) increased AFO SVA increased the angle of shank inclination during walking. These children demonstrated knee extension and foot segment angles within normal limits, indicating a

foot-flat gait pattern. In these limbs, peak knee flexion angle, moment and moment arm in early stance also increased with increasing SVA. Knee extension in mid-late stance decreased sequentially.
In one participant (3), increased SVA did not affect shank kinematics. Rather, the excessive external dorsiflexion moment in early stance was reduced. This child demonstrated increased knee flexion and inclined foot segment angles, indicating absence of foot-flat.
Two participants (2 & 4) demonstrated evidence of both shank kinematic changes and reduced dorsiflexion moment. It is hypothesised that the foot was flat on the ground during mid-stance however increased weight was taken through the forefoot.
The effect of increased SVA on the hip was variable.
Functional assessment indicated that participants demonstrated small improvements in the TUG test at 4 follow-up, with improvements of ranging from 2% to 27 % on the PBS, improvements of 25, 80, 22 and 35m in the 6MWT with clinically significant improvements in at least two of their identified goals in the COPM.

Conclusion

All children in this study demonstrated some improvement in external knee extension moment and moment arm of the GRF during mid-stance due to increased SVA. This was achieved by two mechanisms which appear dependent upon achieving foot-flat during stance phase and even weight bearing across the foot. While some variables were normalised by increased SVA, there were simultaneous detrimental effects on other variables.
It has been suggested that successful AFO tuning requires improvements to both kinematics and kinetics (Butler et al, 2007; Owen, 2002). Evidence from this systematic evaluation of alignment changes suggests that knee moments and moment arms can be normalised without concurrent normalising effects on segment and joint kinematics.
In this sample of children there is evidence to suggest that the effect of an increased SVA may improve functional balance skills. Further investigations into the beneficial effects of adjusting AFO and footwear alignment are warranted.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3400-575]

New Standing Up Powered Orthosis for Paraplegics

Author
Genda, Eiichi (Nagoya JP) | MD
Rosai Rehabilitation Engineering Center - Clinical applicaton research

Coauthors
Oota K, Suzuki Y, Kinosita K, Kimura H. Miyagawa T, Suzuki H, Ootsuka K

Abstract
A new powered orthosis was developed whose main functions are standing-up and keep standing for room use. As the walking function was minimized, it could be designed light and compact. It was applied to paraplegic patients, who could put on the orthosis by themselves on the wheelchairs and could easily stand up using walker with least help of their arms.

Introduction
Several kind of walking orthosis have been developed for paraplegics, however, there is a few who use the orthosis daily basis in Japan. We consider the one of the reasons is the difficulty of standing up by themselves. Most orthoses have to lock their knees in straight position when standing up. It is very difficult to stand up with a walker or crutches while keeping the knees straight. If the main purpose of orthosis is to keep standing while in the room, the walking function could be minimized; as a result the orthosis could be designed lighter and more compact. Therefore, we developed a new powered orthosis whose main functions are limited to standing-up and keep standing.
When healthy people stand up slowly, they lift their buttock from a chair, move their center of body mass on the ankle and extend three joints (hip, knee and ankle) gradually keeping the balance. We adopted this style of standing-up and applied it to our new standing-up orthosis.

Methods
By minimizing walking function, both right and left outer braces of orthosis could be abbreviated, and right and left medial braces were connected and form triangular shape to make the orthosis structure light and rigid (fig.1). The powered unit could be set between two legs. The lengths of thigh and shank braces were adjustable for various leg lengths. A linear actuator (CRES500, THK, Japan) was set between thigh and shank braces. Two gas springs (Hujilatex, Japan) set paralleled to the actuator. When knees are flexed, the actuator moves shorter and gas springs are compressed. When knees extend to stand up, the actuator moves longer and gas springs assist knees to extend. Thus, this mechanism enabled to extend knees to stand up with small power unit.
Knee joints and ankle joints were connected with steal wires. One end of the wire was connected to posterior of ankle joint, the other end was connected to pulley whose rotation axis is knee joint. The lateral sides of two pulleys, the stoppers were attac

Results
1. From sitting position to the center of body weight moving onto the ankle joint, ankle joints dorsiflexed independently from knee joints. 2. At this position, the stoppers hit the thigh brace, the independent dorsal flexion of ankle joint became impossible. 3. The pulleys rotated as knees extended, steal wire were pulled and ankle joints planter flexed. 4. The knees were full extended and ankle joints fixed perfectly (fig. 2).

The wireless control buttons were attached to a walker; pushing right button is standing-up and pushing left button is sitting-down.
This new orthosis was applied two paraplegic patients, 27 year-old man (complete paralysis under TH7) and 24 year-old woman (complete paralysis under TH6).
Both patients were able to put on the orthosis by themselves on the wheelchairs. They could easily stand up using walker least help of arms (fig.3).

Conclusion
A new powered orthosis was developed whose main functions are standing-up and keep standing for room use. As the walking function was minimized, it could be designed light and compact. It was useful for paraplegics to use in the room, to stand up easily and keep stable standing.

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no references

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3238-420]

Clinical Evaluation and Gait Analysis of a New Powered Gait Orthosis with Moveable Knee Joints for Paraplegics

Author
Kim, Gyoosuk (Inchon, Korea KR) | PhD
Korea Orthopedics & Rehabilitation Engineering Center (KOREC) - Computation Engineering Lab.

Coauthors
Kanghee Cho, Sungjae Kang, Jeicheong Ryu, Museoung Mun

Abstract
In this study a power-aided gait orthosis with moveable knee joints and its clinical evaluation are presented. This PGO requires less energy than those with fixed knee joint. Paraplegic patients wearing a PGO with movable knee joints were subjected to gait analyses to assess the kinematic effects.

Introduction
The rehabilitation treatment for paraplegics consists of learning to walk using orthotic devices appropriate for the level of paralysis. The training is effective in preventing joint contracture, decreasing rigidity, and protecting patients from complications [1, 2, 3]. However, as walking with an orthosis requires a lot of energy and is not easy, use of such devices is often discontinued once physical therapy is terminated [4]. Therefore, orthotic devices that are effective for functional walking are needed.
The objective of this study is to assess the effect of regular walking by paraplegics using a PGO modified to incorporate a moveable knee joint after termination of physical therapy. A PGO with air muscles as a power aid is designed to provide flexion and extension movement at the knee joint using a pneumatic cylinder with a spring and a solenoid type lock. The kinematic and clinical effects of the moveable knee joint will be assessed in accordance with the period of training.

Methods
1. Moveable Knee Joint Design
A PGO normally has a fixed knee joint since it provides stability during the stance phase; however, the fixed knee increases the movement of the pelvis. This affects the functional gait of paraplegics and makes it difficult for them to walk [5]. In order to guarantee flexion at the knee without deteriorating the functional gait a small and light solenoid is used to lock and unlock the knee joint. The solenoid unlocks the joint during the toe-off and locks it just before the heel-contact. The knee joint is unable to flex during the stance phase due to the metal locking device attached to the solenoid (Fig. 1).
2. Subjects
None of the participants had any previous experience with PGO's. They went through a minimum of one week of parallel bar training to acclimate to the PGO. In order to get the full effect of gait training, all participants were trained 2 hours a day and 5 times a week for 4 months (Table 1).

Results
1. Gait Analysis
The cadence of each participant was different, but all were improved as the training sessions continued (Fig. 2A). Subject B in particular showed about a 59% improvement by the end of training. Subject A showed about a 26% improvement, and Subject C improved by about 56%.

Gait speed also improved over the course of training (Fig. 2B). Subject A improved about 82% by the end of training compared to the initial stage. The lengths of each step increased for the participants as training progressed (Fig. 2C). Subject A showed an improvement by about 54% by the end of training, and Subject C by about 35%.

2. Clinical Evaluation

In this research, a PGO with a movable knee joint was used to measure the clinical effects of improvement for patients. As to the measurement of bodily constituents, all subjects showed decrease in the BMI, which indicates the level of obesity (Fig. 3A). Especially in the case of subject B, the numbers decreased by about 32% after two months, and the BMI value changed very little after that. This shows that the gait training effectively reduced body fat. However, the subjects maintained similar levels after four months (Figs. 3B, 3C).

Body weight decreased in accordance with the length of the training period (Table 2). Subjects A and C showed about 5% difference; however, subject B showed 27.5% decrease in body weight. The participants showed an increase in the BMD rate in regions of lumbar spine and femur over the course of the training.

Conclusion

In this study, a PGO developed by Kang, et al. [6] modified to incorporate a moveable knee joint for more natural gait was used to validate the effect of sustained functional gait training for the paraplegic with a gait orthosis.

By analyzing the kinematic and clinical improvement effects in accordance with the period of the training in the experiments, the following conclusions were made.

A PGO with a moveable knee joint for paraplegics has greater kinematic effects than one with a fixed knee. Subjects fitted with such a PGO showed improvements in gait speed, cadence, and step length after a long training period.

Continuous gait training using the moveable knee joint PGO resulted in decreased BMI and decreased body fat and cholesterol level to affect bodily constituents. The body weight of the participants decreased over the training period, and the BMD at the lumbar spine and femur increased, bringing it up to a normal BMD level.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3101-299]

The Impact of Silicone Ankle Foot Orthoses (SAFOs) on Cadence, Balance and Falls in Patients with Neurological Diagnoses

Author
Glover, Sally (Birmingham UK) | Mrs
Queen Elizabeth Hospital Birmingham - Physiotherapy

Coauthors
Cartwright N

Abstract
The objective of this small study was to evaluate the SAFO in neurologically impaired adults who demonstrated reduced ankle stability. Following an eighteen month period,48 patients have experienced this orthosis and have found it to be of value in improving their gait and balance.

Introduction
Patients with neurological illness frequently report difficulty maintaining their balance and have a history of falls. During detailed questioning into their activites of daily living, they describe falling when changing direction and when fatigued. This may be attributed to the impaired motor/sensory activity within the lower limbs, which is directly/indirectly related to their diagnosis. Physiotherapists commonly focus on ankle stability to facilitate gait using a combination of exercise, orthotics and occasionally, functional electrical stimulation. The latter all have a motor/sensory component. In an attempt to improve the sensory awareness of the ankle, SAFOs have been trialled(during an eighteen month period) and evaluated in relation to ankle stability, cadence and falls.

Methods
A new orthotic clinic was established within the physiotherapy department in partnership with Dorset Orthopaedic (manufacturer of the SAFO). This operated on a monthly basis, whereby patients who demonstrated poor ankle stability and/or foot drop were jointly assessed with a senior physiotherapist and orthotist. During a eighteen month period 82 patients have attended the clinic. They were evaluated in respect of motor and sensory activity, range of ankle motion, contracture, cadence:number of steps and time to walk 10 metres and their timed ability to stand, turn 360 degrees and return to a seated position.

Results
Of the 82 patients that attended the clinic, 48 were deemed suitable for SAFOs; ie they were able to achieve plantigrade either actively or passively and demonstrated improvement in the 10 metre step test and timed 360 test. Of the 48, 26 patients had a diagnosis of Charcot Marie Tooth Disease, 5 suffered with Multiple Sclerosis, 4 had Chronic Inflammatory Demyelinating Polyneuropathy,3 with Myotonic Dystrophy Type I,3: Spinal root compression,2: Facioscapulohumeral Dystrophy,2:Stroke, 1:Beckers Muscular Dystrophy, 1:Limb Girdle Dystrophy Type 2C, 1: Multifocal Neuropathy, 1:Inclusion Body Myositis and 1: Vasculitis.
43 patients demonstrated an improvement in their ability to perform the 10 metre walk and the timed 360 degree tests. They reported greater confidence in their gait and more able to cope with external environments. 2 patients performed well on the timed 360 degree test and demonstrated greater lateral stability around the ankle but failed to improve their cadence.3 patients were marginally slower in both the

timed walk and 360 degree test, however they did demonstrate a reduction in their lateral sway(the lateral excursion experienced during gait as a result of reduced lateral and proximal instability).

Conclusion

43/48 of patients with neurological illness who trialled the SAFO demonstrated improvement in their gait, balance and reported a reduction in the number of falls. 100 percent of those 48 patients reported wearing their SAFO for a minimum of two hours per day when evaluated between 3 and 6 months post initial fitting and all described the SAFO as comfortable and aesthetically pleasing. There is a need to evaluate the SAFO in a more sophisticated manner; to quantify the degree of change in ankle stability and its effects on lateral sway and balance.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3425-600]

A Method to Investigate the Influence of the Mechanical Characteristics of Ankle Foot Orthosis on Gait Using Individualized Biomechanical Models

Author
Creylman, Veerle (Geel BE)
KHKempen University College - mobilab

Coauthors
Jonkers I3, Vander Sloten J2, Vertommen H1, Peeraer L1,3
1Central Research Laboratory for Biomedical and Rehabilitation Technology (MOBILAB), University College Kempen, Belgium
2Department of Biomechanics and Engineering Design, KU Leuven, Belgium
3Faculty of Kinesiology and Rehabilitation Sciences, KU Leuven, Belgium

Abstract
The potential to predict the effect of the mechanical characteristics of an AFO on pathological gait is explored. Gait analysis data are linked to an individualized biomechanical model in OpenSim. The effect of the AFO is introduced by applying an angle-driven torque around the pathological ankle.

Introduction
Ankle Foot Orthoses (AFOs) are commonly used in clinical practice to normalize the gait of patients with different pathologies as for example in stroke (Halar and Cardenas, 1987). Determining the required stiffness of an AFO for a specific patient still largely depends on the skills and experience of the orthopaedic technician. There is at present no objective method available allowing to determine the mechanical characteristics of an AFO for an individual patient given his specific gait characteristics. Moreover, it is in actual practice impossible to predict how the AFO will influence muscular activation patterns during gait.
The goal of this project is to explore the possibility to investigate the influence of an AFO with specific mechanical characteristics on the gait and muscle activation of a patient using biomechanical models and dynamic simulations in OpenSim (Delp et al., 2007).

Methods
Apparatus: An AMTI force plate (1000 Hz) is used to collect ground reaction forces and moments. Kinematic data are collected using a CODA Motion system with 2 CX1 cameras and active markers, measuring at 200 Hz.
Measurement procedure: The active markers are attached on both legs following a predefined and validated marker setup. This configuration allows to record the kinematics of the lower extremity and trunk. A test subject is instructed to walk barefoot across a 21,5m walkway.
Biomechanical model: A generic musculoskeletal model of the lower extremity with 23 degrees of freedom and actuated by 54 muscles is used. The marker setup in OpenSim is adapted to correspond with the marker setup used in the CODA Motion measurement. The data of the CODA Motion system and AMTI force plate are processed into mot-files that can be used in the OpenSim environment.

Results

Based on the marker position of a static measurement of the test subject, the generic musculoskeletal model is scaled in OpenSim.

Using the marker trajectories during barefoot-gait of the test subject, the kinematics are calculated. These results are combined with the ground reaction forces in an inverse dynamics to calculate the moments and consequently the underlying muscle forces. As the test subject has a pathology that requires an AFO to normalize his gait, we modify the activation sequences of the ankle foot muscles accordingly. More specifically, we restrict the upper boundaries of the muscle excitations and consequently limit the upper limit of active force production to introduce muscle weakness as observed in the individual patient.

In a next step the influence of an AFO is simulated by adding an angle-driven torque on the ankle of the above model. Consequently, the effect of the AFO on the kinematics can be calculated and the potential of the specific AFO to achieve normal gait kinematics can be evaluated. By imposing different angle-driven torques, the influence of the stiffness of an AFO on the kinematics and the muscle excitation in a test subject can be analysed.

Conclusion

In order to determine the mechanical characteristics of a patient specific AFO in a more objective way, we propose to evaluate the influence of the stiffness of an AFO on the gait kinematics as well as muscle excitation patterns using biomechanical models. This process enables the optimization of the stiffness of an AFO based on the pathology of a specific patient. A further evaluation and refinement of the process is however necessary. Preliminary results will be presented illustrating the strong and weak points of this method.

A combination of this process with the FE-analysis of AFOs gives a complete package to develop test-subject specific AFOs, with the correct mechanical properties (Creylman et al, 2009).

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3042-240]

The Effect of Milwaukee Brace on Treatment of Idiopathic Kyphosis

Author
Mehdikhani, Mahboobeh (IR)
Rehabilitation research center, school of rehabilitation of Iran university of medical sciences - rehabilitation sciences

Coauthors
Hamid Behtash, MD
Mohammad Saleh Ganjavian, MD
Esmaeal Ebrahimi Takamjani, MD

Abstract
Milwaukee brace is one of the known orthoses in the treatment of Kyphosis. However, little is known about the possible therapeutic effects of Milwaukee brace on idiopathic Kyphosis.The main purpose was to investigate the efficiency of orthotic treatment on idiopathic Kyphosis.

Introduction
Milwaukee brace is one of the known orthoses in the treatment of Kyphosis. However, little is known about the possible therapeutic effects of Milwaukee brace on idiopathic Kyphosis. The main purpose was to investigate the efficiency of orthotic treatment on idiopathic Kyphosis.

Methods
This is a clinical trial study in which 61 patients with idiopathic Kyphosis over 50 degrees, who were refered to Orthopaedic offices were followed up over 6 years. All patients underwent radiography every 4-6 months of normal visit. The patients were categorized into three groups when they took part in this research while they were about 2 years out of brace.Group1(36 patients) with normal kyphosis after 2 years being out of brace, group2(13 patients) who lost kyphotic correction after 2 years being out of brace and group3(12 patients) who were not corrected by wearing brace.

Results
There was a significant differece between the average of full time wearing of brace in group1 and group3 (P=0.01). The average of curve in the begining of wearing brace full time in group1 and group3 differed(P=0.005).The main difference between group1 and group2 was the more dramatic flauctuation in group2 over the treatment period.

Conclusion
In this research it can be clear that the Milwaukee brace is an effective orthose to treat idiopathic Kyphosis under 70 degrees. The critical key to distinguish the probability of treament is the remarkable reduction of kyphotic curve just after starting wearning brace.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3315-490]

The Effect of Extension Sling with Wrist-Hand Orthosis on Shoulder Subluxation in Hemiplegic Patients

Author
Kim, Yoon-Tae (Uijeongbu KR) | MD, PhD.
The Catholic University Uijeongbu ST. Marys Hospital - Rehabilitation Medicine

Coauthors
Lee JS, Kim JS, Rye JE, Park KS, Ok EJ

Abstract
To compare the corrective effectiveness of extension sling combined with wrist-hand orthosis(WHO) and conventional forearm cuff type extension sling on a shoulder subluxation in hemiplegic patients, the extension sling with WHO is effective to reduce the subluxation of hemiplegic shoulder.

Introduction
There are several types of shoulder slings that used for the hemiplegic patient with shoulder subluxation but most of all dont consider the functional position of elbow and wrist joints. So we developed the design of the extension sling that is combined with wrist-hand orthosis(WHO). This sling was designed as the criteria of Cohen(1978)s Shoulder-Ebow-Wrist sling for hemiplegic patients.
The purpose of this study is to compare the radiological corrective effectiveness of the extension sling combined with WHO and conventional extension sling with forearm cuff on a shoulder subluxation of hemiplegic patient.

Methods
Thirty-nine flaccid hemiplegic patients with a shoulder subluxation were recruited retrospectively from the last 5 years who were inpatients in the rehabilitation department. They were grouped into two; one(20) with extension sling with WHO and another(19) with extension sling with forearm cuff(Fig.1).
We evaluated the degree of reduction with support of sling before and after application in each group. The joint distance (JD), vertical distance (VD) and horizontal distance (HD) on the plain shoulder X-ray were measured. JD is the distance between the humeral head and upper margin of the glenoid fossa. VD is the distance between the most inferior and lateral point on the acromial surface and the central point of the humeral head. HD is the distance between the central point of the humeral head and the glenoid fossa. (Fig. 2).
Figure 1. Extension sling with forearm cuff(A) and with wrist-hand orthosis(B) for hemiplegic patient.
Figure 2. Radiologic measurement of vertical distance(VD), horizontal distanc

Results
The mean values of the JD, VD and HD of hemiplegic shoulder without a sling were 15.12±4.43mm, 43.56±6.02mm and 25.54±1.83mm, respectively, which were measured to 6.89±2.35mm, 34.35±4.53mm and 23.86±2.55mm with extension sling with WHO. The extension sling with WHO provided a good support for correction of shoulder subluxation according to JD, VD and HD parameter compared with those of without a sling ($p<0.01$). The mean difference of JD, VD and HD parameters before and after application of forearm cuff type sling were 8.04±4.45mm, 8.82±4.15mm and 1.63±1.34mm, respectively, which were

measured to 8.23±3.34mm, 9.21±5.05mm and 1.67±1.31mm with WHO type sling. As compared with forearm cuff type sling, there was no significant difference in all parameters with WHO type sling (p>0.05).

Conclusion

The extension sling combined with WHO is effective to reduce the subluxation of hemiplegic shoulder as conventional forearm cuff type sling. It also provides support for drooling hand and maintaining wrist and hand in a functional position. So we conclude extendion sling with WHO has an effect to correct a shoulder subluxation in hemiplegic patient and it would prevent secondary deformity of hemiplegic wrist and hand.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3218-400]

Evaluation of Orthotic Outcomes on Patient with Hallux Valgus

Author
Chiu, Yuen Yi (HK)
Hospital Authority - Prosthetic and Orthotic Department

Coauthors
Leung KL

Abstract
Pain score were recorded for how the pain score change for 16 subjects with mild to moderate severity of hallux valgus angle who were treated with toe spreader.
The result showed there is a significant decrease in pain after toe spreader applied for 3 months (P=0.01), but not in 1 month.

Introduction
Hallux valgus is a very common foot deformity among people and it always accompany with other foot deformities such as overlapping toes, plantar callus, metatarsalgia and claw toe etc. Hallux valgus can be treated surgically or conservatively and there are so many operation procedures and non-operation methods developed for correction.
Many studies analyzed the effective of surgical treatment towards hallux valgus by the amount of corrected angles such as hallux valgus angle, intermetatarsal angle are the main focus for pre and post-operation for these studies and several operation procedures were used for comparison. Patient's satisfaction on the treatment outcomes such as pain reduction, cosmesis, walking ability, and shoe fitting etc. are also the important factors for determining the successfulness of the surgery or conservative treatment.
It is important to find out the effectiveness of orthotic treatment by the means of pain scale rather than just correction of angles.

Methods
20 subjects with hallux valgus were recruited into this study. The inclusion criteria are having a hallux valgus angle greater than 15°. Any patient who had previously foot surgery, orthotic treatments for hallux valgus previously were excluded from the study. Patients fulfill the inclusion criteria were given a consent form asking for participation. Toe spreaders were provided for all the patients who participated in this study and they were asked to wear their self selected shoes but which need to fulfill the shoe selection criteria of extra depth and wider toe box, firm heel counter.
Visual analog scale (VAS) was used to score pain level. VAS consists of a 10cm line and patient was asked to mark on the line reporting their pain level at 0 month, 1 month and 3 month after orthotic treatment.
Friedman ANOVA was used for analyzing the effectiveness of orthotic treatment. SPSS, version 17 (SPSS, Inc., Chicago, IL) was used for all the statistical calculation and analysis and $P<0.05$.

Results
There are total 16 patients (3 male and 13 female) aged 52.3 ±8.41 were completed the study while 4 drop out the study. Half of the patients were with mild deformity and 40% with moderate and the rest 10% have no deformity. The chance of having family history of hallux valgus is close to 50%. Most of the patients are wearing sport shoes for their daily activities. The length of applying the toe spreaders are varies from patient to patient. The mean hours for applying the toe spreader is 6.94 ±3.47.

The pain score before any toe spreaders were applied was 5.14 ±2.3 at 0 month. The pain score was change to 4.11 ±2.1 after toe spreader was applied for 1 month and then further decrease to 2.98 ±2.59 after toe spreader was applied for 3 months.
The pain score showed there was a significant change after toe spreaders were applied (P=0.01). There was no significant decrease in the pain score after 1 month of treatment (P=0.13), but showed significant improvement after 3 months of treatment (P=0.01) with corresponding length of applying toe spreaders.

Conclusion

Although there were studies conducted for evaluating the effectiveness of conservative treatment on hallux valgus, only the corrected angles were concentrated. Studies on evaluating orthotic treatment outcome by the means of pain are minimal. It is important to find out the effectiveness of orthotic treatment by the means of pain score rather than just correction of hallux valgus angle and intermetatarsal angle since not all the hallux valgus patients are suitable for surgical treatment.
The toe spreader is considered an effective conservative treatment for patients with symptomatic hallux valgus by decreasing foot pain.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3378-553]

Clinical Experience of Quick Made forearm Rotation Orthosis

Author
Miyamoto, Tadashi (Omuta JP) | Clinical experience of quick made forearm rotation orthosis
Omutatenryo Hospital - Rehabilitation

Coauthors
Hideo Watanabe
Shiro Hirayama

Abstract
We deviced quick made forearm rotation orthosis for pronation and/or supination contracture using flexible plastic cast.
Results of clinical application of the quick made forearm orthoses for three patients with pro-supination contracture of the forearm were satisfactory.

Introduction
There are some forearm rotation orthoses for correct the pronation-supination contracture. In general, these rotation orthoses are difficult to make, and majority of them are static in function.
We deviced the dynamic quick made forearm rotation orthosis for pro-supination contracture of the forearm.
Main material of this quick made orthosis is Soft Cast (3M Health Care Ltd.) which is flexible plastic cast.
This orthosis can make by doctor or occupational therapist in about 30 to 40 minutes when needed.
Put on or take off the orthosis by the patient is easy as well as handling rubber band traction.
We applied this orthosis clinically for three patients who had limitation of forearm rotation secondary to various injuries. The results of using this orthosis was satisfactory, and suggested similar or better usefulness compare to conventional forearm rotation orthoses.

Methods
Construction method of the quick made forearm rotation orthosis are ;
1. Casting by the Soft Cast on the elbow part and the wrist part separately.
2. Two to three small metal hooks incorporate to each elbow cast and wrist cast.
3. After hardening the casts, cut the both elbow and wrist part with scissors and take off.
4. After proper trimming performed, put on the two casts, and catch the hooks by rubber bands in order to tract the direction for correct the rotation contracture.
Standard method of the treatment with the orthosis is 20 minutes exercise by 3 to 4 times a day.
We applied this quick made forearm orthosis clinically for three patients with pro-supination contracture.
Case 1 40y male. Reason of the contracture was fracture of radius head and medial collateral ligament injury of elbow joint.
Case 2 20y male. Reason of the contracture was open fractures of distal part of radius and ulna.
Case 3 60y female. Reason of the contracture was fracture of distal part of radius.

Results
All three patients improved range of motion of pronation and/or supination with the quick made orthoses.
Pre# Post#
Supination Pronation Supination Pronation Duration of apply
Case1 40° 80° 2 months

Case2 30° 60° 90° 90° 4 months
Case3 70° 50° 90° 90° 2 months

Conclusion

Quick made orthosis has following features ;
1. It can construct short period of time (about 30 to 40 min.).
2. It can make easily by doctor or occupational therapist.
3. Handling of the orthosis by patient is easy.
4. Adjustability of traction power and direction for correct pro-supination is good.
5. Cost of the orthosis is moderately cheap.

Soft Cast is one of the proper material of quick made forearm rotation orthosis. Maximum merit of the orthosis for patient is considered rapid make of the orthosis when orthotic indication determined by doctor or therapist.

Problems of the orthosis will be consider its durability. As far as concern our three cases, no breakage of the orthoses were happened.

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Image: Correction for pronation contracture by the orthosis_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg241774/cg43951

Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3242-424]

Development of Prosthetic Foot through Analysis of Changes in the Mechanical Properties of CFRL in Relation to Materials and Length of Adhesion Planes

Author
Cha, Gook Chan (KR)
KOREC(Korea Orthophedics & Rehabilitation Engineering Center) - R&D 3team(Materials Lab.)

Coauthors
jong Kwon Kim, Sukmin Lee, Mu Sung Mun

Abstract
Polyurethane elastic materials and foams were applied between carbon fiber reinforced laminates (CERL) and the length of the adhesion planes between the materials and the laminates were changed and changes in the mechanical properties were analyzed to develop highly functional prosthetic foot.

Introduction
Recently, studies of rehabilitation engineering have been repeating rapid development along with the development of diverse materials. In the case of prosthetic foot among medical instruments for rehabilitation, great deals of interest and efforts have been poured into developing products with remarkably improved functions and performances using the properties of diverse materials constituting prosthetic foot such as cutting-edge compound materials, highly functional elastic materials and adhesives. In addition, studies being conducted on artificial limbs and prosthetic foot used by patients with cut lower limbs include many studies conducted from the viewpoint of materials considering the functions to not only support the body but also restore motor functions and enable walking as well as durability. Especially, as participations of disabled persons with cut lower limbs in society increase, needs for highly functional prosthetic foot that can restore body functions are increasing too.

Methods
As shown in Table 1, polyurethane elastic materials and foams were applied between the top and bottom 250mm carbon fiber reinforced laminates and the length of adhesion length was changed to make 9 prosthetic feet. Using the INSTRON 8511 of INSTRON Co. as shown in Figure 1, the loads imposed on the toe (the angle between the central axis and the prosthetic foot: 70°) when the 9 prosthetic feet were compressed by 30mm from the ground and the loads imposed on the toe (the angle between the central axis and the prosthetic foot: 80°) when compressed by 20mm were measured. Then, the loads imposed on the heel (the angle between the central axis and the prosthetic foot: 70°) when the 9 prosthetic feet were compressed by 20mm from the ground and the loads imposed on the heel (the angle between the central axis and the prosthetic foot: 80°) when compressed by 10mm were measured and the values were compared and analyzed.

Results
Figure 2- # shows a graph made with the loads occur on the toe when the prosthetic foot was compressed by 30mm from the ground, it can be seen that, the loads would not be changed 1mm and 3mm polyurethane elastic materials using the between top and bottom layers of CFRL but the loads of 2mm and the adhesion plane length is made to 80mm was decreased. Figure 2- # shows a graph made with the loads occur on

the toe when the prosthetic foot was compressed by 20mm from the ground and this graph show a trend similar to that of #. Figure 2-# shows a graph made with the loads occur on the heel when the prosthetic foot was compressed by 20mm from the ground and the graph shows that when 1mm, 2mm or 3mm were applied, the time point of the roll over from the heel treading produced in walking was remarkably advanced but when the foam was applied, the time point of the roll over showed a tendency of being delayed or lagging. However, when the length of the adhesion planes was increased to 90mm, almost no change was shown in the case of the 3mm but roll over time points similar to those when no form was applied were shown in the case of 1mm or 2mm. Figure 2-# shows a graph made with the resultant loads imposed on the heel when the prosthetic foot was compressed by 10mm from the ground and all of the 9 prosthetic feet showed advanced roll over time points and 1mm showed a tendency of the fastest and rapidest roll over time points.

Conclusion

Polyurethane elastic materials and foams were applied between the top and bottom 250mm CFRL and the length of adhesion length was changed to make 9 prosthetic feet to examine the values of loads occur on the toe and the heel. In the toe test, it could be seen that there would not be a great change in general but the loads occur on the toe would be decreased if 2mm were applied and the length of adhesion planes are made to 80mm and foams were applied. In the heel test, roll over time points became faster and rapider when only polyurethane elastic materials were applied while roll over time points were delayed and lagged when forms were applied. It is expected that the results of the analyses of the mechanical properties of the 9 prosthetic feet and many clinical tests will become effective preceding studies for the development of optimum highly functional prosthetic foot.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3313-488]

The Present State of our Rapidly Constructable Lower Extremity Orthosis

Author
Tokuda, Shozo (Kumamoto JP) | The present state of our rapidly constructable lower extremity o
Tokuda Prosthetics and Orthotics Co.,LTD - Orthotics

Coauthors
Asami T(MD,Saga University Hospital)
Yamanouchi N(MD,Saga University Hospital)
Watanabe H(MD,Omutatenryo Hospital)

Abstract
Constructable lower extremity orthosis which we use is easily constructable one when needed. We can choose various types of ankle joints as well as knee joints to the constructable orthosis in order to fit patient’s pathology. The orthosis is the effective approach to the early stage of disease.

Introduction
Usually, the individualy order made orthosis in Japan takes time about one to two weeks from taking cast model of the patient to complete the orthosis by orthotic manufacture. We noticed the benefit for the patient to wear the constructable orthosis immediately when indication of the orthotic treatment determined.
We deviced adjustable modular type constructable ankle foot orthosis in 1987, and reported at the 6th ISPO. Afterward, we added knee ankle foot orthosis and knee orthosis to the constructable lower extremity orthosis. And necessary modification was continued in order to make more effective rapidly constructable lower extremity orthoses.

Methods
As a prototype of rapidly constructable orthosis, we made a bilateral uprights ankle foot orthosis with shoe insert, using ankle joint with double adjustable ankle lock. We tested various ways to fix the upright and cuff band, and made three types of size. Next, we developed a knee orthosis and a knee ankle foot orthosis. We improved the structure for long time use, and changed the foot ankle assembly from shoe insert type to conventional type. Moreover, in order to be able to fit the size of lower limbs, we attached a sliding type adjustment mechanism to the cuff and cuff band, and fix it by wrench. Each part is a modular type, and we prepare two types (large and medium) to meet the needs for adult female and male. Now, you can attach the knee joint with ring lock and dial lock. Besides, plastic ankle foot orthosis are widely used for a case of CVA hemiplegia, so you can choose from posterior leaf spring type, or bilateral uprights type such as Gillette ankle joint and Dream brace.

Results
We are making number of rapidly constructable lower extremity orthoses, and the structure of them are almost the same as generally used lower extremity orthoses. You can attach knee cap and T-strap as the need arises, so their function is also equal to usual orthoses. Another advantage is that you can use them as ankle foot orthosis by detaching knee joint and thigh part from knee ankle foot orthosis. Since plastic ankle foot orthoses are widely used, we made possible the use of plastic ankle foot orthoses with many kinds of ankle joints. This will surely meet the needs of patients and prescribers.

Conclusion
Rapidly constructable orthosis is easily constructed when in need, therefore it can be used as a training orthosis until the ordered orthosis is completed, and also it is alterable from knee ankle foot orthosis to ankle foot orthosis. In addition to that, now we are preparing variety of knee joints and ankle foot orthoses, so that we can meet the needs of wide range of patients and prescribers in point of function and design. From now on, this orthosis will surely be much greater of use.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3458-633]

Can Method of Orthotic Quantification Alter the Long-term Result of Adolescent Idiopathic Scoliosis (AIS)?

Author
Rafiu, Abdulla (Greater Manchester UK)
The University of Salford - School of Health, Sport and Rehabilitation

Coauthors
Stephen Hutchins, PhD
Laurence Kenney, PhD

Abstract
Orthotic treatment for AIS has been routine practice for many years. However, the long term end-result of treatment lies close to that of pre braced values. Little is understood about quantifying overall orthotic correction using geometrically linked parameters in all three dimensions.

Introduction
Adolescent Idiopathic Scoliosis (AIS) is a three-dimensional deformity of the spine of unknown origin in children aged > 10 years, which results in alteration in the geometry of functional spinal units in all three planes of motion beyond normal acceptable limits. Many studies during the past ten years have demonstrated that altering the natural history of AIS by orthotic intervention is a proven fact that can no longer be questioned. Though the basic science is proven, the outcome of end result of the brace treatment appears to have remained more or less unchanged during the past 20 years, irrespective of brace type. Since statistics show that with bracing, one third of the patients show progress where as without bracing two third of the patients progress. Considering this fact, we postulated that better end-result could be achieved if all the geometrically linked parameters of AIS were considered to quantify overall orthotic correction.

Methods
A literature search was conducted to analyse the behaviour of the curve under orthotic treatment and to see how parameters of orthotic treatment have been quantified in previous publications by following the definition of scoliosis and the principles of spinal orthotic treatment. The search was limited to English Language only.

Results
The behaviour of the curve in orthotic treatment involved three main stages, the pattern being significant correction in immediate in-brace phase, followed by maximum correction during the in- brace phase; usually within the first year of treatment. However, there appears to be gradual loss of correction after about one year which continues till the brace is weaned and the final post-brace value remains ± 5º of the pre brace value.
Each plane has well defined parameters that have a predominant effect on scoliosis and they are linked both within the same plane and also to other planes. These parameters are geometrically linked and can have positive and negative effects when manipulated in one plane.
Cobb’s angle was measured in all the studies. However, no prospective study included pelvic parameters in coronal or sagittal plane irrespective of end point control being one of the principles of spinal orthotics.

Conclusion

AIS is a three-dimensional deformity comprising geometrically-linked parameters in all three planes of motion, namely coronal, sagittal, and transverse plane. Coronal plane involves Cobb's angle, Overall Balance Summation (OBS), Sacral/Pelvic obliquity, Sagittal parameters include, Thoracic kyphosis, Lumbar lordosis and Pelvic Incidence. Coronal parameter involves Apical Vertebral Rotation.
The pelvis is the foundation of spine and has a significant influence on the spine in both coronal and sagittal planes of motion.
Investigations into the efficacy of orthotic intervention in the form of spinal bracing and the design of such orthoses should involve consideration of correction in all three planes and considering functional abilities and quality of life using SRS-22 questionnaire.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3180-367]

Effectiveness of Custom Moulded Low Temperature Thermoplastics Orthosis and Aluminium Bar Reinforced Fibre Orthosis for Patients with CTS

Author
Szeto, On (HK) | Effectiveness of Custom Moulded Low Temperature Thermoplastics O
Tuen Mun Hospital, Hospital Authority - Prosthetic - Orthotic

Coauthors
Szeto O, Leung KL Aaron

Abstract
To compare the effectiveness of Custom Moulded Low Temperature Thermoplastics Orthosis and Aluminium Bar Reinforced Fibre Orthosis on symptoms relief, functions, motor and sensory recovery in patients with mild to moderate Carpel Tunnel Syndrome.

Introduction
Carpal Tunnel Syndrome (CTS) is one of the most common median nerve compression syndromes inside the wrist. For pain relief, both Custom Moulded Low Temperature Thermoplastics Orthosis (CMLTTO) and Aluminium Bar Reinforced Fibre Orthosis (ABRFO) have been prescribed to support the wrist in neutral position and keep the metacarpophalangeal joint in extension. However, the research in aluminium bar reinforced orthosis supporting the wrist in neutral position and allows minimal control side to side movement of wrist-hand orthosis at night time was not widely conducted. The effective, inexpensive, reliable, safe and simple treatment for patients was being found. In the orthosis selection gap, thus, it is useful to conduct a scientific study to compare the effectiveness of CMLTTO and ABRFO in neutral position at sleeping time.

Methods
Thirty three patients were recruited in this study. There were a total of 28 and 23 hands affected with CTS, and they were randomly assigned to Group A were treated with CMLTTO (Fig. 1) and Group B treated with ABRFO (Fig. 2) respectively. The relative effectiveness between treatment groups were compared and analyzed correspondingly by Self-Administered Carpal Tunnel Syndrome Questionnaire (Chinese version)1 in score of symptoms severity and functional status, hand grip test, pinch grip test and monofilament test at week 1, week 5 and week 9. The original questionnaire developed by Levine DW2 .All subjects were instructed to apply the orthosis during every sleep time for at least 6 hours per day for 8 weeks.

Results
Parametric two-way mixed model repeated measures analysis of variance (ANOVA) was performed to analyse the outcomes, using data collected from hand grip test, pinch grip test and sensation monofilament test. Nonparametric statistic Friedman test was used to analyse the score of questionnaires.
The main effect of symptoms severity score ($P<0.01$) and functional status score ($P<0.01$) of questionnaire, hand grip test ($P<0.05$) and monofilament test ($P<0.01$) showed significant difference across week 1, week 5 and week 9. The main effect result of pinch grip test ($P>0.05$) is not significant in both groups.

Conclusion

There is evidence that the CMLTTO and ABRFO kept the wrist in neutral position and demonstrated effectiveness toward mild to moderate CTS patients in terms of scores of Self-Administered Carpal Tunnel Syndrome Questionnaire (Chinese version), sensory recovery and motor recovery of hand grip. The pinch grip force showed no significant improvement after either CMLTTO or ABRFO treatments.

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Image: CMLTTO and ABRFO_None.JPG (see online)

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3402-577]

Research of Hybrid Gait Orthosis Analysis for Paraplegics

Author
Kang, Sungjae (Incheon KR) | Research of Hybrid Gait Orthosis Analysis for paraplegics
Korea Orthopedic and Rehabilitation Engineering Center - Research 1Team

Coauthors
Ryu JC, Kim GS, Mun MS

Abstract
In this research we development of the hybrid system with power assisted system and FES system. Using the artificial muscles, hip joint controlled. knee brake could be locked at the stance phase. After that knee flexor and extensor muscle could be controlled at swing phase using FES

Introduction
Paraplegic walking in the secondary system for a lot of research has been going on[1,2,3]. Paraplegic gait for the improvement of health status and function is essential to rehabilitation. Previous hybrid electrical stimulation exercise system had a problem about muscle fatigue and excessive energy consumption.
Therefore, hybrid system about combining the benefits of functional electrical stimulation devices and gait orthosis is necessary.
In this study, we development the hybrid gait orthosis. It consists a pneumatic artificial hip muscles and FES knee joints control system to use the existing power of the weakness at the knee.

Methods
FES electrode attached at the patients knee flexor and extensor muscles.
Swing phase knee flexion and extension was controlled for the knee flexion using electrical stimulator. The control of an artificial hip and pelvic muscles to control the worker with a band attached to a switch that controls the behavior was the point.
For the wireless stimulation control, labview software was using. The sensor signals of the angle information and foot swith were used knee joint angle control.
Using surface electrodes, patients muscles were electrically stimulated to control the flexion and extension angle at the swing phase .
Appropriate stimulation position are looking for individual patients for electrical stimulation at the knee to flexion and extension, and training program was enhanced by electrical stimulation for improved muscle strength .

Results
Hybrid control of the stance phase during gait using the knee clutch brakes were.
At the heel contact period, the weight load on the knee by the load brake is operating, machine provides a knee lock.
Hybrid in swing phase secondary loads by eliminating the load of the knee joint and brakes release. Since mid-swing period in the knee joint, knee brake could be locked at the heel contact peroid.
This study suggested a hybrid gait orthosis knee flexion and extension can be controlled simply because functional electrical stimulation device, the advantages and disadvantages of other gait orthosis that is an alternative to improve.

60kg weight subject who allows controlling the knee joint by a small force of less than 2Nm.In order to analyze the kinematic effects of the paraplegic under study, one participant was selected. stance phase. In normal gait, the duration of the stance phase and swing phase are 60% and 40% of the total gait cycle respectively. In hybrid gait orthosis walking, the duration of the swing phase is reduced.
the duration of the stance phase and swing phase are 79.8% and 20.2%. The gait speed is 36.4step/min at the hybrid gait orthosis walking.

Conclusion
Electrical stimulation is also a small current and, basis of the brake by the term takes a break.
Powered gait orthosis walking during the swing phase ratio is approximately 30% of gait cycle. So duration of only 15% are to muscle contraction.
Therefore, the problem muscle fatigue are small .
Because using the patients surviving muscles, muscle strengthening and rehabilitation is effective.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3399-574]

Contrivance of Quick Made Lower Extremity Orthosis Using Flexible Plastic Cast

Author
Hirayama, Shiro (omuta JP)
Omutatenryo Hospital - Rehabilitation

Coauthors
Watanabe H, Miyamoto T

Abstract
We deviced a quick made lower extremity orthosis for various disorders using flexible plastic cast. This orthosis can be made by a physical therapist in short period of time.
It can be used as a temporary orthosis for training until the ordered orthosis is completed.

Introduction
There are various types of lower extremity orthoses with the feature of functionality, convenience and etc. in order to treat various disorders. Usually, individualy order made orthosis in Japan takes time about one to two weeks from taking cast model of the patient to complete the orthosis by orthotic manufacturer. Therefore this waiting period for the patient may be disadvantageous to the proper recovery. We developed quick made lower extremity orthosis using the material of the Soft Cast (3M Health Care Ltd.) which is flexible plastic cast, and made it simply at rehabilitation room by a physical therapist. Results of clinical application of the quick made orthoses were satisfactory.

Methods
Construction method of the quick made orthosis are ;
1. A stockinette is covered over the particular part of lower extremity.
2. A kraft tape is roll up on the stockinette.
3. Holding the joint in proper position, casting is done by Soft Cast tape.
4. Cut with scissors after the cast is set and take it off.

The Soft Cast has special features such as flexibility even after complete set, and easily trimmed by scissors. We made the orthosis for various lower extremity disorders such as CVA hemiplegia, deformity of ankle and foot, instability of knee joint and etc.

Results
Among our experienced cases, here shown two example cases.
Case 1 : 53 years old male admitted urgently to our hospital because of cerebral infarction.
We made quick made knee orthosis and ankle foot orthosis on 19th day after onset because of very weak muscle strength on suffered extremity. Ambulation exercise was efficiently performed with the orthoses. The order made ankle foot orthosis (rigid TIRR type) was comleted 45th days after onset, at that time temporary used quick made orthosis is discontinued.
Case 2 : 57 years old female with multiple sclerosis admitted to our hospital because of increasing weakness on right lower extremity. She showed flaccid palsy and could not stand up or walk even in parallel bars. We made rigid type quick made knee orthosis and flexible type ankle foot orthosis. Fortunately she became possible to walk without orthosis on the 31st days after admission.

In both cases, no breakage of the orthosis happened, and there was no skin trouble due to the orthosis application.

Conclusion

It is desirable to make orthosis rapidly when needed. Our devised quick made lower extremity orthosis is made easily at rehabilitation room in short period of time. Functionality of the orthosis is satisfactory and can also expect something equal to conventional orthosis. Handling of the Soft Cast is easy and doesn't require a special technique or tool.

The orthosis can be applied to various dysfunction of the lower extremity. There were no problems on the function by the former use. We are thinking that the indication of the orthosis is as trial orthosis or temporally use orthosis during early stage of treatment until ordered orthosis completed.

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Image: Quick_made_orthosis_for_ankle_and_knee_disorders_574.jpg (see online)

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3144-342]

In-brace Corrections Using a New Brace Design in the Treatment of Thoracic Kyphosis

Author
Weiss, Hans-Rudolf (Gensingen DE) | Dr. med.
Praxis Dr. med. Weiß - Orthopädie

Coauthors
Werkmann M, Bohr S

Abstract
Our efforts to reduce brace material have resulted in a special bracing design. Aim of this presentation is to study possible in-brace corrections which can be achieved with this brace. An average in-brace correction of > 15° as achieved with this new kyphosis brace seems to be favourable.

Introduction
Little is known about the in-brace correction effects of braces used for the treatment of kyphosis. While Bradford et al. have found their attempts effective treating Scheuermanns kyphosis with Milwaukee braces, they did not report on in-brace corrections. However, patient comfort is largely reduced in the Milwaukee brace. Therefore in Germany braces generally are prescribed for kyphosis using transverse corretion forces, only. Our efforts to reduce brace material have resulted in a special bracing design. Aim of this presentation is to study possible in-brace corrections which can be achieved with this brace.

Methods
56 adolescents with the diagnosis of a thoracic Scheuermann kyphosis or a thoracic idiopathic kyphosis (22 girls and 34 boys) and an average age of 14 years (12-17yrs.) have been treated with this kyphosis brace between 5/07 and 10/08. Average Stagnara angle was 55,6° (43-80). In-brace correction was recorded and compared to the initial angle with the help of the t-test.

Results
Average Stagnara angle in the brace was 39°. The average in-brace correction was 16,5° (1-40°), which compares well with the amount of correction achieved with scoliosis braces of a higher standard. Average in-brace correction in % of the initial value was 36%. The differences were significant in the t-test ($t = 5,31$, $p < 0,001$). There was no correlation between the in-brace correction in % and the age of the patient, but a high significant correlation between in-brace correction in % and initial Stagnara angle.

Conclusion
If we assume that outcome of brace treatment positively correlates with in-brace correction the treatment should start before the curvature angle exceeds 55°. In scoliosis bracing an average in-brace improvement of > 15° predicts an end result correction. At average we have achieved > 15° also in kyphosis bracing Therefore we estimate to achieve a favourable outcome using this brace type when compliance can be gained [1].
An average in-brace correction of > 15° as achieved with the help of this new kyphosis brace seems to predict a favourable outcome.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2941-139]

Study Design for Analysing Compliance Improvement with Technical Aids in Rehabilitation

Author
Dannehl, Susanne D. (Berlin DE)
Berlin Institute of Technology - Center of Human_Machine Systems research training group prometei

Coauthors
Hochmann D, Kraft M

Abstract
Compliance, which is the adherence to therapeutical advices, is an important precondition for most of medical treatments. This behaviour is influenced by a lot of variables and varies in dependence of patient ´s expectations. In this study relevant factors for acceptance of knee orthoses are analysed

Introduction
A meager compliance rate, e.g. in use of medication or for regular preventive examinations, is a notorious problem in medicine. Even in the use of technical aids therapeutical effects are reduced because of a lack of compliance (Parker et al., 2006). In conclusion the progresses in medical developments cannot be completely unfolded. With interventions, which support patients in the recommended use of technical aids, the effectiveness of a treatment can be positively influenced.
The usage of orthotic devices, like a knee orthosis, is connected with some disadvantages because of its function (e.g. skin contact, stiffness). Often it is not promtly associated with a reduction of afflictions. With mere improvements in design the subjective perception cannot be influenced sufficiently, in a way that the short-term burdens (the time needed for correct application, limitations in habitual activities etc.) are accepted for long-term benefits.

Methods
For this study it is planned to recruit different groups of orthoses users. These groups consist of patients, who wear either a prophylactic or a functional orthosis. For these groups different kinds of intervention are created an deduced from the Health Action Process Approach which aim to improve the compliance.
There are assumed different degrees of compliance which are supposed in the Health Action Process Approach of Schwarzer (1992). In this theory certain assumptions are made, what supports patients to cope with barriers when transferring a health behaviour in daily life.
The interventions should be easy to handle. A risk communication intervention and a brochure for planning the usage of knee orthoses by means of barriers and resources will be tested. The expected number of test persons in each group should be n = 20. To compare the effects of the interventions there will be two groups without treatment, but wearing the same type of orthoses (randomized control group design).

Results
The research cluster medical technique in the research training group prometei at the TU Berlin was founded in April 2009. The first step of this project was the definition of the study design. Comparable studies exist, where the Health Action Process Approach (HAPA Model) was successful employed to improve the compliance with interventions in diabetes controlling (Plotnikoff et al., 2008). For a directed improvement of compliance with orthotic devices there are no studies yet. Nevertheless, it was important,

that all relevant barriers which make it harder for patients to comply, were considered. Therefore an expert consultation was scheduled to evaluate the barrier itmes. Because of no consistent therapeutical guidelines, it was also necessary to define what a non-compliant behaviour is. Another issue, related to missing standard values for therapy duration, was an adequate period between first and second measurement to have a meaningful predication for long-term compliance. All this concerns had to be mentioned to ensure a comparability with typical therapeutical conditions. The expert consultation was aimed at people, who work for longer times with patients, who received a knee orthosis and also at designers.

Conclusion

Currently, a first conclusion ca be drawn, that it is absolutely necessary to investigate the compliance of patients in the treatment with technical aids. Because of small compliance rates for knee orthoses (cf. Hiemstra et al., 2009) it is an urgent therapeutical need to develop interventions to improve the acceptance. This interventions should refer to all relevant barriers in the use of knee orthoses. It should also be easy to apply in the therapeutical process and transferable to other medical aids with only little effort. The first steps in this described study design are implemented with the expert consultation. We are planning the recruitment of patients in the 4th quarter of 2009.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3361-536]

Application of 3-D Ultrasound for Tracing the Spinal Curvature of the Patients with Scoliosis

Author
Wong, Man-Sang (Hong Kong HK) | PhD
The Hong Kong Polytechnic University - Department of Health Technology & Informatics, ST418,

Coauthors
LI M, CHENG J, YING M, NG B, ZHENG YP, LAM TP, WONG A, WONG MS

Abstract
This study aims to apply 3-D ultrasound to trace the spinal curvature of patients with scoliosis and the intra rater reliability of using this method to measure spinous process angle was found > 0.9. This promising result indicates the potential of this method in assessing spinal curvature.

Introduction
The most commonly used parameter to evaluate scoliotic curvature in radiography is Cobb's angle, which is defined as the angle between two lines drawn parallel to the end plates of the most titled vertebral bodies at the beginning and the end of a curve. Spinous process angle (SPA), which was proposed to be an intermediate parameter to assess spinal curvature, is measured by accumulating the angles formed by every two lines joining three neighboring spinous processes (Herzenberg et al., 1990). High correlation between Cobb's angle and SPA was found by Herzenberg et al. (1990), however, the methodology was not clearly elaborated. Many researchers demonstrated the possibility of using ultrasound to detect the spinous processes (Burwell et al., 2002; Furness et al., 2002; Lam et al., 2004; McLeod et al., 2005). With the advancement of clinical ultrasound, tracing spinous processes along a scoliotic spine becomes possible, which means SPA can be obtained from ultrasound images.

Methods
All ultrasound examinations were performed with an Esaote ultrasound unit with a 7.5 MHz linear transducer, and in conjunction with a 3-D add-on system (Tom Tec, Germany). A water bag was designed and attached to the probe to ensure a good surface contact between the skin and the probe. The subject was positioned in standing with feet at shoulder width and eyes looking at a horizontal steadfast object. With the 3-D system activated, the region of scoliotic spine was scanned through a single sweep (see Figure 1). To identify the spinous processes, the reconstructed 3-D images were reviewed, and the bright reflection at the tip of spinous process and the reflection on the origin of laminae in the images were the major indicators for confirming the identification procedure. Using the SPA Calculator developed in this study, lines were drawn through the tips of spinous processes, the angles between the lines were accumulated, and the sum angle was the SPA of the measured curve.

Results
In this study, scanning trials were conducted on 22 major curvatures from16 patients with adolescent idiopathic scoliosis (AIS) to investigate the feasibility of using ultrasound to detect the thoracic and lumbar spinous processes. With all these images, 3-D ultrasound imaging has been verified to be effective in tracing all the spinous processes (From T1 to T12 and from L1 to L5), though these procedures need competent scanning skills.

After identifying all the spinous processes, the Spinous Process Angle Calculator was used to calculate the spinous process angle. The average of spinous process angles is 22 degrees (range from 15 degrees to 29 degrees). The intra-rater reliability [ICC (1, 3)] for using ultrasound to measure spinous process angle is > 0.9 ($p < 0.05$), which means the measuring method is repeatable. A significantly high correlation ($R=0.94$, $p < 0.01$) between spinous process angles obtained from the 3-D ultrasound images and those measured from X-ray images indicates that this measuring method is reliable. A formula for estimating Cobb's angle was generalized from the correlation of Cobb's angle and spinous process angle in X-ray images which is $y=0.8663x-0.7891$ (y=spinous process angle, x=Cobb's angle, $r=0.97$, $p < 0.01$). Furthermore, the Pearson's correlation coefficients between the Cobb's angle estimated from the measurement of spinous process angle in 3-D ultrasound images and the Cobb's angle measured from X-ray is significantly high ($R=0.98$, $p < 0.01$).

Conclusion

According to these findings, 3-D ultrasound imaging can be further developed as a non-invasive real-time assessment tool for spinal curvature. Since the outcome of orthotic intervention for AIS is considered to be associated with accurate orthosis fitting. By the means of ultrasound assessments, SPA could thereby be evaluated and used as a parameter to determine the optimal biomechanical environment for curvature control. In this study, SPA can be closely monitored under ultrasound scanning. Therefore, SPA is proposed to be an objective indicator for checking the effectiveness of spinal orthosis during the fitting procedure. The results of this study can contribute to scientific practice of orthotic intervention and formation of a database for further developments of orthotic treatment protocol for AIS. Consequently, this may attain better control for spinal deformity and reduce the number of surgeries.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3140-338]

The Sagittal Realignment Brace in the Treatment of Chronic Postural Low Back Pain

Author
Weiss, Hans-Rudolf (Gensingen DE) | Dr. med.
Praxis Dr. med. Weiß - Orthopädie

Coauthors
Werkmann M, Bohr S

Abstract
For adult scoliosis patients with chronic low back pain bracing is initially indicated before spinal surgery is considered. With a sagittal realignment brace (physio-logic™ brace) we can predict a successful outcome in this specific patient population.

Introduction
For adult scoliosis patients with chronic low back pain bracing is initially indicated before spinal surgery is considered. Until recently the effect upon pain reductions in the mid or long-term has not been reported upon. Promising results have been documented in short-term for the application of a sagittal re-alignment brace in patients with spinal deformities and suffering from pain; however mid-term or long-term results are not yet available. The purpose of this study is to investigate the mid-term effects of this brace with respect to pain control.

Methods
65 patients (56 females and 9 males) with chronic low back pain (> 24 months) and the diagnosis of scoliosis or kyphosis were treated with a sagittal realignment brace (physio-logic brace™) between January 2006 and July 2007. The indication for this kind of brace treatment was derived from a positive sagittal re-alignment test (SRT) and the restriction of no successful conservative treatment during the last 24 months. The aim of this intervention was to avoid surgery for chronic low back pain.
After the anthropometrical data (circumferential and longitudinal trunk measurements) are registered, the foam model is milled from a blank hard foam block. This hard foam model is wrapped in a heated PE-plate, which is vacuumed to the models surface. The brace parts are cut from the PE-model and adjusted to the patient [1].

Results
The average pain intensity on the Roland and Morris VRS (5 steps) before treatment was 3.3 (t1), at the time of brace adjustment 2.7 (t2) and after an average observation time of 18 months 2.0 (t3). The differences were highly significant in the Wilcoxon test.
A group of 21 patients were able to completely remove the brace after significant improvements of pain intensity were recorded (see table 2). In certain patients the symptoms of spinal claudication were also significantly reduced.

Conclusion
Contrary to unspecific orthoses, which after a short period are worn no longer, the sagittal re-alignment brace (physio-logic™ brace) leads to an effective reduction of pain intensity in mid-term even in patients

who have stopped brace treatment after the initial 6 months of treatment. Precondition for an appropriate brace application is that the pain is classified as being of postural origin.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2932-130]

The Influence of the Knee Orthoses “GenuNeurexa” on Walking Ability and Gait Pattern in Patients with Hemiplegia and Genu Recurvatum

Author
Oesch, Peter (Valens CH) | MSc
Rehabilitationszentrum Valens - Therapien

Coauthors
Meier Khan, C
Kesselring, J

Abstract
GenuNeurexa is a new knee orthoses designed to correct the hyperextension of the knee in hemiplegic patients during the stance phase. This study examines the influence of the GenuNeurexa on the walking ability and gait pattern of patients with hemiplegia with genu recurvatum.

Introduction
Hemiplegic patients are restricted in their walking ability. A frequently observed gait pattern in hemiplegic patients has already been described in the 19th century by Wernicke & Mann. Typical gait characteristics are the propulsion of the trunk and reduced walking-speed. In the stance phase of the affected leg the hip is flexed and the knee hyperextended. The swing phase of the hemiplegic leg is achieved by a circumduction, the foot is in plantar flexion and supination [1, 2]. GenuNeurexa is a new knee orthoses developed by the Otto Bock Company designed to correct the hyperextension of the knee in hemiplegic patients during the stance phase. It is assumed that GenuNeurexa improves walking ability, gait pattern in hemiplegic patients thus heightening the sense of security when walking. The aim of this study is to examine the influence of the GenuNeurexa on the walking ability and gait pattern of patients with hemiplegia with genu recurvatum.

Methods
A single subject design with random test allocation (A walking without - B walking with GenuNeurexa) in 20 patients with hemiplegia is utilised. Patients are required to be able to walk 20m without assistance and knee recurvation must be present. General functional abilities and specific functions of the leg and foot are determined with the Chedokee-McMaster stroke assessment [3]. Gait parameters are assessed with GAITRite® System. Knee- and hip-joint movements are evaluated with dynamic gait analysis using KineGAIT®. Timed-Up and go test [4] and the Stair-Measure test [5] assess performance during mobility. Questionnaires are used to capture the patients and therapists perspective on safety, comfort, pain, ability to handle and compliance to wear GenuNeurexa. Descriptive statistics (including Kolmogorov-Smirnov test) are performed to describe the patient group and assess normality of the distribution. According to data distribution parametric or non-parametric tests are used to compar

Results
Data of 20 patients of this ongoing study will be presented

Conclusion
Will be drawn at completion of the study.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3236-418]

Significance of Orthotic Ankle Axis Orientation: Computer Modeling and Clinical Observation

Author
Chen, Hung-Bin (TW) | MS, PH.D. Candidate
National Taiwan University - Institute of Biomedical Engineering, Colleges of Medicine and Engineering & Rehabilitation Engineering Research Center, College

Coauthors
Chang, LW

Abstract
Three orthotic ankle axis (OAA) orientations configured differently in transverse plane were investigated, one of which even resulted in uncomfortable impingement. No orientations could theoretically enable ankle internal/external rotation (AIER). It suggested the AIER component not be overlooked.

Introduction
The traditional alignment of articulated AFO makes OAA perpendicular to the sagittal plane of the leg at the ankle neutral position. It was however clinically hypothesized that the congruency of the orientations of OAA and the anatomical ankle axis (AAA) would lend itself to desired ankle motions [1-2]. This hypothesis was implemented by placing joint components along with the projected orientation of AAA on the transverse plane, which is called tibia-torsion configuration in this study. Up to date, no scientific research had demonstrated the benefits of tibia-torsion configured AFO (TAFO).
This study was to investigate the significance of OAA orientation. Research hypothesis was TAFO would comply with natural ankle motions. A kinematic model was proposed to assess the effect of OAA orientations to ankle motions. In addition, clinical significance was investigated by an observation of the dynamic interactions between the human ankle and the three AFOs with different OAA orientations.

Methods
Kinematic Model: With the assumption of no relative movement between the shank and AFO calf, the rotational matrix of AFO coordinate system (C_afo) could be determined by the rotational matrix of shank coordinate system (C_shank) and the prescribed orientation (Rt) of OAA, i.e. C_afo = C_shank * Rt. Thus, by allowing a sagittal movement (theta_r) of the shank and the AFO, the C_shank could be determined as following:
C_shank(theta_r) = C_afo (theta_r) * R't
= C_afo(0)*Rs(theta_r)*R't
Where Rs is the rotational matrix of AFO sagittal rotation and R't is the transpose matrix of Rt.
While prescribing the shank and foot coordinate systems as identity matrices at anatomical neutral position (theta_r =0), ankle joint angles could be obtained accordingly.
Research Protocol: A computer simulation of the developed model and the clinical observation of pen-pick movements with three different AFOs were conducted. Detail procedures were described in the result section.

Results

Simulation: A simulation was implemented by prescribing the ankle excursion from 15 degrees plantarflexion (PF) to 30 degrees dorsiflexion (DF) for the kinematic model with the set parameters according to the three different OAA orientations in terms of neutral, tibia-torsion, and anti-tibia-torsion.
Simulation Results: Angle-to-angle phase plots of simulated joint angles corresponding to each axis orientation were shown in Figs.1a-b. Neutral configured AFO resulted in the inhibition of joint motions in frontal and transverse planes whereas anti-tibia-torsion and tibia-torsion configured AFOs primarily affected joint motions in frontal plane.
Clinical Observation: With the three different OAA orientations, three 5mm polypropylene right AFOs with tamarack ankle joints (Becker Orthopedic, USA) were fabricated from the same plaster mold taken from a healthy subject . Under each orthotic condition, placed a pen on the floor in front of the subject and instructed the subject to step the right leg forward about 40 cm from static standing. Subsequently, asked the subject to squat and pick up the pen.
Clinical Observation Results: Regarding the clinical observations (Figs.1c-d), notable torsional deformation of tibia-torsion configured AFO at the large ankle dorsiflexion prevented the subject from finishing the pen-pick task due to the uncomfortable impingement by AFO calf plastic edge.

Conclusion

According to the simulation results, all the three OAA orientations could not significantly enable ankle internal/external rotation, which was the inherit disadvantage of designing OAA orientation only in the transverse plane. From clinical observations, a fairly amount of shank internal rotation was required to finish the pen-pick task and no AFO was able to modify this moving pattern. Particularly, the calf of the tibia-torsion configured AFO underwent excessive torsional deformation in order to comply with shank internal rotation. This undesired deformation finally ended up with uncomfortable impingement by AFO plastic edge at the large DF.
Mimicking AAA orientation only in the transverse plane, i.e. tibia-torsion configuration, was not beneficial on complying with the prescribed ankle motions because of the inability of AFO calf performing internal/external rotation. It suggested the component of internal/external rotation not be overlooked in the design of OAA orientation.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2894-92]

The Effects of Prophylactic Knee Braces on Performance in Athletes

Author
Mortaza, Niyousha (Tehran IR)
Iran University of Medical Sciences - Orthotics and Prosthetics

Coauthors
Morteza N, Ebrahimi I, Abdollah V, Jamshidi AA, Kamali M

Abstract
Objectives of the present study were to examine the effect of three prophylactic knee braces upon performance of athletes.

Introduction
Knee injury is one of the major problems in sports medicine, and the use of prophylactic knee braces is an attempt to reduce the occurrence or severity of injuries to the knee joint(1,2). In addition to providing protection, an effective knee brace should not interfere with normal joint function(3,4).

Methods
31 healthy male collegiate athletes volunteered as subjects to examine the effect of these braces on function through isokinetic and functional tests in four sets: 1.without brace (control) 2. Wearing knee sleeve without stays 3. Sleeve with four bilateral stays and 4. With prefabricated brace (which is made by the examiner). Order of sets was randomized and the domain limb was evaluated. The test protocol consisted of Cross-over hop and vertical jump tests, in which the best jump distance of three trials was recorded, then the subjects administrated an isokinetic knee flexion and extension test at 60deg/sec, 180 deg/sec and 300deg/sec, and the following isokinetic variables were recorded: Peak torque to body weight ratio and average power.

Results
Repeated measures analysis of variance revealed no significant difference in peak torque to body weight ratio, average power, vertical jump and hop measurements as they were tested within the experimental conditions and one control condition ($p>0.05$).

Conclusion
These findings suggest that the selected brace/sleeves did not significantly inhibit athletic performance. Inasmuch as function of knee joint was not impaired while wearing the neoprene sleeve without stays, furthermore knee sleeves are supposed to ameliorate knee joint position sense, it seems that it is beneficial to use neoprene sleeves as the main structure of prophylactic knee braces(5,6).

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3388-563]

Influence of Functional Knee Bracing on the Isokinetic and Functional Tests of Anterior Cruciate Ligament-injured Patients

Author
Mortaza, Niyousha (Tehran IR)
Iran University of Medical Sciences - Orthotics and Prosthetics

Coauthors
*N. Morteza, A.A. Jamshidi

Abstract
The purpose of this study was to examine effects of a functional knee brace and two neoprene knee sleeves on the isokinetic and functional tests in patients with anterior cruciate ligament (ACL) injury.[1]

Introduction
Use of functional knee braces has been suggested to provide protection and to improve kinetic performance of the knee in anterior cruciate ligament-injured patients. However, the efficacy of knee bracing in achieving these goals is still controversial.

Methods
This study was a clinical trial on six male subjects with anterior cruciate ligament deficiency to examine the effects of functional braces on performance through isokinetic and functional tests in four sets: 1.without brace (control) 2. Wearing knee sleeve without stays 3. Sleeve with four bilateral stays and 4. With prefabricated brace (which is made by the examiner). Order of sets was randomized and the injured limb was evaluated. The test protocol consisted of cross-over hop and vertical jump tests, in which the best jump distance of three trials was recorded, then the subjects administrated an isokinetic knee flexion and extension test at 60deg/sec and 180deg/sec, and the following isokinetic variables were recorded: Peak torque to body weight ratio and average power.

Results
Paired samples T Test showed no statistically significant difference in peak torque to body weight ratio, average power, vertical jump and hop measurements between experimental conditions and one control condition ($p>0.05$). Means of peak torque to body weight ratio and average power while wearing sleeves with four bilateral stays were higher comparing other test and control conditions in both speeds (60 and 180deg/sec), yet this difference was statistically insignificant; this could be referred to the small sample size.

Conclusion
These findings suggest that the selected brace/sleeves did not cause any significant performance difference in joint torques and powers in the patients with ACL deficiency. However, use of these braces seems to be beneficial to this group of patients considering the protective effects of functional knee braces and the positive effects of neoprene sleeves on knee joint position sense in ACL deficient subjects. Further studies with larger sample size seems to have the potential to reveal more effects of functional knee braces in patients with ACL deficiency.[2-5]

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3073-271]

Effects of a Stance-Control Knee-Ankle-Foot Orthosis on the Gait of Able-Bodied Subjects

Author
Zissimopoulos, Angelika (Chicago US)
Northwestern University - Biomedical Engineering

Coauthors
Fatone S, Gard SA

Abstract
Stance-control knee-ankle-foot orthoses provide stance phase stability while allowing swing phase knee flexion. This study investigated the biomechanical and energetic effects of a stance-control orthosis on the gait of able-bodied subjects.

Introduction
The knee joint provides stability during stance-phase and a hinge with which to flex the lower-limb during swing-phase. A locked knee-ankle-foot orthosis, used to assist a weak knee joint, provides stance-phase support but prevents knee flexion during swing. To create toe-clearance, energy inefficient compensatory actions may be used (1-6). While some patients require the stability of a locked knee, a subset could benefit from a device that locks for support during stance-phase and unlocks to allow knee flexion during swing-phase. We investigated the effects of such a device, known as a stance-control orthosis, on the gait of able-bodied persons. We hypothesized that stance-control mode gait characteristics would more closely resemble those obtained with the knee joints unlocked than with the knee joints locked. We further hypothesized that the ability to flex the knee during swing (in the stance-control mode) would result in lower energy expenditure compared with locked-knee gait.

Methods
A custom thermoplastic knee-ankle-foot orthosis (KAFO), incorporating the Horton Stance-Control Orthotic Knee Joint (SCOKJ), was fabricated for each of nine able-bodied subjects. This device has three modes of operation: unlocked, locked, and auto (stance-control). After the fitting, subjects practiced walking with the orthosis for 20-30 minutes each day, up to ten days, both overground and on a treadmill. All data were collected at the Department of Veterans Affairs (VA) Chicago Motion Analysis Research Laboratory (VACMARL) of the Jesse Brown VA Medical Center (Chicago, Illinois). Bilateral kinematic data were collected with eight Eagle Real-Time Cameras with a total of 5 testing conditions: three conditions at self-selected speed in each mode, and two conditions matched to the slowest of the first three conditions. This created a self-selected data set and a speed-matched data set. Energy expenditure data were collected with a Cosmed K4b2 portable spirometer and a treadmill.

Results
Walking speed and cadence were significantly higher in the unlocked mode compared to the locked mode ($p=0.01$ and $p= 0.005$) but no other significant differences were observed. In the locked mode, subjects exhibited a reduced knee range of motion. Peak-to-peak stance phase knee flexion was lowest for the locked mode, followed by the auto and finally the unlocked modes with significant differences observed for all cases. In swing-phase, locked mode peak-to-peak knee flexion was significantly lower than the

unlocked and auto modes (p<0.001) with no significant differences observed between the unlocked and auto mode peak-to-peak knee flexion (p=0.9). Swing-phase peak to peak pelvic obliquity was significantly greater when subjects walked in the locked mode compared with the unlocked and auto modes (p<0.01). No significant differences were observed between the unlocked and auto modes (p=0.6). All subjects exhibited significantly increased peak to peak pelvic tilt during orthotic side swing phase in the locked mode compared with the unlocked and auto modes (p<0.001 and p=0.005). No difference was observed between the unlocked and auto modes (p=0.3). With regards to energy expenditure, subjects used significantly less energy to walk in the unlocked mode compared with the other to modes (p<0.007), however no significant difference was observed between the locked and auto modes (p>0.99).

Conclusion

In this study, the effects of a stance-control orthosis were investigated in able-bodied individuals to create a more homogeneous subject population. Temporospatial, kinematic, and energetic variables were analyzed. As expected, few significant differences were observed between the auto and unlocked modes with regards to temporospatial and kinematic data indicating that subjects walked with a more normal gait pattern in the auto mode compared with the unlocked mode. However, unexpectedly, subjects did not exhibit reduced energy requirements in the auto mode compared to the locked mode. This could be due to an insufficient training period or could indicate that a different training protocol was necessary. Future studies should investigate the effects of stance-control orthoses in pathological populations and should investigate training protocols to determine the most effect method.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3001-199]

Treatment of Juvenile Cruciate Ligament Injuries - Chances, Possibilities and Limits

Author
Semsch, Hartmut (Markgröningen DE)
ORTEMA GmbH - Orthopädie-Technik

Introduction

The treatment of children and adolescents with knee braces following knee injuries is very demanding for the field of orthopaedic technology. The small-sized knee joints such as the partially not yet defined muscles pose special demands to the specific orthoses. In the last few years an increasing number of juvenile cruciate ligament injuries was treated at the Orthopaedic Clinic Markgröningen allowing us to gather a lot of experience concerning the orthotic treatment thereof.

Methods

Sports and traffic accidents are the main causes of these injuries. Especially regarding children and juveniles these injuries are on the increase. Scientific studies support the thesis that should the LCA be missing in children and adolescents this definitely needs to be replaced to avoid degenerative effects such as osteoarthrosis. Due to the small dimensions of the lower extremity it is however very difficult to orthotically treat these patients with off-the-shelf products, often making the use of customized bracing inevitable.

Results

Due to the high number of surgically treated juvenile knees in the department of Sports Medicine at the Orthopaedic Clinic Markgröningen we were able to further our knowledge regarding the bracing of these patients. This resulted in the development of two new knee bracing systems which accommodate for the small circumferences of thigh and calf but also the reduced dimensions of the bones making up the knee joint. Concerning children aged 10 years or less it is often only possible to brace with customized products relying on a plaster mould. The mechanical polycentric knee joints used are 30% smaller than those used for adults. The treatment has to be discussed with the surgeon regarding the biomechanical criteria to guarantee an effective knee orthosis.
Further the expected muscle growth and the changing lengths need to be considered.
It is further important to advise the parents of the patients on how to use the brace correctly and improve the reduced compliance of the child or juvenile to avoid improper use and positioning of the brace.

Conclusion

Very often we are asked to offer knee braces which can be used as a measure to prevent injuries in higher risk sports. For this reason a semi-confectioned knee brace system was developed which consists of a material that can be thermoplastically moulded to meet individual requirements. It is important for the physician and orthotist to understand the specific anatomical requirements posed by the knees of children and adolescents and to put these into consideration for the post-surgical management. Especially when additional structures such as meniscus or cartilage have been damaged by the injury.
Often not treated correctly the knee joint of children and juveniles nowadays is put into a different perspective offering new possibilities of treatment by surgents for the field of orthopaedic technology.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3122-320]

A Case Study: Pelvic Hip Torso Orthosis for a Post –operative Removal of Ileum with Total Hip Joint of ABC Malignant Tumor of 12 Year Old Female

Author
Pandey, Jagdish (New Delhi IN) | Prosthetist and Orthotist
All India Institute of Medical Sciences - Orthopaedics

Coauthors
Professor Orthopaedics Rastogi S

Abstract
This is a single case study covering the assessment, casting, fabrication and fitting of a pelvic –hip torso orthosis for the early mobilization of the post-op patient of ABC of ileum and undergone surgical excision of whole affected ileum including total hip joint.

Introduction
This is a single case study covering the assessment, casting, fabrication and fitting of a pelvic –hip torso orthosis for the early mobilization of the post-op patient of ABC of ileum and undergone surgical excision of whole affected ileum including total hip joint. The patient/client was assessed by the orthopedic surgeon (treating doctor) and orthotist. The team worked on the following grounds:
1. REQUIREMENT OF THE CLIENT
2. REQUIREMENT OF THE PATHOLOGY
3. EARLY MOBILITY OF THE CHILD

Methods
Considering on the above mentioned grounds initial designing of the orthosis was designed with following options
1. TOTAL CONTACT PELVIC GIRDLE BRACE ATTACHED WITH UNILATERAL KAFO
2. ISCHIAL WEIGHT RELIEVING HKAFO
3. PELVIC GIRDLE (TOTAL CONTACT) PVC BRACE EXTENDED UPTO KNEE CONDYLE (Allows full available range of motion)
No.3 option was approved by the team

Results
This orthosis is Avery effective and patient specific device that has several advantages. The orthosis is user friendly and comfortable. However, the goal of enhancing the quality of life and independence has been achieved without loosing demand of the pathological requirement. Patient is able to do her activities of daily living. To be successful the end user must be highly motivated and have high level of participation in the process.

Conclusion
Surgical management of the excised part is still under consideration. Our aim was to avoid long term immobility and thereby help the patient gain some confidence in day to day activities.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3009-207]

Comparison of Energy Cost of Walking with and without a Carbon Composite Ankle Foot Orthosis in Stroke Subjects

Author
Danielsson, Anna (Göteborg SE) | Dr
University of Gothenburg, Institute of Neuroscience and Physiology - Clinical Neuroscience and Rehabilitation

Coauthors
Sunnerhagen KS, Willén C

Abstract
Oxygen cost, gait speed and perceived exertion was measured in 10 subjects with stroke walking with and without a carbon composite ankle foot orthosis. Walking with ankle foot orthosis was statistically less energy demanding and the speed somewhat higher compared to unbraced walking.

Introduction
The opinions on effects of AFOs on functional outcome after stroke are inconsistent and the clinical significance of changes reported has been questioned. The improved walking velocity with an AFO as compared to unbraced walking seen in some studies may involve a reduction in energy cost. To our knowledge, only two studies report reduced energy cost with the use of an AFO. The aim was to measure and compare the energy expenditure and walking speed with and without a carbon composite AFO in stroke subjects.

Methods
Ten persons with prior stroke, habituated to a carbon composite AFO were included. First the self-selected speeds on a tredmill without (speed I) and with (speed II) the AFO were determined in randomised order. The energy expenditure and heart rate were estimated with a stationary, computerized system for breath-by-breath analysis. Two measurements of energy expenditure were carried out with and without the AFO in randomized order at speed I. A third measurement was made with the AFO at speed II. Each trial lasted for five minutes. The measurements were repeated in reversed order once within one week. The energy cost per minute was divided by walking speed for estimation of energy cost per distance. Data was analysed with Wilcoxons sign rank test.

Results
The mean self-selected walking speed was 20% higher ($p = 0.027$) with the ankle foot orthosis than without. Walking at speed I with an AFO was 4% less energy demanding (VO_2 mL·kg-1·min-1) ($p=0.028$) than walking without AFO at the same speed. The energy cost (VO_2 mL·kg-1·m-1) at speed I was also significantly lower with the AFO ($p = 0.037$) than without. Heart rate or perceived exertion did not differ between the two conditions.
There was no significant difference in energy expenditure (VO_2 mL·kg-1·min-1) between walking at speed I without AFO and speed II with AFO. However, the energy cost (VO_2 mL·kg-1·m-1), was 12% lower ($p=0.024$) with the AFO. Heart rate and perceived exertion showed no difference between the two conditions.

Conclusion

A carbon composite ankle foot orthosis may decrease energy demands and increase walking speed after stroke. The differences in energy cost seen in this study were small and not clinically significant whereas an increase in walking speed might have some impact on walking capacity. Further studies on the effects of an AFO on walking ability after stroke are wanted.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3171-363]

Determining Optimal Halo Pin Management Practices to Decrease Pin Complications

Author
Wheeler, Karly (Melbourne AU)
The Alfred Hospital - Orthotic Department

Coauthors
Burchall G, Byrne M, Malham G

Abstract
The most commonly reported complication associated with Halo Thoracic Orthoses is pin loosening. This study examines complication rates and pain associated with regular re-tensioning of pins compared with no re-tensioning. Results showed significantly less complications in the re-tensioning group.

Introduction
The Alfred Hospital is Australasia's largest major trauma centre. The Alfred treats 11,000 trauma patients per year. 4,500 trauma patients require admission of which 1150 are classified as major trauma (Injury Severity Score (ISS) >15).
The Halo Thoracic orthosis is a common treatment modality employed to treat fractures of the cervical spine. It has been termed the "golden standard" (Glaser et al. 1998).
Despite the Halos wide spread use, literature still reports numerous complications (Garfin et al. 1986). The most commonly reported halo complication is pin loosening. Loosening has also been linked to other complications such as pin site infection and delayed healing (Garfin et al. 1986). There have been no previous studies reporting the effects of regular re-tensioning to prevent loosening.
This study compared two pin management protocols and their complications associated with halo wear. Our aim was to reduce Halo related complications including pain and pin loosening.

Methods
The study was a prospective randomised control trial. Patients fitted with a Halo and requiring long term follow-up at the Alfred Hospital between April 2008 and July 2009 were approached to participate. Patients unable to have their pins tensioned to 8lb/inch pressure were excluded. Consenting participants were randomly allocated to either:
Group 1. (Control) Standard Treatment: Pins were not re-tensioned throughout the 12 week treatment period. This is the current long term management.
Group 2. (Treatment) Routine Re-tensioning: Pins re-tensioned fortnightly throughout the 12 week period.
Data collected at fitting included: 1) Demographics (age, gender, BMI, ISS); 2) Fracture Type; 3) Mechanism of injury; 4) Other Injuries; 6) Pin tension 7) Numerical Pain Scale.
Data Collected at review appointments included: 1) Numerical Pain Scale; 2) Anxiety Test 3) Pin tension reading and 4) Pin Complications.
Analysis compared the differences in pain and complications between the two groups

Results
Ninety-three patients were fitted with a Halo at The Alfred during the study. Forty four patients were recruited. Nine patients were excluded because they had their ongoing care at another centre. Eighteen

participants were randomly allocated to the Control Group (No regular re-tensioning) and seventeen participants were in the Treatment Group (Regular Re-tensioning). Participants and researchers were blinded to group allocation. Participants in the control group still underwent the same re-tensioning procedure at each review; however, the pins were only tensioned to 0lb/inch. While in the Treatment Group pins were re-tensioned to 8lb/inch.
Fourteen of eighteen participants (77.8%) in the Control Group suffered complications compared to five of the seventeen participants (29.4%) in the Treatment Group (p=0.004). Refer to Figure 1.
Demographic data showed no significant difference between the two groups. The control group had a mean age of 45.5 (range: 23-89) compared to the Treatment Group of 47.3 (range: 23-79). Ten (55%) of the Control group and eleven (65%) of the Treatment group were male. The mean Body Mass Index was 22.4 and 23.9 respectively in the Control and Treatment Groups. Average halo wear time was 82 days in the Control Group and 87 days in the Treatment Group.
During the re-tensioning procedure pain increased by an average of 2 points on the numerical pain scale. Patients experiencing complications reported an average increase in pain of 8 points.

Conclusion
Results showed significantly lower complication rates in the Treatment Group.
The main considerations in relation to regular re-tensioning of pins prior to completing this study were pain and risk of pin penetration. No patients in this study suffered from pin penetration. Additionally, it was found pain only increased by a small degree during re-tensioning. In contrast, pain associated with a complication showed a large increase in pain for participants. Patients in the Control Group (not undergoing regular re-tensioning) were significantly more likely to experience severe pain associated with a complication than those in the Treatment Group.
Treatment protocols at The Alfred Hospital have been modified as a result of this research. Halo pins are now routinely re-tensioned at fortnightly review appointments.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3100-298]

Effect of Early Wearing of the Chignon Dynamic Ankle-foot Orthosis on Hemiplegic Gait

Author
Vandeven, Daniel (Leuven BE)
Ortec N.V.

Coauthors
Dr. Mathieu de Sèze
Mr. Jean Jacques Chignon

Abstract
This presentation will prove that the early start of using this type of orthosis will reduce the most important gait deviations such as: drop-foot, genu varum/valgum/recurvatum and most important spasticity, of patients after Cerebrovascular Accident (CVA).

Introduction
The recovery of gait after stroke appear in about 80% of the patients. Traditional physiotherapy, and then development of many rehabilitation techniques (botulinum toxin injection, tibial neurotomia, polypropylene ankle-foot orthosis (AFO), isokinetic gait training, body weight support gait training, ...) allow an improvement of gait quality in hemiplegics. Nevertheless, none of these techniques aims to substitute for propulsive deficiency of the injured lower limb, no more than to prevent appearance or development of spasticity. The Chignon dynamic ankle-foot orthosis is a dynamic hinged boot who has been recently developed to answer at these both objectives, on top of the classical polypropylene ankle-foot orthosis. In our work, we set the ankle-foot orthosis among traditional and innovative rehabilitation methods, we describe his effect on hemiplegic gait and his technical evolution.

Methods
A prospective, multicentric, controlled and randomized clinical trial , comparing a traditional ankle foot orthosis with a Chignon AFO during the rehabilitation of the vascular hemiplegic patient.
Randomization:
A patient list is kept by a doctor who is not involved in the evaluation. This last will be contacted by the investigator after inclusion of a patient to know the AFO to be proposed.
Patient criteria:
• Male / female age 18 – 85 year
• Hemiplegia after cerebrovascular accident
* requiring an admission in a center of rehabilitation
* dating of more than 30 days and less than 6 months
* of ischemic or hemorrhagic origin
* first clinical CVA
* presence of a walking defect : drop foot or varus equinus
Criteria of judgment
Most important criterion
• maximum walking speed on 10 meters realized with the AFO at the thirtieth day of wearing.

Results

The orthosis of Chignon involves a better correction of the gait defects of hemiplegic patients (steppage, varus, recurvatum) in a statistically significant way compared to the AFO and this already from day 0. But improvement of the quality of the gait of the hemiplegic patient with the Chignon orthosis is also observed in terms of functional results, which is primordial for the patient. The comparison of the profits obtained on the test of the ten meter walk between the Chignon group and the control group showed a strong statistically significant difference on day 30 as on day 90 in favor of the Chignon orthosis. In the same way, the comparison of the profits obtained by each group on the FAC realized with orthosis shows a statistically significant difference on day 90 in favor of group Chignon.

Effect on the spasticity

Other major stake of the orthosis of Chignon, beyond of a superiority on the improvement of the quality of walking, is the prevention, stabilization, even the reduction, of the spasticity.

Thus, our study brings the proof of the clinical reduction of spasticity of the triceps surae, and the quadriceps, thanks to the orthosis of Chignon, and this with a statistically significant difference compared to the other AFO.This reduction of spasticity related to the orthosis has as a consequence an increase of the dorsi#exion angle of the ankle, thus preventing complications for the long run, and especially that lead to reduce the necessity of botox.

Conclusion

Our study that included 28 stroke patients allowed us to proof the effectiveness of the Chignon orthosis on gait trouble and on the improvement of functional gait performance of the hemiplegic vascular patient in the early phase of revalidation, thus providing him a gait of better quality.

This effectiveness is statistically higher than that of a standard AFO concerning the correction of the recurvatum, the steppage and the varus of the foot, just as for the profit carried out at the time of the 10 meter walk with orthosis and on the FAC.

The Chignon Orthosis is much more useful than the AFO right from the start, and its effectiveness is durable.

Moreover, our study made it possible to highlight a statistically significant difference between the two groups in connection with the spasticity in favor of the Chignon group, implying for this group a better comfort, a prevention of the complications of the spasticity, and a less use of medical treatment.

References

Identities of the investigators and centers of investigation:

Investigator-coordinator: Dr. Mathieu de Sèze (CHU de Bordeaux)

Investigators:

- Dr. Emmanuel Burgeret (CHRU of Lille)
- Dr. Emmanuelle Coste (Ladapt)
- Dr. Walter Davelny (CHRU of Lille)
- Dr. Jean-Christophe Daviet (CHU of Limoges)
- Dr. Emmanuelle Duprey (Clinical of MPR Napoleon)
- Dr. Eric Gaujard (Large Oaks)
- Dr. David Goossens (the Tower of Gassies)
- Dr. Hachemi Meklat (Richelieu Center)
- Dr. François Muller (the Tower of Gassies)
- Dr. Marc Rousseau (CHRU of Lille)
- Dr. Cécile Visentin (Richelieu Center)

Centers of investigation:

Service of Physical therapy and Readjustment

USN Tastet-Girard

CHU de Bordeaux - Pellegrin Hospital
Place Amélie Raba-Léon, 33076 Bordeaux Cedex
Center Rehabilitation and of Readjustment of the Tower of Gassies
Rue de la Tour de Gassies
33520 Bruges

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [2851-66]

Correlation between Psychosocial Issues and Noncompliance in Spinal Orthosis in Patients with Adolescent Idiopathic Scoliosis

Author
Aziz, Ahmad (Peshawar-Pakistan PK) | Mr
PIPOS - Prosthetic

Abstract
The study was conducted in PIPOS (Pakistan Institute of Prosthetic and Orthotic Sciences) Peshawar Pakistan during the time period of June, 2008 and Feb: 2009.

Introduction
The aim of this study is to find a correlation between psychosocial issues and noncompliance in spinal orthosis, in patients with adolescent idiopathic scoliosis.

Methods
The brace questionnaire (BrQ) was used to collect the quantitative data. All the questions were answered according to the likert scale in the following five responses, “Always”, “Most of the times”, “Some times”, “Almost Never” and “Never”. Descriptive statistical analyses were done and a correlation coefficient test was applied to get the results.

Results
The total numbers of participants were 11 (04 boys and 07 girls) with mean age of 11 + 3.59 years (range 5 to 17). The average negative psychosocial impact was 52.4% + 10.5%. A strong correlation of 0.8462 was found between noncompliance and the psychosocial issues in clients with spinal orthosis.
Discussions:
In contrast to many researchers we found that young clients fitted with SO were not using special clothing (63.6%). The average negative psychosocial impact was 52.4% + 10.5%, which less than 84% is found by Mastunaga et al (2005).

Conclusion
The difference in results of this study to previously published material may be due to the different demographics and culture in which the study was performed. Psychosocial counseling of adolescents with AIS along with orthotic treatment may improve compliance and therefore, the outcome.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3087-285]

Management of Severe OA of the Knee Using a Customised Off-Loading Knee Orthoses

Author
Munro, William (Clydebank UK)
Anatomical Concepts (UK) Ltd - Rehabilitation Engineering

Coauthors
Buchan M, Jones D

Abstract
This study reports on the results of using a custom made knee orthosis as an alternative to surgical intervention. Outcomes with 100 patients are reviewed along with case details of four patients with valgus/ varus deformity in excess of 20 degrees.

Introduction
Various orthosis designs exist for the management of patients with osteoarthritis of the knee. Custom or off-the-shelf unloader knee orthoses are used in relieving pain in patients with uni-compartmental osteoarthritis during weight bearing activities.
Although these designs can be mechanically successful, patient tolerance may be low due to a higher concentration of pressures being exerted by straps or condylar pads. This is especially so with severe deformity and can severely limit the duration over which an orthosis can be tolerated.
The authors have applied a new custom orthosis design in an experience of over 100 fittings. The design was investigated due to its ability to fine-tune comfort levels at fitting, its light weight and relatively efficient design.

Methods
The Varum Valgum adjustable stress (V-VAS™) custom knee orthosis is a new concept for treating patients who present with medial or lateral compartmental arthropathies.
Its design incorporates features intended to increase both effectiveness and compliance for the patient.
Instead of using a narrow frame as seen on most designs it uses a total contact cuff on the thigh and tibia along with an adjustable self aligning polycentric joint system to create four points of pressure instead of three.
With two points of pressure being applied as a counter force and two points of pressure applied as the corrective force, there is no need for a condylar pad.
The system's self-aligning, polycentric hinge design, has a means of linearly adjusting the varum or valgum angle (depending on which compartment is affected) without causing mechanical joint binding.
Patients liked the fact that the design allowed the structure to closely follow the knee of the knee without binding.

Results
There are many design options available to those patients needing offloading knee orthoses. We know from reviewing literature that offloading orthoses are ethical and very effective. There application will minimize use of medication, delay arthroplasty in the younger patient and control pain in those patients with co morbidity. They are also used as a pre-operative tool or post operative tool to determine the success of a

surgical technique or offloading of the operative compartment respectively. As health care professionals we should strive for optimal outcomes when recommending various designs. Compliance, effectiveness and efficiency in design are all key factors in achieving this optimal result in the current healthcare arena. The unique features in this new design are an efficient and effective alternative used to achieve optimal results.

Conclusion

Each patient was assessed radiographically and a custom cast made of the knee in a comfortable, corrected position. Partial correction of deformity by the orthotist during cast taking was important in minimising discomfort in wearing the brace. At the fitting stage the design of the orthotic joint was such that fine adjustments of the amount of offloading were possible. Immediate feedback on pain relief was a very positive aspect of the design.

A significant number of patients were not candidates for surgery due to co-morbidity. The paper will describe the design principles and report on the specific findings in four severe cases.

Radiological assessment before and after use and the decrease in pain on movement were the primary methods of measurement of clinical effectiveness.

The use of orthoses as a cost effective and satisfactory outcome to a clinical episode will be assessed and discussed.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3200-387]

Modified Constraint-Induced Movement Therapy (CIMT) Employing a Modern Restriction Cuff

Author
Hartwig, Maik (Bad Neustadt DE) | Msc Neurorehabilitation
Neurologische Klinik Bad Neustadt - Neurorehabilitation / Ergotherapie

Coauthors
Seyfarth U

Abstract
Constraint-Induced Movement Therapy (CIMT) is a modern therapeutic procedure with a high degree of evidence basing. Modified, less intensive forms are more practical and also intensively promote the arm function and the reuse of the affected arm in everyday life.

Introduction
The brain possesses the ability to adapt its functional and structural organisation, described as neuroplasticity of the brain. These plastic adaptations in the cortex are influenced through learning and training processes. But learned non-use of the affected arm and conditioning of these negative learning experiences come about through a lesion-induced sensomotoric restriction. CIMT was developed on the basis of the insights of neuroplasticity and theory of learned non-use. This is characterised through three contents: movement restriction of the unaffected arm; active, repetitive, task-oriented training of the affected arm; and the principle of shaping. A modified form of CIMT has been successfully practiced for several years at the Bad Neustadt Neurological Clinic. The movement restriction of the healthy upper limb occurs in this connection with a newly developed restriction cuff.

Methods
The modified CIMT is offered within the scope of a small group with up to four patients. Training is implemented under intensive therapeutic guidance five times a week for one hour. Inclusion criteria are at least 20° extension in the wrist as well as 10° in the metacarpophalangeal joint, minimal grasping function of the thumb and sufficient balance for activities while standing. Severe cognitive disorders are contraindicated. The patient’s consent occurs via a therapy contract. In addition to complete restriction of the healthy arm, the use of the affected arm is activated through adapted task-oriented training. The therapies include individually adapted, repetitive exercises of individual movement elements of the arm and hand, up to training of complex everyday situations under the principles of shaping. The ICF assessments via the Wolf Motor Function Test (modified form) and the Nine-Hole Peg Test (NHPT) are utilised for regular sequential diagnostics.

Results
The patient population treated up to now in a period of two years was able to be assessed quite well in the course through the documentation of all conducted tests. An overall improvement in the movement quantity and quality of the affected upper limb was shown with each of the patients treated with modified CIMT. Significant improvements were continuously shown with the test parameters in which the use of the affected hand was assessed in a specific everyday activity (e.g. grasping and lifting a bottle with standardised weight, folding a towel). But the patients also showed very good motoric improvements with complex

everyday actions on the participatory level. A substantial increase was also recognisable in the range of finger dexterity in the follow-up with the Nine-hole-Peg-test(NHPT)and applicable in everyday sequences.

Conclusion

The achieved results with regard to the use function of the affected arm and the hand confirm the efficacy and high quality of CIMT. Despite the modification and necessary adaptation to existing therapeutic sequences, the clinic demonstrated a degree of high practicability. The high compliance of patients for the modern restriction cuff – which promotes the reuse of the affected upper limb even more through the complete restriction of the non-affected arm – is also to be mentioned as a positive aspect. Due to the achieved improvements, the efficient applicability and the positive feedback of all patients treated up to now, this modified form of CIMT is to be recommended as an essential component of modern neurorehabilitation.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3359-534]

Stance Control Orthosis in Patients with Spina Bifida – Low Lumbar Level

Author
Angarami, Maria Pia (Buenos Aires AR) | Medical Doctor
Ortopedia Alemana - Research and Development

Coauthors
Lofiego, Marcelo
Sibila, Monica

Abstract
The patients with Spina Bifida – Low Lumbar Level, generally start ambulating with AFO braces and some time after due to the knee instability they need to be braced with a long leg orthosis (KAFO)
This presentation shows the Stance Control KAFO as an alternative orthotic brace to provide a dynamic g

Introduction
The Spina Bifida is a congenital pathology that causes a motor and sensitivity paresis below the affected level. The incidence in Argentina is 1 per x 1,000 newly born babies. The patients with Spina Bifida at a low lumbar level, generally start ambulation with AFO braces. The studied patients do not have contraction in the mediums gluteus, therefore lateral
swinging of the trunk is needed in order to liberate the contra lateral lower extremity to be able to take the step (trendelemburg sign). In time, this type of walk generates medio-lateral instability of the knees, causing a deformity. When this deformity is present, they need to be
braced with knee ankle orthoses (KAFO). In this way, we obtain knee stability in the stance phase, but we loose knee flexion during the swing phase. The locked knee limits the patient's activities of daily living like to sitting down or standing up, particularly it makes difficult to go up or down stairs. This daily difficulty predisposes the patient to stay sitting for long

Methods
Fivelow lumbar Spina Bifida patients were included in this study, 3 women 2 males. The average age was of 12.6 years old (between 10 and 16 years of age) All of them presented muscular force values according to Kendall scale in hip flexors, adductors and quadriceps equal
to or above 4/5, and below 3/5 in knee flexors. No muscular contraction was recorded in abductors, hip extensors, plantar flexors and foot eversion muscles. All of them presented hip flexion lower than 30°, a limitation to reach full knee extension (-10°) and plantar flexion with more than 10° of ankle range of motion. Prior to the Stance Control brace, all of them were able to independently walk with their AFO's but with an important medial-lateral knee instability during the stance phase. The 5 patients were fitted with Stance Control KAFO. The knee control during gait and the daily activities performance were checked. The gait results were measured by a video analysis in 2D, using the Physician`s Rating
Scale(PRS) modified for gait.

Results

All patients fitted in this study with a Stance Control orthosis were able to lock their knee while extended during the stance phase and to unlock the knee during the swing phase of their gait cycle and obtain a 20º knee flexion. The Stance Control was able to control the medial-lateral
knee instability and the crouch gait which were present in this patients gait while using an AFO, during mid stance. During daily activities, all of them were able to sit down unlocking the knee mechanism and to stand up from a 90° hip and knees flexion position, using their quadriceps power to achieve to do it. The patients were able to learn how to climb stairs activating their quadriceps to lock their knee
in full extension and unlock the orthotic joint to go down the stairs with alternate gait patterns.

Conclusion

We are able to show that the Stance Control Orthotic System is a valid functional option for myelomeningocele patients. It is an orthotic alternative that obtains better results than the traditional ones such as Lock Knee KAFO that are commonly prescribed for this pathology.
Thanks to its locking mechanism, it allows knee stability during the mid stance phase and the flexion during swing phase. The KAFO orthesis with locked knees are difficult and energy increasing systems for most patient's. In our experience, therefore many of this patients end up permanently using wheelchairs in order to obtain better quality of life. This leads weight gain. This makes walking more difficult, creating a vicious circle. The new braces with a Stance Control System offer a dynamic gait to myelo patient's previously confined to a rigid leg brace. The great goal is to delay the moment for permanent e
wheelchair as means of permanent mobility as much as possible.

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Poster Session: Orthotics
Thursday 2010/05/13 | 12:00 - 14:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Poster [3295-470]

Knee Moments during Walking in Stance-Control Knee-Ankle-Foot-Orthoses

Author
van Schie, Carine (Amsterdam NL) | Dr
Academic Medical Centre, Amsterdam - Rehabilitation

Coauthors
Sabelis LWE, Otterman N, Nollet F

Abstract
Knee moments showed that not all patients use the knee mechanism during walking. Only a few trusted the knee, although moderate safety and mild fear of falling during walking was experienced. This indicates that patients may only use the SC-knee hinge as a safety system in unsafe walking situations.

Introduction
Knee-ankle-foot-orthoses (KAFO's) are used by patients with weakness of the knee extensors. Until recently patients were given a locked knee-ankle-foot orthosis (KAFO) to assure stability during walking. The disadvantage of this orthosis is that the "natural" gait pattern is disturbed mainly with respect to the swing-phase of the affected leg. In order to reduce the interference during swing phase when using a locked KAFO, several types of "stance-control KAFO's" (SC-KAFO) have been designed. These devices allow free flexion of the knee in swing, while providing full stability in stance by automatically locking on initiation of the stance phase of gait. Several locking mechanisms, both electronic and mechanical are available from different manufacturers. We were interested whether SC-KAFO users were making use of the stance control knee mechanism during walking.

Methods
We have studied 9 former polio patients (7 male, 2 female) aged between 51 and 75 years with quadriceps weakness. Patients were assessed in their previous orthosis condition (4 no orthosis, 1 AFO, 2 KAFO (with locked knee), 2 SC-KAFO), and in their current SC-KAFO orthosis. Patient experiences with regards to safety during walking, trusting the knee mechanism and fear of falling were assessed using a VAS score (score 0-10, 10 = max positive score), and 3D-motion analysis of walking was conducted. The average knee moment data from 5 trials were used for analysis.

Results
In the SC-KAFO condition, the average knee moment during loading response (0-10% gait cycle) was an external extension moment in 7 out 9 patients. The average knee moment during midstance (10-30% gait cycle) was an external extension moment for 8 out of 9 patients. This indicates that the majority of the patients do not make use of the knee locking mechanism during stance, thus the knee hinge doesn't need to compensate an external knee flexion moment. Compared to their previous orthosis condition, the average knee moment during loading response and midstance in the SC-KAFO orthosis had moved towards an external flexion moment in 4 out of 9 patients, indicating an improved knee gait pattern. With regards to patients' experience, 6 out of 8 (n=1 missing) patients felt save during walking (score>6), although only 3 out of 7 (n=2 missing) patients indicated to trust the knee mechanism and 5 out of 8 (n=1 missing) had

mild fear of falling (score between 6 and 8). Objective knee moment data was not necessarily related to patients' experience of trusting the mechanism or fear of falling.

Conclusion

These preliminary results show that objective data of the knee joint of SC-KAFO users indicate that patients do make limited use of the stance control knee mechanism during normal walking on an even surface (i.e. in gait laboratory). This may indicate that patients only use the knee locking mechanism as a (back-up) safety system, which may only be used when there is an unsafe situation in which patients cannot maintain an external knee extension moment in their gait. This hypothesis is also supported by the subjective data.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3788-None]

Rehabilitation: the Key to Ability ...

Keynote Author
Geertzen, Jan (RB Groningen NL) | Prof. Dr.
University Medical Center Groningen

Abstract
In the Netherlands the incidence of major lower limb amputation is about 19 per 100.000 inhabitants. Every day clinicians such as surgeons, rehabilitation doctors, prosthetists, physical therapists, psychologists and other members of the multidisciplinary rehabilitation teams, who are involved in the care of amputee patients, have to make choices in the treatment of their amputee patients. There are in the world very few clinical guidelines in the field of amputation and (prescribing) prostheses which can help the clinician. However, none of these are complete Evidence Based guidelines. One or two are (partially) evidence based but only for one profession or for a small area in this field.
Evidence based practice is a hot topic in the last decade. Evidence based practice is the conscious and systematic use of the best available research evidence in making decisions about the care of individual patients. It is not a mandate for daily practise but it can assist the clinician in the decision making process ab

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3833-None]

Open Forum 5

Session Chair
Heim, Winfried (Toronto CA)
Sunnybrook Health Sciences Centre - SCIL

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg618017

Session: Open Forum 5
Thursday 2010/05/13 | 15:00 - 16:30

Congress Lecture [3834-890]

The Rehabilitation of a Chinese Hemicorporectomy Amputee after Pelvic Trauma

Author
Yang, Ping (Beijing CN)
China Rehabilitation Research Center - prosthetics and orthotics

Co-Author
Xuejun, Cao (CN)

Co-Author
Tian, Gang (CN)

Coauthors
Xuejun Cao & Gang Tian

Introduction
The rehabilitation of a hemicorporectomy amputee needs multidisciplinary team work. Few patients can survive after severe crushing pelvic traumas which is an indication of hemicorporectomy (HCP, also called translumbar amputation). Also, few literatures discuss the rehabilitation of such a patient. This article aimed to describe the rehabilitation procedure of a Chinese HCP amputee. Case study method was used. A 46-year-old male patient came to our hospital 3 years after accidental emergency amputation from pelvis. Orthopaedist, physiotherapists, psychologists, prosthetists, engineers and social workers made up a rehabilitation team. It took over 5 months for the patient to attain most of activities of daily living independent. A self-suspending socket independent of wheelchair was made for him. Walking was also realized with a reciprocating gait prosthesis. Results suggest that rehabilitation is essential for HCP amputees to improve independence and return to the society.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg618017/cg618324

Session: Open Forum 5
Thursday 2010/05/13 | 15:00 - 16:30

Congress Lecture [3838-None]

Sand Casting an Alternative Method for Fabricating Trans-Tribal Sockets

Author
Mwaijande, Violet T. (TZ)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg618017/cg619758

Session: Open Forum 5
Thursday 2010/05/13 | 15:00 - 16:30

Congress Lecture [3880-881]

Effect of Lateral Wedged Insole on Knee Mechanics

Author
Huang, Meng (Hong Kong HK) | Research student
The Hong Kong Polytechnic University - Department of Health Technology and Informatics

Introduction

Lateral wedged insole is a common treatment option to medial knee Osteoarthritis (OA) by alerting knee alignment and thus joint loading. It was first proposed in 1980s [1]. A quantitative evaluation on the relationship of wedged location and knee alignment is performed. The research could provide information for orthotists to establish better treatment protocol.

Methods

Tow degrees (3 and 5) of rearfoot and forefoot lateral wedged insoles (Shore A65, EVA) were trimmed to fit the walking shoes (Adidas, Superstar) and randomly assigned to 3 healthy subjects. There were 45 makers were placed on both side of lower extremity. The motion and 3D ground reaction forces (GRF) of subjects were recorded using motion analysis system (Vicon Nexus, Oxford) operating at 100Hz with 8 infrared cameras and 2 AMTI force platforms (Advanced Mechanical Technology Inc. Newton, Mass, USA).

Results

There was no apparent change on time-distance parameters and vertical GRF magnitude upon different wedge conditions. Rearfoot lateral wedge could reduce GRF by 9% and 15% on AP and ML direction respectively (Fig. 1).In the ML direction, the center of pressure (COP) was increased by 15% with rearfoot lateral wedge (Fig. 2). However, the knee adduction moment was reduced by 15% with forefoot lateral wedge compared with the shoes alone. (Fig. 3)

Conclusion

Studies of wedged placement has been conducting to suggest the best combination of insole design for knee OA patients. It is important to note that individual biomechanical responses to reduction of knee adduction moment could aid in treatment of knee OA. Additionally, biomechanical studies showed wedged insoles could reduce knee adduction moment by
average 10% compared with barefeet or shoes alone and it was similar to this study. Other studies showed that insoles wedged laterally along the full length of the foot significantly reduced the knee adduction moment whereas a rearfoot lateral wedge did not [2]. In this study reduces the adduction moment more with forefoot lateral wedge. This supports prescription of
forefoot rather than rearfoot wedges. Furthermore, lateral wedges cause a small lateral shift in the center of pressure location of the ground reaction force. In the literature, this likely decrease the knee joint moment arm, thereby reducing the adduction moment.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg618017/cg759593

Session: Open Forum 5
Thursday 2010/05/13 | 15:00 - 16:30

Congress Lecture [4096-927]

Wheelchair Adaptation to High Level Paraplegic Patients

Author
Tang, Dan (Guangzhou CN) | Dr.
Guangdong Provincial Work Injury Rehabilitation Centre

Coauthors
Li Kuicheng

Introduction
High level paraplegic always associate with restriction of activities of daily living (ADL), especially in motor function and mobility. Electric wheelchair can provide of great help to patients with high level paraplegic, but it is too expensive for most patients in developing country. The modification of wheelchair and wheelchair adaptation could also enhance the participation of spinal cord injury patients with lower cost. The aims of this study were to find a feasible way to modify the wheelchair and to explore the effects of its application.

Methods
A single subject design (AB) study was applied to three subjects with high level paraplegic. Each patients would used an ordinary wheelchair and received rehabilitation routine training for four weeks, then, the ordinary wheelchair would be modified by adding an electromotor, a direction-control handle, and a speed-control handle. The participant would use the modified wheelchair for four weeks. He or she would also receive rehabilitation routine training during this phase. A six months follow-up was done after wheelchair modification. The walking/ wheelchair item of functional independent measure (FIM) were applied to evaluate the ability of mobility before wheelchair modification, 4-week after modified, and six months after modified.

Results
The mobility abilities of all the three subjects improved. They all could easily participate in family and community activities. Case A, a completed C6 level spinal cord injury patient, could care herself independently. The score of wheelchair of FIM improved from 3, before wheelchair
modification, to 6, four weeks after modification. The score of 6 means she could use her wheelchair independently. She could participate in most community activities, including shopping, independently. Most importantly, she returned to work during the follow-up phase. Case B, a 52 years old men with completed C6 level spinal cord injury, got 4 score of wheelchair item of FIM increased (from 2 to 6). Case C, a completed C6 level spinal cord injury girl, raised her wheelchair item score from 3 to 6.

Conclusion
Wheelchair modification can enhance the patients to take part in family and community activities and the cost is very lower. It is available for high level paraplegic patients in developing countries.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3663-None]

Lower Limb Prosthetics - Socket

Session Chair
Babbar, Ajay (New Dehli IN)
All India Institute of Medical Sciences, Ansari Nagar, New Dehli - Department of PMR

Session Chair
Boone, David (Washington, D.C US)
OrthoCare Innovations

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Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3448-623]

Anatomical Socket vs. Ischial Containment Socket: First Results in an Intraindividual Comparison Under Clinical, Biomechanical and Prosthetic Aspects

Author
Linkemeyer, Ludger (Münster DE)
Klinik und Poliklinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Coauthors
Linkemeyer L, Wuhr J,Rummler M,Drerup B, Wetz HH

Abstract
In a prospective study patients after transfemoral amputation are provisioned with an ischial containment socket and with an anatomical or ramus containment socket. The two provisions are compared intraindividually from clinical, biomechanical and prosthetic aspects.

Introduction
In a recent intraindividual study it has been shown, that the ischial containment socket provides functional benefit for the amputee in nearly every aspect over the quadrilateral socket. Marlo Ortiz, the promoter of the Marlo anatomic socket ("MAS") one kind of a ramus containment socket describes this socket type to be a consequent further development of the ischial containment socket. It offers enlarged mobility range in the hip joint, improved steering properties and excellent comfort in various sitting positions. It is hypothesized, that independent of activity level, range of motion, stump length and stump conditions all amputees take profit from the provision.

Methods
In a prospective study with 6 patients after transfemoral amputation each patient has been provisioned both with a ramus containment socket and an ischial containment socket. In three of these patients a liner insert was used. During production and alignment prosthetic aspects are recorded, after a period of 4 weeks the functional profit is assessed with respect to clinical and biomechanical criteria.
The clinical :criteria refer to the harmony of gait, comfort of sitting in different positions and activities of daily life
Biomechanically duchenne limp, pelvic tilt and inclination, relative movement between stump and socket (pumping and shifting), lumbar lordosis and the range of motion are assessed.
Prosthetic aspects are the tools and instruments needed to produce the sockets and number of test sockets required in aligning the prosthesis.

Results
The production of the sockets has not been yet completed however no special instrumentation was needed in MAS sockets. Alignment of the MAS sockets was more elaborate than for the ischial containment socket and more test sockets were needed.
It seems, that especially for the "challenging stump" satifying results can be obtained, whereas supposed easy provisioning stumps the profit was less apparent.

Conclusion

The decision between ischial and ramus containment socket depends on the individual situation and needs of the patient.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222013/cg44033

Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3590-670]

Lower Limb Prosthetics II: Analysis and Design Considerations of a Prosthetic Socket

Author
Kistenberg, Robert (Atlanta US) | MPH, CP, LP, FAAOP
Georgia Institute of Technology - School of Applied Physiology

Coauthors
Tawfik, S
Kistenberg, R
Kondor, S
Browne, E

Abstract
A three-dimensional solid model of major tissue of the residual limb is developed from MRI data. To conduct further analysis and simulations, solid models of major tissues are to be assigned respective material models and specific interaction properties in Abaqus Finite Element software.

Introduction
A three-dimensional solid model of the residual limb is transformed into a mechanical model following a number of steps. Firstly, material models associated to sub-structural tissue types are identified and assigned to their corresponding solid models. Secondly, the interaction properties between each two solid sub-structures in the model are identified, e.g. the sliding contact between the femur and the tibia at the knee joint. Each interacting surface pairs are identified and assigned their corresponding interaction property. Finally, optimized finite element mesh is obtained for the entire structural model of the residual limb.

Methods
Four material categories are identified corresponding to major tissue structures, namely bones, tendons, muscles, skin and fat. Mechanical models available in literature [1-5] are assigned to corresponding structures. Two major interaction properties are identified, namely sliding and tied. The sliding contact is associated to the interface at the knee joint while tied contact exists at the interfaces of several pairs such as tendons/bones, muscles/bones, and muscles/fat. Finally, a refined mesh is required at stress concentration areas when a prosthetic socket is donned on the residual limb. A final limb/socket assembly model is prepared for loading simulation and further socket design steps.

Results
The attached figures provide different aspects of the methods used. Figure 1, shows the, three-dimensional mechanical models of the patella, patellar tendon and the tibia in an exploded view. Figure 2 provides an assembled side-view of the patella, the patellar tendon, and the tibia. In this assembly attachment points of the patellar tendon to both the patella and the tibia are identified and applied. In Figure 3 the meshed structures of the patella, patellar tendon and the tibia are provided. It can be seen that a much coarser mesh

was used for the tibia in contrast to a refined mesh for both the patella and the patellar tendon.

Conclusion

Abaqus Finite element software is used to construct a mechanical model from a threedimensional solid model of the residual limb. Steps involved in constructing a mechanical model include assigning material model to different tissue types, identifying interaction properties and contact surfaces, and optimized meshing. The resulting Finite Element model is prepared for analysis and simulation under different loading conditions.

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Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2962-160]

Skin Problems of the Stump in Lower Limb Amputees; Influence on Vocation and/or Hobbies

Author
Meulenbelt, Henk (Groningen NL) | MD
University Medical Center Groningen, University of Groningen - Department of Rehabilitation Medicine

Coauthors
Geertzen JHB, Jonkman MF, Dijkstra PU

Abstract
Influence of skin problems on vocation and/or hobbies was assessed with a questionnaire (giving a sum score, range 0-27). There were 805 participants (507 had skin problems). The mean sum score was 5.5 (SD=4.1). The sum score significantly correlated with the number of complaints (r= .483, p=.01).

Introduction
Skin problems of the stump in lower limb amputees are frequently seen in clinical practice. Clinicians may instruct the amputee not to wear the prosthesis for a certain period to support the healing process of the skin problem, which may jeopardize vocation and/or hobbies. However, these observations are anecdotic.[1-3] It may be interesting to evaluate the impact of being forced to use the prosthesis less in activities concerning vocation and/or hobbies due to skin problems of the amputation stump. There is no literature available concerning the influence of skin problems in lower limb amputees on vocation or hobbies, although this question has been posed in literature previously.[4] The aim of this study is to analyze the influence of skin problems of the amputation stump on vocation and/or hobbies in lower limb amputees, and to investigate a relationship between number of present skin problems and prosthesis use.

Methods
For assessing the influence of a skin problem on vocation and/or hobbies, items were used from the Dermatology Life Quality Index (DLQI). The DLQI is a valid and reliable instrument to measure influence of skin problems on quality of life.[5]
The 9 items of the DLQI with a 4-point rating scale were adapted specifically for lower limb amputees. The scores on each item are added, resulting in a sum score with a minimum score of zero, and a maximum score of 27.
The items were part of a questionnaire which had as purpose identifying skin problems and determinants of skin problems of the stump in lower limb amputees.[6] The time window for a skin problem was the month prior to receiving the questionnaire. Participants who filled in the questionnaire and reported a skin problem in the month prior to receiving the questionnaire were asked to answer the items concerning the influence of their skin problems on vocation and/or hobbies.

Results
In total 2039 people were invited to participate, eventually 805 questionnaires were available for statistical analysis. One or more skin problems were reported by 507 participants (=63%).
Most common level of amputation was transtibial (49%). Most common reason for amputation was trauma (44%).
On average a participant reported 2.9 skin problems (SD=1.7).

Especially household tasks, use of the prosthesis, social functioning, and performing sports are negative affected by the presence of a skin problem.
Concerning the influence of skin problems on the use of the prosthesis, 498 participants responded to this item being valid. The mean number of complaints per response categories is: “not at all” (2.2 (SD 1.2), n=172)”; “a little” (2.9 (SD 1.4), n=201); “a lot” (3.6 (SD 2.0), n=88); “very much” (4.1 (SD 1.7), n=37).
ANOVA indicated a statistical significant difference among the groups ($F_{3,494} = 25.50$; $p<0.01$). The median (IQR) sum score was 5 (2 to 8). Males had a significantly lower mean sum score (5.2; SD=4.0) compared to women (6.0; SD=4.3) (p=.03) (Mann Whitney). The Pearson correlation between number of skin problems and sum score was 0.48 (p=.01).
Determinants which were related to the sum score were gender, and the number of reported skin problems, interaction between these determinants did not contribute significantly to the model. Analysis of the possible cumulative effects of multiple skin problems gave no result. The determinants did explain 23% of the variance.

Conclusion

Skin problems of the stump in lower limb amputees do have influence on vocation and/or hobbies. Twenty-five percent of the participants were forced to wear their prosthesis less frequently. The low percentage of explained variance (23%) of the model by the identified determinants (gender and number of reported skin problems) may indicate there are other determinants which are of influence on the impacting of skin problems on vocation and/or hobbies in lower limb amputees, but were not assessed in this study. Since the DLQI was adapted, the results of this study can not be compared to previous studies with the DLQI research. The results of this study may give direction to future research to either identify determinants which have an association with the influence of a present skin problem of the amputation stump on vocation and/or hobbies or to assess the extent of the influence of a skin problem. The clinical implication of the score from the regression model has yet to be established.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222013/cg34909

Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3281-456]

Prosthetic Limb Sockets: Replacement of Acrylic Resins, Carbon and Glass Fibres with Vegetable based Materials

Author
Campbell, Andrew (Glasgow UK) | Dr
University of Strathclyde - National Centre for Prosthetics and Orthotics

Coauthors
Kinsman H, Sexton S, Schaschke C, McLaughlin B, Boyle M

Abstract
Manufacturing of prosthetic limbs sockets produces irritant gases and dusts. We are working towards developing a safer composite material derived from plant based resins with a view to subsequent production and ISO testing.

Introduction
Artificial limbs able to meet international testing standards include custom made limb sockets that are currently manufactured globally from resins and fibres derived from petroleum products in a process known as “lamination”. The techniques of artificial limb socket manufacture have not changed in the last 30 years. Problematic by-products of the manufacturing process for acrylic resins, pigments and carbon or glass fibre composites are: gasses that can cause respiratory problems and that require specialist Local Exhaust Ventilation equipment; dusts that can cause skin irritation and that require specialist extraction equipment to be used; and waste off cuts that are not bio-degradable.
Researchers working together from the departments of Prosthetics & Orthotics and Chemical Engineering at the University of Strathclyde, Glasgow, Scotland, United Kingdom are developing a novel composite for prosthetic limb manufacture using plant based materials.

Methods
The project team aimed to address the research question “Can vegetable based materials replace acrylic resins, carbon and glass fibres in prosthetic limb manufacture?” The original idea for the project came about because of an identified need in teaching practice supervising relatively large classes of undergraduate students manufacturing prosthetic limbs. 10% of students developed respiratory problems when using acrylic resins despite meeting all advised safety precautions.
An initial scoping exercise indicated that plant based resins and fibres (most significantly, soya based resins and bamboo fires) were suitable for composite manufacture for the prosthetic socket application. Further to this a range of composites will be manufactured with varying lay-ups to produce a composite material tested at industry standards. During the project a new production method, a vacuum bagging technique, was devised to achieve the desired plant based prosthetic socket.

Results
The first investigation tested whether a composite could be made from vegetable oils adopting a standard fibre lay-up and this proved to be possible. Four acrylic resin sample composites and four bioresin sample composites using comparable stockinette lay-ups and cut to a standard test template were destructively tested for tensile strength. Average results for the acrylic resin sample and for the bioresin sample were similar. The second investigation manufactured a composite from acrylic resin and bamboo cloth fibres

as reinforcement. Again, four acrylic resin and bamboo composite samples were produced. Tensile test results showed that the average bamboo sample test gradient was similar to the other two samples but failed earlier.
A literature review was then conducted to source appropriate biomaterials with a view to identifying suitable materials for the manufacture and testing of a biocomposite in three iterative steps.

Conclusion
Plant based resins and fibres could be adopted for prosthetic socket manufacture in the field of rehabilitation subject to further research and development.
Structures incorporating plant stems, conventionally considered to be more chaotic structures, can offer lightweight alternatives to the usual array of carbon fibre, glass fibre or petroleum based products. The researchers will explore the concept that engineered products must be entirely comprised of perfectly formed component parts, but indicate that targeted production methods are important if the benefits of natural fibres are to be realised.
Recommendations for further research include extending the collaboration between the disciplines of prosthetics and orthotics and chemical engineering to develop and test new materials for the manufacture of prosthetic limbs.

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This research is sponsored by The National Institute for Health Research (NIHR) which provides the framework through which the research staff and research infrastructure of the NHS in England is positioned, maintained and managed as a national research facility. NIHR i4i funding is available throughout the UK. www.nihr.ac.uk

Image: NCPO_biomaterials_icon_high_definition_None.tif (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222013/cg43550

Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3349-524]

Study of Residual Limb/Prosthetic Socket Compliance in Transtibial Amputees

Author
Gard, Steven A. (Chicago, IL US)
Northwestern University Prosthetics Research Laboratory & Rehabilitation Engineering Research Program - Physical Medicine & Rehabilitation, Feinberg School of Medicine

Coauthors
Boutwell EV, Stine RL, Hansen AH, Tucker KA, Gard SA

Abstract
This project investigates the effect of prosthetic gel liner thickness on compliance at the residual limb-prosthetic socket interface, pressure distribution on the residual limb, and selected gait parameters related to shock absorption.

Introduction
Shock absorption during walking is of concern in lower-limb prosthesis users. The loss of anatomical structures due to the amputation affects the body's ability to readily attenuate shock. The implementation of a prosthetic gel liner may increase shock absorption by deforming under body weight, thereby dissipating or absorbing impact forces. This deformation, contributing to system compliance, may help regulate pressure through the residuum (Lin et al., 2004, Silver-Thorn and Childress, 1996). We hypothesized that a thick gel liner would increase compliance at the limb-socket interface and create a more uniform distribution of peak pressure across the residual limb. It was also hypothesized that this increased compliance would allow subjects to walk at a faster self-selected speed and alter other gait parameters, such as ground reaction force profiles and kinematics.

Methods
Persons with a unilateral transtibial amputation participated in two data collections that involved a gait analysis, a loading protocol, and a questionnaire. Subjects were provided with an experimental prosthesis including a 3mm or 9mm gel liner. A gait analysis was performed at self-selected walking speeds while pressure data on the residual limb were monitored in five locations. Next, the subjects participated in a loading protocol; subjects loaded their prosthesis by stepping in place as marker position data and ground reaction forces were recorded. Subjects filled out a questionnaire about the liner, and were then fit with a new prosthesis that included the second of the two liners. Subjects repeated the protocol on this prosthesis two weeks later. Joint kinematics, ground reaction forces, and temporal-spatial data were calculated from the gait analysis; compliance was determined using a linear spring model. Statistical analysis was performed with a 2x3 repeated measures ANOVA.

Results
Eleven subjects participated in this study. Subjects' residual limbs were categorized as bony (n=5), average (n=1), or padded (n=5) based upon residual-limb soft tissue coverage. Subjects with bony residual limbs (BRL) and padded residual limbs (PRL) were analyzed as groups. At greater than 10% of body weight (BW), the 9mm liner displayed a statistically insignificant decrease in stiffness (88.04 N/mm to 80.00 N/mm). BRL subjects experienced a decrease in peak pressure at all analyzed locations with the 9mm liner,

while PRL subjects found a decrease in peak pressure at the fibular head, an increase at the distal tibia, and no change at the patellar tendon with the 9mm liner. The decrease in pressure at the fibular head was significant for all subjects ($p = 0.01$). However, when compared to uniform normal pressure estimates, the 9mm liner created a more uniform distribution of pressure at the limb-socket interface for all subjects. The PRL group experienced a small increase in walking speed ($p = 0.04$) with the 9mm liner, and all subjects had a larger vertical ground reaction force (GRF) weight-acceptance peak on the prosthetic side ($p = 0.02$) with the 9mm liner. No other kinematic or kinetic variables were altered with the thicker gel liner. Questionnaire data indicated that BRL subjects found the 9mm liner much more comfortable than the 3mm liner, while PRL subjects had more divided opinions on the two liners.

Conclusion

Statistical significance was difficult to determine for many variables owing to small sample sizes and high variability between subjects. Despite these limitations, some evidence to support the hypotheses was found. The 9mm liner demonstrated a statistically insignificant decrease in stiffness compared to the 3mm liner at loads greater than 10% BW. We also found that the 9mm liner created a more uniform pressure distribution, as suggested by Lin et al. (2004) and Silver-Thorn and Childress (1996). Finally, although small increases in walking speed and vertical GRF peaks were found with the 9mm liner, no clinically significant changes in gait were observed. Even so, many subjects – mainly in the BRL group – perceived the 9mm liner to be more comfortable. Therefore, a thicker prosthetic gel liner may be suitable for many transtibial amputees with reduced soft tissue on their residual limb, while thicker gel liners may be too hot and bulky for amputees with more residual-limb soft tissue.

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Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3627-686]

Observed Socket Forces During Running

Author
Boone, David (Washington, D.C US)
OrthoCare Innovations

Coauthors
M. Markmiller
A. Pollock

Abstract
With recent developments in technology that provide the ability to observe forces placed on the residual limb, the investigation of how high impact activities will effect these forces becomes possible. Using running as experimental condition and walking as a baseline we collected force data sets.

Introduction
With advancements in prosthetic design, amputees are increasingly accomplishing things that just a few years ago were thought impossible. Perhaps no where is this more visible than with paralympic runners who are desiring to compete with sound body runners. While the technology my have reached a point where these feats are possible we must be keenly aware of the toll that
can be exacted upon the amputees already traumatized body. During high impact activities such as running, the importance of the forces experienced increases for the health of the residual limb, as well as for the fatigue life of the components. It is with this in mind that we under took in an effort to quantify these forces in real world environments. By attaching a dynamic force measurement system to a subject, we were able to observe and record these elusive force values. It was our hypothesis that the torques seen during running
would have greater magnitudes than the average torques seen in non-running prostheses.

Methods
Following the recruitment of a local paraylmpic runner as a single test subject, we integrated a Compas™ alignment system into his standard competition setup. A transtibial amputee who utilizes an Össur Flex-Run™ Sprint Foot, had their standard 4-hole pyramid replaced by a Compas™ Smart Pyramid, which is structurally similar, but contains sensors which
measure the anterior-posterior and medial-lateral torque forces between the socket and foot. To null the effects of misalignment, the limb alignment was verified by multiple prosth, include the subject himself who at the time was finishing his residence, prior to gathering data. A data cord was used to connect the Smart Pyramid to the Compas™ Master unit, which was worn in a fanny-pack rather than directly attached to the limb, to reduce the pendulum effect of the added mass while running. The subject ran on an oval competition track during the experiment. Torque data was recorded from a standing position throughout the first turn on the

Results
Methods: track. The sprint length was approximately 100 meters.
Results: Intuitively, one might expect comparatively large torques between the socket and sprint foot due to the high vertical load forces involved in running (Martin, 2002). This assumption is reinforced by many observed instances of prosthetic limbs failing catastrophically during competitive races.

However, the data recorded in this initial study shows the hypothesis and null-hypothesis to both be invalid.
The Compas™ observed that the vertical axial load values were in fact greater than those for average non-running prostheses; this is somewhat expected as during running downward acceleration is increased thus increasing this force. However, this did not translate into an across the board increase in torque moments. An increase was observed in the forces on the residual limb as the subject makes contact with the ground. This results in higher forces on the distal anterior and proximal posterior portion of the limb.
As the subject rolls through the stance phase the anticipated increased “toe moments” do not arise, in fact they were less than the average torques seen with non-running prostheses. This might be explained by two differences that are inherent in running prostheses. First during running, unlike walking, the greatest loading of the prosthesis occurs as the runner is more near vertically over the portion of the device in contact with the ground. Additionally, and the reason for the first reason is

Conclusion
Results: the effective toe of the sprint foot is essentially much shorter than the standard prosthetic foot. These two combine to result in a reduced lever arm and thus a reduction in moments.
Conclusion:
The results gathered by this initial research, while unexpected, provide us with further insight as to the forces and moments experienced during running. The pursuit of further research studies will be necessary to fully understand the data collected. These studies will need to include multiple subjects utilizing unique component setups. The method used here for measuring dynamic forces may also aid in the alignment of sprint feet for individual athletes.

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Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2987-185]

An Introduction to Methods used for Assessing the Socket Fit in Above Knee, #Below Knee and Knee Disarticulation Prostheses

Author
Fallahian, Nader (Tehran IR) | Full-time Lecturer
University of Social Welfare and Rehabilitation Sciences - Orthotics and Prosthetics

Coauthors
Nader Fallahian
M.Sc. TO, University of social welfare and rehabilitation Sciences
Department of Orthotics and Prosthetics, Tehran, Iran #
Vahid Rashedi
Post Graduate Student in Rehabilitation Management
University of Social welfare and Rehabilitation Sciences

Abstract
This article is aimed to provide a summarized understanding of the methods #used to evaluate the socket fit in lower limb prostheses for prosthetists or #specialists and includes a brief introduction, accuracy, pros and cons and #limitations to each method.#

Introduction
The prosthesis socket, as the human-machine interface, has to be designed #properly to achieve satisfactory load transmission, stability, and efficient control for #mobility and may be of great importance in fitting and fabrication of functional and #comfortable lower-limb prostheses[1]. A comfortable and properly fitted socket #could provide Better compliance with the prostheses, and may improvement of the #quality of life of the lower limb amputees. #
A revolution in trans-tibial prosthetic design began at the end of World War II #with the development of new materials and a dramatic improvement in the #understanding of biomechanics[2]. This knowledge has advanced the science of #socket fitting and provided a better understanding of stump/socket interface #biomechanics0. While some authors tried to use imaging techniques[3, 4], There #have been attempts to quantify the normal/direct stresses at the interface[2] or #changing in the amputee's gait pattern[5].#

Methods
Knee/Trans+Socket+Prosthe* within the Abstract/title/keywords were Searched #primary with EndnoteX2 Program in Web of Science #, PubMed # and #MEDLINE # databases and Google Scholar.#
Articles were selected from Journals:#
Prosthetics and Orthotics International
J. of Prosthetics and Orthotics
Clinical Prosthetics Orthotics
Bulletin of prosthetics research
J. of Rehab. Research and Development
International J. of Rehab. Research
Clinical Rehab.#
Archives of physical medicine and Rehab.#
American J. of physical medicine & Rehab.#

Physical medicine and Rehab. clinics of North America
IEEE Transactions on Rehab. Engineering
IEEE Transactions on neural systems and Rehab. engineering
Clinical Biomechanics
J. of Biomechanics
J. of Biomechanical Engineering
Medical Engineering and Physics
J. of Biomedical Engineering
Medical and Biological Engineering and Computing
Assistive technology
Gait and Posture
famous journals of Orthopedics # and Physical Therapy # and prosthetics #World Congresses.

Results

After reviewing the Articles, an Endnote “enl” format file database including 723 #articles was used to extract data.#
There are Qualitative and Quantitative Methods for assessing the socket fit that #can be classified into: Questionnaires(Pain, Function, Mobility and Performance), #Visual techniques(Observation, Video analysis, Clear or Photo Elastic check #sockets), Imaging Techniques(such as different kinds of Radiography, CT and #MRI), Fluoroscopy and Video fluoroscopy, Ultrasound, Gait analysis, Using #sensors(for Pressure, shear, friction and slippage Measurements)and #investigations on Tissue Responses to Mechanical Loading. Computational(FEA) #Models and CAD/CAM methods are also used to help the prosthetists in clinical #and/or research climates.#
An introduction to the techniques and methods used to assess the lower limb #prosthetic socket are presented. Advantages and disadvantages or limitations to #each method are also discussed. Some of these methods and procedure are also #compared briefly to each other.#

Conclusion

Today there are many different methods for assessing the prosthetic socket fit. #Each method has its own advantages and disadvantage, so it is impossible to #consider a single method as a single feasible and appropriate method for both #laboratory and clinical use.#
Developments has been made that offer clinicians the quantification and #visualization of the interactions within the residual limb and the prosthetic socket.#
Nowadays, such methods are very advanced, but many of them are still limited #to laboratory climate tests. Many of them are designed by the researches for the #survey so knowledge is still limited to laboratories and these procedures are not #commercially available. There are some producers and companies that provide #such devices, but most of them are expensive and may be hard to afford for clinical #assessment.#
There is also little evidence that current computer aided design systems offer #many significant advantages over more conventional techniques[2].#

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222013/cg35040

Session: Lower Limb Prosthetics - Socket
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3039-237]

A Comparitive Study on Transtibial Prosthesis between Sand Casting Technique & Normal Casting Methods

Author
Babbar, Ajay (New Dehli IN)
All India Institute of Medical Sciences, Ansari Nagar, New Dehli - Department of PMR

Coauthors
Singh,U (Dr.)

Abstract
The sand casting system uses the dilatency phenomenon to its best use by fabricating the socket with some material which can be reutilized and the socket/liner too in more accurate,quicker and cost effective way.The time reducing factor is important for a developing country with large no of amputees

Introduction
The sand casting technique was introduce in AIIMS with the objective of reducing the long waiting list for latest/advanced endoskeltal prosthesis for transtibial amputees. The initial training was given by Y.Wu and H casanova of Centre for international rehabilitation at BMVSS New Delhi. The tecnology was implemented speedily in a government hospital and given actuality with machine and equipment installation and relay training/demonstration to staff members. The use of sand casting method instead of plaster of paris bandage and pop filling which create a loss of mess was very much appreciated and liked.

Methods
The patients (old users and new users) were given an option to go for sand casting measurement with the prosthetist finally deciding whether the stump is suitable for sand casting technique. After the final fitting they were asked /clinicaly evaluated about the difference they feel between the old prostheis and the newer one with sand casting technique. Some patients also wanted to change the liners in their old prosthesis and were also given new liners with sand casting in one hour only. They were asked about the time duration, number of visits from long distances they had to made earlier and effictiveness of fabricating immediately in their presence with the end result in one to two hours.

Results
The result was patient satisfaction in reduced time of fabrication , less no of visit to the centre/ hospital , more scientific and accurate fitting and less messy and cleaner way of fabrication in Prosthetist / orhotist point of view and finally the cost effectiveness and reuseability of material.

Conclusion
The sand casting methodology is a more scientific accurate and cost effective system with highly reduced time period for transtibial prosthetic socket fabrication though it can put a little bit of pressure on the prosthetist to complete the procedure in small time frame (there is no going back) one has to start all over again if there is a system failure due to bag leakage or without continous vaccum due to electrical failure.

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Image: 24082009059_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222013/cg35441

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3615-None]

Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management

Session Chair
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Session Chair
Hagberg, Kerstin (Göteborg SE) | PhD
Sahlgrenska University Hospital - Dep. for Prothestics and Orthotics, Centre of Orthopaedic Osseointegration

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008

Symposium: Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3729-761]

OPRA Rehabilitation Protocol and Outcome of Transfemoral Osseointegration in Sweden

Author
Hagberg, Kerstin (Göteborg SE) | PhD
Sahlgrenska University Hospital - Dep. for Prothestics and Orthotics, Centre of Orthopaedic Osseointegration

Abstract
Patients treated with OI-prostheses report significantly increased amount of prosthetic use. At 2-years follow-up 93% used the OI-prosthesis.

Introduction
Treatment with osseointegrated transfemoral prostheses (OI-prosthesis) has been performed in Sweden since 1990. It comprises two surgery sessions (S1 and S2) and rehabilitation. Patients treated during the first couple of years did not follow any specified training. A treatment protocol named OPRA (Osseointegrated Prostheses for the Rehabilitation of Amputees) was developed during the subsequent years and has been followed since 1999. It is differentiated into two slightly different rehabilitation protocols; the normal speed- and the half speed protocol. The half speed protocol has been developed for patients with poorer skeleton conditions. The aim of both is to gradually increase the loading of the bone/implant to prepare for unrestricted use of the artificial limb.
Also in 1999 a prospective study (the OPRA study) was started with the aim to report outcome at 2-years follow-up. The OPRA study includes a total of 55 implants on 51 patients, with 4 patients treated bilaterally.

Methods
The specific training is started 6 weeks after S2. The normal speed protocol includes about 6 weeks of gradually increased weight-bearing training on a knee-level short training prosthesis before use of the OI-prosthesis is started. During the first 3 months walking should be done supported by crutches. Pain during weight-bearing can be a sign of overload and should be avoided. Pain registration is performed using the Visual Analog Pain Scale (VAS 0-10) and the patient is instructed to not perform activities perceived as pain above VAS 4-5.
The OPRA study includes assessments performed prior to S1 and until 2 years after S2, such as radiography, registration of complications, hip range of motion, energy cost, computerized gait analyses and health-related quality of life. One self reported outcome is the Prosthetic Use Score (0-100) in which 0 means not using prosthesis at all and 100 means using the prosthesis 7 days/week >15 hours/day.

Results
In December 2009 42 (21 male, 21 female, mean age at inclusion 44 years (Sd 12,9), cause of amputation; 26 trauma, 12 tumour, 4 other) of the 51 patients included in the OPRA study had been followed until 2 years after S2. Among the 42 patients 35 had a unilateral transfemoral amputation (6 bilateral transfemoral, 1 transfemoral and transtibial).
Preoperatively 17% (7/42) did not use any prosthesis at all and 60% (25/42) used a prosthesis on a daily basis. At 2-years follow-up 7% (3/42) did not use a prosthesis at all and 87% (36/42) used the OI-prosthesis on daily basis. The Prosthetic Use Score was improved from a mean of 47 (Sd 38) score points preoperatively to 80 (Sd 26) score points at 2-years follow-up ($p<0.000$). A Prosthetic Use Score of 100 was

reported among 40% using OI-prostheses as compared to 12% using a conventional socket prosthesis at inclusion.

Conclusion

Those preliminary results from the OPRA study indicate that the treatment with transfemoral OI-prostheses performed in Sweden significantly increase the amount of prosthetic use. At 2-years follow-up 93% used the OI-prosthesis and 40% reported to wear the prosthesis more than 15 hours every day. Complete results will be reported during 2010 as soon as all included patients have been followed for 2 years.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008/cg292851

Symposium: Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3811-780]

Rehabilitation and Outcome of Upper Extremity with Bone Anchored Prostheses in Sweden

Author
Winterberger, Kerstin Caine (Göteborg SE)
Sahlgrenska University Hospital - Upper Limb Rehabilitation Center

Coauthors
Jönsson S, Brånemark R

Abstract
Twenty years of experience of bone ancored upper-limb prosthesis indicate improved functionality due to the increased motion in the shoulder and elbow joints for short transhumeral and transradial level and improved gripfunction for thumb level. Patients state better quality of life and increased daily use of prosthetic device compaired with previous conventional prostheses. For thumb amputation there is no good prosthetic alternative.

Introduction
A titanium fixture was implanted for the first time for below-elbow amputation by Per-Ingvar Brånemark. The penetrating abutment in radius and ulna were used to attach a prosthesis after a two stage operation.The method has also successfully been used for transhumeral- and thumb amputation to anchor prostheses. After the first operation the patient is instructed to move the limb in a pain-free range-of-motion and six weeks postoperatively the patient can do strengthening exercises of the shoulder, back, chest and upper arm muscles. When the oedema is reduced, the patient can wear the previous prosthesis. After six months the second operation is performed and a skin penetrating abutment is connected to the fixture. A few days later the patient is instructed to carefully move the limb in a painfree range-of-motion. Approximately 3 weeks after operation weight loading is started by pressing and loading using a short training prosthesis. A cosmetic prosthesis can be attached to the abutment by a special device af

Methods
All users with bone-ancored upper limb prostheses were given a questionnaire at a clinical follow-up. The patients must have been prosthetic users for a minimum of one year. There were 11 patients at transhumeral level, 9 at transradial level and 5 thumb amputations, totally 25 patients. Four were female and 21 male with age ranging from 24 to 77 years of age. One patient is a bilateral amputee and presented as two cases and one patient could not be reached for follow-up. Four patients were none users and were excluded.

Results
Overall function has improved in 84 percent and 88 percent state increased quality of life. Range-of-motion has improved in 84 percent and 72 percent use the prosthesis more than 8 hours daily. Eighty-four percent state that they have better sensation with the bone anchored prosthesis than with the previous situation.

Conclusion

The patients indicate improved functionality, full freedom in proximal joints as no harness is used, higher comfort as no socket is needed, easy to don/doff, improved sensibility due to osseo-perception and higher quality of life.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008/cg491553

Symposium: Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3730-886]

Rehabilitation and Outcome of Endo-Exo-Femurprostheses in Lübeck

Author
Hoffmeister, Thomas (Lübeck DE)
Sana Kliniken Lübeck GmbH - Klinik für Hand- und plastische Chirurgie

Abstract
Since 1999 40 patients in Lübeck have been treated with EEFP. The results of a retrospective study including 20 patients using the EEFP for one year or longer show a significantly increased mobility level and quality of life as well as less problems in everyday use.

Introduction
The bone anchored Endo-Exo-Femurprosthesis (EEFP) for above knee amputees has been implanted in Lübeck since 1999, most of them within the last 5 years. Meanwhile the prosthesis is generally implanted in two steps, being followed by the rehabilitation process. Because of the variety of collateral injuries there exists currently no sole rehabilitation protocol. In 2009 we run a retrospective study to control the outcome of our previously treated patients.

Methods
We included 27 patients that were provided with an EEFP for at least one year, of which 20 patients took part in the study by now. We developed two questionnaires (one before EEFP-treatment, another as follow up) and asked for data about general prosthetic use, complications, pain, mobility and quality of life.

Results
After treatment with EEFP we found a significant increase of patients mobility concerning various life situations. The everyday use improved. Pain frequency as well as intensity decreased. Satisfaction with the prosthesis and subjective rating of flexibility, activity, walking ability, expenditure of energy, sense of balance, self-respect and life quality grew.

Conclusion
Treatment with the EEFP certainly enhances life quality as well as the grade of mobility of the patients that where supplied with the EEFP in Lübeck. The 7 “missing” patients of our study can hopefully be convinced to take part in the study in order to receive the complete data. The study continues as a prospective study with preferably all upcoming patients provided with EEFP to reach a higher evidence level of results.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008/cg293012

Symposium: Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3996-888]

Complications and Problem Solving Including Studies in Lübeck

Author
Clausen, Astrid (Lübeck DE) | Dr. med.
Unfallchirurgie SANA Kliniken Lübeck GmbH

Abstract
Complications and number of remedial treatment could be reduced by changing the prosthesis design.

Introduction
Rehabilitation of transfemoral knee amputated people with the EEFP is practiced in Lübeck, Germany since 1999. In Sana Hospital Lübeck Dr. Aschoff started with this treatment in 2003 and he and his team are keeping a continuous watch up to now over 42 patients and 44 implants. To alleviate analysis and evaluation a databank was created in 2009. According to experiences and results the design of the implant was changed and the treatment modified.

Methods
From our 42 patients 40 suffered with transfemoral amputation, 2 of them bilateral and 2 patients with transtibial amputation. Predominant reason for amputation is trauma in 32 cases, tumour in 5 and 5 cases with other problems like septic knee replacement or vascular disease.
All in all we could count 185 surgical procedures. This number includes the two steps of regular treatment, remedial treatment of irritation or infection of the stoma or adjacent tissue, implant failure, stabilization of fractures and mostly harmless problems with the external components.
According to special experiences with components and assemblies we changed the design of the stem, bracket and external modules, particularly with regards to the allocation of the special surface. We also classified stem and bracket in special types of design.
Balancing benefit and risks we decided to abstain from using the bracket since May 2009 subjected to the condition that the diameter of the stem is greater than 16 mm.
As agreed with othe

Results
We could show that the number of patients which needed remedial treatments diminished relating to the stem. The bracket, which enlarges the secreting cavity behind the stoma is still a focal point. We couldn’t find a significant correlation between the bracket types and number of complications.
9 patients had early infections, 10 late infections but the rate of severe infections is small. Three times we had to remove the EEFP, once due to material fatigue, once due to septic loosening and once due to necrosis of the distal part of the bone under the bracket. We needed a great many of remedial treatments, but the incidents often were trifle.
We also could show with smear tests that bacterial colonization of the moist stoma-ambience is unavoidable and there is no correlation between type of colonization and tissue-infection. We learned from our surveillance, that disinfection and medical treatment of the bacterial colonization is counterproductive.

Conclusion
The evidence our studies is lessened due to the fact that half of our patients have been operated on in the last two years. We have to continue the prospective surveillance and assess further results critically. We

still have problems with the bracket and soft-tissue, but we are working on reducing them. And almost all of our patients cherish the advantages of this special form of rehabilitation.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008/cg1887315

Symposium: Osseointegration Technique - Rehabilitation, Long-Term Results, Complication Management
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3732-819]

Dealing with Complications and Long Term Results

Author
Branemark, Rickard (Göteborg SE) | MD PhD
Sahlgrenska University Hospital - Centre of Orthopaedic Oesseointegration, Dept. Orthopaedics

Abstract
This presentation will report on how to deal with complications when using bone anchored amputation prostheses as well as report on the long term results from the experience with this treatment since 1990

Introduction
Treatment with osseointegrated transfemoral prostheses (OI-prosthesis) has been performed in Sweden since 1990. It comprises two surgery sessions (S1 and S2) and rehabilitation. Patients treated during the first couple of years did not follow any specified training. A treatment protocol named OPRA (Osseointegrated Prostheses for the Rehabilitation of Amputees) was developed during the subsequent years and has been followed since 1999.

Results
Complications can be soft tissue or hard tissue related as well as implant related. Soft tissue complications can be handled using ordinary surgical principles, but hard tissue complications and implant related complications require special attention. Experience from dealing with complications will be reported. No long term studies are completed, but preliminary resultr from the since 1999 ongoing OPRA study will be reported. As of December 2009, 42 (21 male, 21 female, mean age at inclusion 44 years (Sd 12,9), cause of amputation; 26 trauma, 12 tumour, 4 other) of the 51 patients included in the OPRA study had been followed until 2 years after S2. Among the 42 patients 35 had a unilateral transfemoral amputation (6 bilateral transfemoral, 1 transfemoral and transtibial). Of these 42 patients 4 have had there implants removed due to loosening and or deep infection.

Conclusion
Most complications can be handled without the removal of the implant . Preliminary long term results will be presented as well as an update from the ongoing prospective study.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg102008/cg293334

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3772-None]

Life Long Learning in the OT Business, Needs, Musts and Ways to Improve

Session Chair
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Session Chair
Hasenpusch, Michael (Duderstadt DE) | Dr. Ing.
Otto Bock HealthCare GmbH

Abstract
Idea of this symposium is to discuss what has to be done to ensure a continuous life long learning of practitioners and technicians to be able to provide best treatment of customers with the right products. What can we do to make continuous learning attractive? Which are the right methods? Are there differences between emerging and developed countries?

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg398325

Symposium: Life Long Learning in the OT Business, Needs, Musts and Ways to Improve
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Education

Congress Lecture [3774-742]

The Need of (Further) Education And the Way of Otto Bock. Education as Part of the Company Business Strategy

Author
Näder, Hans-Georg (Duderstadt DE) | Prof.
Otto Bock HealthCare GmbH

Introduction
Rapidly evolving advanced fitting techniques and high-tech products in the OT business require specific expert knowledge. Thus continuing education becomes crucial for orthopaedic technicians to keep their Know how up-to-date in order to ensure best patient treatment. Hence training and support of education is an integrated part of the business strategy of Otto Bock and will become even more important for the whole industry in future.

Methods
This will be exemplified by approaches of Otto Bock in emerging markets which are often lacking infrastructures for education and further training and consequently suffer by inappropriate quality standards. New approaches of know how transfer to increase the level of current fitting practices and to ensure high-quality treatment are shown. The development of innovative technologies and state-of-the-art fitting techniques has to go hand in hand with training and education concepts to prepare orthopaedic technicians for the increasing challenges in the course of the treatment process.

Results
In cooperation with ISPO and local institutions the OT industry has to support the establishment of sustainable high-class infrastructures for know how transfer. Only by a joined effort comprehensive access to education and training can be ensured and international orthopaedic treatment standards can be aligned.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg398325/cg401639

Symposium: Life Long Learning in the OT Business, Needs, Musts and Ways to Improve
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Education

Congress Lecture [4085-None]

New Study Course "Orthobionic" at PFH Private University of Applied Sciences Goettingen

Author
Albe, Frank (Göttingen DE) | Prof. Dr.
Private Fachhochschule Göttingen

Author
Blumentritt, Siegmar (Duderstadt DE) | Prof. Dr.
Otto Bock HealthCare GmbH - Research

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg398325/cg2961470

Symposium: Life Long Learning in the OT Business, Needs, Musts and Ways to Improve
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Education

Congress Lecture [3776-744]

ISPO Level 2 Exam Preparation, Example Germany

Author
Becker, Karl (Duderstadt DE)
Otto Bock HealthCare GmbH

Introduction
The first ISPO Level II examination in Germany as a pilot project with the aim of adapting the national apprentices final examination in the German orthopaedic technology trade to an international standard is presented. Within the scope of globalisation, this is of great importance especially for the trade, the industry and the ISPO.

Methods
The aim is to set an international standard for skilled workers and journeymen in order to ensure international recognition on national level.
The individual steps from the first idea in 2007 and the discussions with national and international committees to the realisation at the beginning of 2010 are shown.
A summary of the pilot project is given and the perspectives for international education in orthopaedic technology are described.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg398325/cg402193

Symposium: Life Long Learning in the OT Business, Needs, Musts and Ways to Improve
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Education

Congress Lecture [3775-743]

New Ways of Training Development and Train the Trainer Approaches

Author
Hehn, Roland (Duderstadt DE)
Otto Bock HealthCare GmbH

Introduction
The importance of training in the OT business suggests the conclusion that we have to put the same emphasis in our training as in our products. The need for a high-quality delivery leads to the question if training is a product itself.

Methods
Trainings in the OT business are very often run by trainers or teachers with excellent product or treatment skills. This ensures a high quality of the content. Often these trainers are less experienced in methods and didactics. Consequential the learning targets of the trainings are not optimal imparted. The interactive use of media and other methods has to become integrated part of the training.
Hence standards and guidelines have to be developed to best support the trainer in the delivery of the content and to ensure the high quality of the training.
Trainer guidelines structure the training process by providing learning targets, methods and scheduling. Additionally they ease the preparation of the training by providing further information such as target group, number of participants and required material. Train-the-trainer concepts are required to impart the knowledge on the development of trainer guidelines and how training can be delivered professionally. Trainer guidelines are an effective w

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Symposium: Life Long Learning in the OT Business, Needs, Musts and Ways to Improve
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Education

Congress Lecture [3947-835]

The Development of a Public Private Partnership in Education: an ISPO perspective

Author
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Abstract
The importance of collaboration within the field of Prosthetics and Orthotics is critical for the long term development of the field and to ensure that services for those we serve is at a high level in terms of quality and standards. Due to the ever changing and evolving nature of our field and demands on practitioners, it is critical that there is a focus around the importance of education and “life long learning” for professionals. In turn, it follows that we must collectively work together to develop collaborative partnerships in education as a means to support this objective.

Introduction
Due to the ever changing and evolving nature of our field and demands on practitioners, it is critical that there is a focus around the importance of education and “life long learning” for professionals. In turn, it follows that we must collectively work together to develop collaborative partnerships in education as a means to support this objective.
The importance of collaboration within the field of Prosthetics and Orthotics is critical for the long term development of the field and to ensure that services for those we serve is at a high level in terms of quality and standards. The team of professionals and partners involved in this professional field is relatively small and specialized, only hi-lighting the need for more collaborative efforts and partnerships. Additionally, with the ever increasing changes in our field and the demands on professionals to keep their knowledge and skills current, the importance of collaborating and forming partnerships in the area education is a critical issue.

Results
Since the turn of the century, there are ever increasing demands on the professionals involved in delivering Prosthetic and Orthotic to practice in a more accountable way, to substantiate treatment protocols, to stay abreast of advancing methodologies and techniques of treatment, and to stay current with the surge of new technologies emerging. These factors alone bring increasing demands on the professions involved in our field to continually evolve professional standards within a dynamic and changing practice environment. More importantly, it puts much pressure on the “entry level to practice” education to stay current and relevant and also demands that the practitioner in the field is able to access necessary information and educational opportunities to stay current.
For this reason, the importance of collaborating and pooling our collective resources together and forming partnerships in the area of education cannot be overstated. There must be collective support by all stakeholders for both the undergraduate professional programs and probably more importantly for the front line professional who must maintain a professional standard in this demanding environment.
Movement to develop educational based partnerships not only between educational institutions, professional associations and societies, government agencies and alike is very important but there must be more creativity and open thinking about also forming more public/private partnerships in this area.

Conclusion

This specifically applies to our leading industry partners who have similar interests in ensuring professionals that implement their technologies are well trained and competent.

Following the previous discussion, it is only logical that we work towards developing such partnerships as it is only in our best interests to do so.

In addition, more details will be given on the developing public-private partnership in education that the International Society for Prosthetics and Orthotics is promoting and partaking in.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg398325/cg1011242

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3680-None]

Foot & Shoe - Sports

Session Chair
Peikenkamp, Klaus (Steinfurt DE) | Prof. Dr.
Fachhochschule Münster - FB Physikalische Technik, Abt. Biomechanik

Session Chair
Massen, Robert (Stuttgart DE) | Prof. Dr. Ing.
corpus.e AG - R&D

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg231734

Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3338-513]

Influence of Custom-Moulded Footorthoses (NFO) with Neuromuscular Operating Elements on Muscle Activity – a Randomized Control Study

Author
Stief, Thomas (Steinfurt DE) | Dipl.-Ing. (FH)
FH-Muenster - Labor für Biomechanik und Biosignaltechnik

Coauthors
Peikenkamp K, Wagner H, Duvillard F, Furnier B

Abstract
NFO are controversially discussed and still not evaluated. In contrast to recent studies we are interested in muscular activation. Based on the detected effects, a better understanding and an individual treatment of NFO should be resulting in increasing benefit for patients.

Introduction
Bourdiol developed in the 70s an insole concept by which the human posture should be changed positively by influencing the plantar foot sensibility with special elements on flat insoles. These NFO are used to treat posture ailment of the whole human locomotor system, whereas mechanically operating Footorthoses (MFO) focus on orthopedic foot problems. Several scientific studies validated the effects of CUSTOM MOULDED Footorthoses (CFO), a special kind of MFO. But there is no proof of long-term effects and the sustainability of the MFO. NFO are still controversially discussed due to the missing scientific background. Research topics of a majority of studies were the influences of the insoles during upright standing. This analysis is going to test orthopedic insoles, which combine mechanically and neuromuscular operating factors (NCFO). The following question has to be answered: Is there an influence of the NCFO on the activation of the muscle chains?

Methods
In this longitudinal randomized controlled study 50 individuals (6 till now, age 35±2,4 yr) with hypotonic posture and pain in the lumbar region will participate in this study. The used NCFO (OPCT Tonic 01, SIDAS; figure 1) were built by one of the authors. Myoelectric signals of 24 muscles at the lower limb and trunk were recorded with EMG (Biovision, 2000 Hz). All cycles were performed on a treadmill (Callis Ortho, Sprintex) by using subjects own shoes with two conditions (NMFO and control). Subjects walk at their favored speed (range 3,5-5,0 km/h). IEMG during stance phase of 50 steps was analyzed for each condition. The following muscle chains were considered: flexion chain (GAM), extension chain (GPM), internal rotation chain (KAM) and the external rotation chain (GPM) were focused. The IEMG of the control conditions were normalized to 100 % and the IEMG of NCFO were related to the control condition.

Results
The IEMG of the GAM (figure 1: GAM_inhib.), which should be inhibited, decreases from 100 % ± 11 % to 92 % ±7 %. Simultaneous the activation of the GPM (GPM_activ.), which should be activated, increases from 100 % ± 14 % to 124 % ± 9 %. The IEMG of the KAM_inhib. is reduced from 100 % ± 11 % to 97 % ± 14 %. The IEMG of the KPM_activ. raises from 100 % ± 9 % to 112 % ± 12 %. The activity of

the GAM_activ does not increase it decreases from 100 % ± 13 % to 97 % ± 11 % and the IEMG of the GPM_inhib. decreases from 100 % ± 17 % to 96 % ± 8 %.

Conclusion

The aim of this study was to evaluate the influences of the NCFO on the activation of the analyzed muscle chains. IEMG of the GAM_inhib. could be reduced (figure 1), as it is suggested in the NFO concepts. But there are some individual variations, the deviation was between 7 % and 11 %. Influences on the GAM_activ., GPM_inhib., KAM_inhib. and KPM_activ. were quite low compared to the relatively high deviations. The increase at the GPM_activ. can be interpreted as an activation. Neuromuscular operating elements behind the metatarsal heads had the postulated influence on the activity of the muscle chains. So we can deduce that there is a different activation of the muscle chains caused on the NCFO. Until the congress in Leipzig there will be further interesting parameters, more representative results and evidence to these insoles, caused by a bigger investigational group and conclusions for practical use of the NCFO should be possible.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg231734/cg43911

Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3562-659]

The Influence of Different Sports Shoes on the Pronation and Pressure Distribution under the Foot

Author
Vertommen, Helga (Geel BE)
K.H. Kempen University College - MOBILAB Health Care and Chemistry Department

Coauthors
Dewindt W., Bukenbergs S., Sevit R., Peeraer L.

Abstract
This project evaluates the influence of shoe type on the unroll of the foot by measuring kinematics and the pressure distribution under the foot during barefoot running and wearing 5 different types of sports shoes.

Introduction
Over 2.5 Billion pair of shoes are sold in Europe annually. A justified selection of shoes, based on static and dynamic shoe properties and taking into account the intentional utilization is essential: inappropriate shoes lead to an increased risk of (stress) injuries.
Earlier studies revealed a correlation between the human foot unroll including the pressure distribution under the foot and the risk of injuries.
Today different types of sports shoes claim to influence the unroll of the foot and are commercially available. For example anti-pronation shoes should reduce excessive pronation and related injuries.
In this study the influence of shoe type on the unroll of and the pressure distribution under the foot was determined by comparing these measurements with barefoot measurements of the same subjects. In second order, this study verifies if these results are subject dependant or can be generalized.

Methods
Subjects: 20 healthy adult male participants were randomly selected and gave written informed consent.
Apparatus: Pressure data gathered making use of a RS Scan 1m pressure plate. An AMTI force plate (1000 Hz) is placed under the 1m pressure plate. Kinematic data are collected using a Codamotion system with 2 CX1 cameras and active markers, sampling at 200 Hz. Furthermore the measurements are captured with a high speed video camera(120 Hz).
Procedures: Active markers are attached on both legs and shoes following a predefined and validated marker setup. This configuration allows amongst others to measure a and ß angles (see fig 1). Participants are asked to run across a 21,5m Tartan track. Data are collected during 6 series of 12 measurements. The first series is effectuated running barefoot (reference). The next series concern 5 types of shoes of different brands.
Data Analysis: Kinematic and pressure data, including the a and ß angle and angular velocity, were collected and averaged.

Results
First results show a significant effect between running with sports shoes and barefoot at the level of damping. As expected, the sports shoes increase the damping.
The a and ß angle were used to characterize the unroll of the foot during running and are influenced by the type of shoe. Strong variations in angular speed could provoke sports injuries. Until today few researchers

spent effort on the correlation between those angles and shoe parameters, sports injuries and the unroll of the foot. The first results of this study show that shoe types influence the unroll of the foot. There is a decrease of maximum a angle variation during the landing phase by running with shoes compared to running barefoot and the a acceleration during running with shoes is decreased.
Final data collection and processing is currently underway. Results will be reported.

Conclusion
The significance of the results will be increased by measuring a larger group of test persons. The influence of diverse shoe construction parameters on the unroll of the foot will be investigated .

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Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2871-71]

Results of an Evidence-based Orthotic Supply System for Reducing Pain Caused by Chronic Overuse Injuries of Athletes

Author
Lang, Sarah (Fulda DE) | Sportwissenschaftlerin M.A.
IETEC Akademie - Forschung & Entwicklung

Coauthors
Bauer H

Abstract
A successful and long-ranging reduction of chronic overuse injuries, can be guaranteed by the evidence-based orthotic supply system of “movecontrol” which is predicated on the prospective studies of Dr. phil. Heiner Baur & Prof. Dr. med. Frank Meyer (University of Potsdam, Center of sports medicine.

Introduction
The increase in leisure activities, as for example marathon and triathlon, has become more important over the past years. Thus, it is not surprising, that more and more people complain of typical overuse injuries that are dependent upon stress. According to MOVECONTROL, the evidence-based supply system contains an accurately defined standard, after which many athletes with chronic overuse injuries were already treated successfully. Besides the classical video recording, the 2-D-Scan and foam imprint as well as the intensive anamnesis of the customers, the inspection plus the palpation of the lower limb is paid high attention to. Furthermore, depending on the clinical presentations, about 22 functional tests in sports medicine are made. All the results of the 7 sub-steps are incorporated into the conception of the orthotics. The customised polyurethane sports shoe orthoses depends on the weight and the standard of proficiency of the customer and is individually modulated to ones foot.

Methods
The supply system according to "movecontrol" includes a well structured process. Besides the exact definition on the content – 2-D-Scan & foam imprint, anamnesis, palpation & inspection, functional tests, marking the customers with 32 dots as well as the biomechanical motion analysis of 4 different camera perspectives - the order of these components are clearly defined. The supply of orthotics is based upon the prospective studies of Dr. phil. Heiner Baur et. al. of the "Center of sports medicine, University of Potsdam". To be able to guarantee an equivalent high supply of orthotic insoles Europe-wide, the education as “movecontrol-motion analyser” takes place in terms of a series of seminars which are based on each other. The education consists of 5 compulsory seminars but can be immersed by additional qualification seminars. This established supply system is certified according to the IQZ-credits and is under a continuous quality management process.

Results
Nearly 200000 athletics were treated by movecontrol. Based on the prospective studies of Dr. phil. Heiner Baur and Prof. Dr. med. Frank Meyer, it could be proved that the functional-dynamic movecontrol-insoles can achieve a statistical significant reduction of pain within the therapy of running-related overuse injuries (4-week rehabilitation period; $p<0.05$). The insoles are an effective conservative therapy strategy for chronic injuries with high comfort and acceptance of injured athletes. The custom-made movecontrol

insoles affect a medial increase of pressure at the length arch. This triggers a reflationary effect on the muscular activity of the M. Peroneus longus. The early and intensive activation of the M. Peroneus longus can lead to a clear reduction of pain. An extensive multidimensional supply system that regards the “functional flexibility” of the patient and the results of the biomechanical motion analysis is necessary because the supply of insoles can only be optimal if the “muscular activity” is considered as well. A long-term reduction of the pain respectively elimination can only be guaranteed if this aspect is also incorporated into the construction of the insoles and the conservative treatment that will follow. With this multidimensional supply system undesirable training break can be reduced due to acute medical conditions.

Conclusion

The long standing success of “movecontrol” shows, that a successful supply must be scheduled individually, interdisciplinary and holistically. To achieve a long-ranging successful therapy, more needs to be done than only to analyze the kinematics of the lower limb on the treadmill. The inspection of the muscular activity has an equal standing, which can provide important information according to the “functional flexibility” of the patient, already before the real biomechanical motion analysis. The channel of supply of movecontrol contains an insignificant additional expense compared only to motion analysis. But only thus, one can precisely and individually treat a patient successfully with its custom-made and functional-dynamic insoles. Geared to long-term profitability, frequent overuse injuries that are based on running can be reduced.

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Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3475-650]

Mechanical and Biomechanical Comparison of a Bonded and a Vulcanized Insole for Running Shoes

Author
Peikenkamp, Klaus (Steinfurt DE) | Prof. Dr.
Fachhochschule Münster - FB Physikalische Technik, Abt. Biomechanik

Coauthors
Benkhoff U, Möller M

Abstract
A multifactor comparison between a bonded and vulcanized insole for jogging was performed in this case study. After using 470 km the vulcanized insole shows (i) a reduced asymmetry in mean pressure, (ii) no reduced thickness and (iii) a lower density compared to the bonded version in the heel area.

Introduction
There are several testing procedures to analyze the effectiveness of insoles or material for insoles with respect to running shoes. These designs usually consider thermal, mechanical, or biomechanical properties of the tested probe. However, the shoe-athlete-interaction is very complex which often leads to inconsistent results between mechanical and biomechanical test-designs (Nigg 2001, Nigg & Wakeling 2001). These problems hinder to apply the results of different studies to practice.

Methods
One pair of insoles was manufactured for an experienced jogger. Both insoles were constructed in the same way except the fact that for one of them the different layers were bonded and for the other vulcanized. This paper will focus on the heel region which consisted of one soft upper layer and one hard lower layer. At the beginning (M1) both insoles were tested by x-ray to achieve infomation about the density, by thickness-measurements of each layer and by pressure distribution measurement during running. All measuring procedures were repeated after 6 weeks and a total running distance of 470 km (M2). The following parameters were analyzed for both insoles: Thickness of the upper and lower layer, the grey-value as an indicator for the materials density and the mean pressure under the heel during the stance phase of running. A low grey-value indicates a material of high density, a high value represents a low-density material. Additionally, the jogger gave his subjective comparison.

Results
For the bonded insole the thickness of the upper layer decreases from 4.1 mm (M1) to 2.1 mm (M2) after 470 km. The thickness of the lower layer remains almost constant when comparing M1 (2.1 mm) with M2 (2.0 mm). Furthermore, the grey-value obtained by the x-ray measurements increases about 8% for the upper material. The corresponding value for the harder lower material remains almost constant. For the vulcanized insole the parameters mentioned above hardly change after the use for 470 km. Both thickness and grey-value differ less than 1% when comparing M1 with M2.
The figure shows that for the bonded insole the mean heel pressure remains almost constant when comparing M1 (8.9 N/cm²) with M2 (9.0 N/cm²). Mean heel pressure is reduced wearing the vulcanized insole for both measurement M1 (7.8 N/cm²) and measurement M2 (8.3 N/cm²). Therefore, mean heel

pressure under the vulcanized insole is 12% lower at the beginning (M1) and 8% lower after the use for 470 km jogging (M2) compared with the bonded insole.
The jogger himself stated that from his subjective point of view the comfort during running does not differ between both insoles.

Conclusion

Although the thickness of the insoles heel pad is reduced at M2 when using the bonded version the x-ray measurements does not show the expected result which is an increase in the density. This could be due to a change of the molecular structure of the upper layer during use induced by salting humidity as a result of sweatening. Perhaps these changes lead to the effect that the mean heel pressure under the bonded insole remains almost constant between M1 and M2 despite the reduced thickness. The lower mean pressure for the vulcanized insole could be either the result of the vulcanisation or an asymmetrical initial contact of the jogger between both feet. However, the vulcanized insole seems to reduce this asymmetry when using it over a certain period.
The results clarify that the only use of mechanical tests and / or subjects feedback does not allow to draw conclusions with respect to the mechanical load acting on the athlete but a combination with biomechanical tests is indispensable

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Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3435-610]

Changes in Ground Reaction Force and Pressure Distribution during the First Four Weeks of Wearing MBT-Shoes

Author
Müller, Stephan (DE) | Dipl.-Ing. (FH)
FH-Münster - Labor für Biomechanik

Coauthors
Natrup J, Peikenkamp K, Möller M

Abstract
In load response the MBT-shoe causes pressure shifting from the heel to the midfoot, it hampers forward motion and prevents damping of plantarflexion.
This increases impulse, forcerate und force maximum, respectively. The curved sole decreases the pressure in the forefoot area.

Introduction
According to the manufacturer the MBT-shoe imitates walking on soft, uneven, natural ground and causes an instability, which has to be compensated by active muscle work. Therefore, the MBT-shoe strengthens the leg and trunk muscles which improves the posture. The most important parts of the sole are the soft Masai sensor under the heel, the hard balance area under the midfoot and the curved polyurethane sole. This provokes an active overcome the balance area´s vertex [2]. The front area of the polyurethane sole is curved in order to ease up rolling the forefoot. The instability is caused by a soft buffer under the heel, the “Masai Sensor”. The consequence may cause in a decrease of typical diseases of civilization like backpain. During walking with MBT-shoes the load of the knee and the hip joint is reduced, too.
The goal of the study is to investigate the gait parameters with MBT-shoes, which are the pressure, the ground reaction force, the force rate and the impulse, respectively

Methods
The average and the maximum pressure [N/cm²] was determined using the pressure measurement system GP Mobil Data by GeBioM. The foot is divided into six areas: the heel, the midfoot, three ball areas (medial/ middle/lateral) and the toes. Furthermore, the parameters force [N], force rate [kN/s] and impulse [Ns] were determined. 15 subjects voluntered for the study (8 female, 7 male, average age 43 ± 19.5). The volunteers had no injuries in the lower extremities during the year before and never weared MBT-Shoes before.
Four measurements were taken under different conditions. The first was a barefoot measurement as a reference, followed by a first measurement in the MBT-shoes, both during walking. The measurement was repeated after one week and after four weeks of wearing MBT. Under each condition ten repeated measurements over five meter distance were taken. The volunteers wore the MBT daily and kept a time protocol.
Statistics included univariate repeated measures ANOVAs ($p < 0.05$).

Results
Compared to the barefoot measurement the MBT-shoe shows a significant increase of the impulse, the force rate and the first peak, respectively. Within four weeks of wearing MBT, the value of these parameters decrease continuously, but it does not reach the level of the barefoot values.

Furthermore, the MBT-shoes decrease the maximum and the average pressure at the heel and at the forefoot. Under the midfoot, there is a significant increase of the average pressure. The maximum pressure has the same tendency, but this effect is not significant. Within the three measurements wearing the MBT, the maximum and the average pressure decreased in all foot areas except the midfoot.

Conclusion

At initial contact the heel sinks into the soft Masai sensor and the midfoot rests on the stiff balance area of the MBT-shoe which limitates plantarflexion to a minimum [2]. This eliminates the damping effect of plantarflexion [3] and hampers the forward motion. Both observations result in an increase of the impulse, the force rate und the force maximum, respectively. At load response the heel sank into the Masai Sensor and the stiff balance area of the polyurethane sole generates a resistance under the midfoot. This causes a pressure shifting from the heel to the midfoot. Furthermore, the curved polyurethane sole decreases the pressure in the forefoot area [1].

The measurements after one and after four weeks show that there is a decrease of almost all load parameters during adaptation to the MBT-shoe. This may be caused by better trained leg muscles and and an improved coordination.

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Session: Foot & Shoe - Sports
Thursday 2010/05/13 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2822-48]

Optimized Production and Selection of Orthopaedic and Sports Footwear with a novel „multi-sensorial“ 3D Foot Scanner

Author
Massen, Robert (Stuttgart DE) | Prof. Dr. Ing.
corpus.e AG - R&D

Coauthors
Rutschmann D

Abstract
A new low-cost photogrammetric 3D foot scanner integrates a sole pressure map scanner to produce in one run a 3D model combining registered (aligned) geometric and pressure data of the patient foot. This allows for precise and fast production of customized shoes including a personalized foot-bed.

Introduction
Optical foot scanners are limited to the generation of geometric information: the spatial 3D foot model, 2D foot silhouettes etc.. Whereas this information is sufficient for a crude computer-based search for a best-fit last from a database, the equally important information on the foot sole pressure distribution is missing. If a separate sole pressure measuring device is used, the sole pressure data is independent from the geometric 3D foot model: both data sets are not aligned and scaled within a common coordinate system, they are measured under different postures, body balance etc..Orthopaedic shoemakers agree that both the 3D foot geometry and the sole pressure distribution should be used for producing customized or for selecting best-fit footwear with an appropriate foot bed. The actual 3D foot scanners are not able to generate a “multi-sensorial” digital foot model, i.e. a single model which integrates both the geometric foot shape and the spatial sole pressure distribution.

Methods
The foot of the patient is covered with an elastic sock marked with a special code. The patient stands upright on a code-marked platform with a built-in sole pressure sensor. A digital camera viewing both the platform and the foot is moved under computer-control on a circular trajectory around the patient, generating via photogrammetry a dense geometric 3D model of the foot and simultaneously a sole pressure map, registered and aligned to the foot model. Both data sets merged into a digital “multi-sensorial” foot model which is used in three different ways: A) for a best-fit selection of a suitable last from a digital last database enabling the production of a customized shoe and including a best-fit selection of a suitable foot bed from a database of pre-produced models. B) for the production of an individual last through multi-axis numerical milling and the milling of an individual foot bed fitting with to the last and the produces shoe C) for any combination of A) and B)

Results
The new multi-sensorial scanner technology has first been tested in the business of high-end customized skiing boot since mid 2008. It has been operating in daily business during the winter 2008/2009 skiing period in three high-end skiing shops in Bavaria. The scanning of the feet of the customer generates two distinct left/right multi-sensorial digital 3D models which are then used for customized shoe production

including a customized foot bed. This foot bed fills up in an optimal way the space between the foot convex hull and the inner concave hull of the boot.
The new scanner is currently also used for the production of customized bicycle shoes by a leading producer in a number of shops and will be introduced shortly for the customization of best-fit hiking footwear.
Our strategy is to motivate the traditionally hesitant and sceptical orthopaedic footwear craft by demonstrating the acceptance of this technology within the more R&D driven world of sports footwear. This strategy is not really a deviation, as many of the technological challenges for producing customized shoes or for selecting best-fit shoes are common both to the orthopaedic and to the sports/leisure shoe business.

Conclusion
The novel, Internet-based “multi-sensorial” 3D foot scanning technology has proofed its benefits and new potentials in the business of customized sports footwear. These results are now about to be transferred to orthopaedic footwear. The required very low in-shop investment makes it easy for the orthopaedic shoemaker to move beyond his traditional subjective “feeling art” to a more precise, more rapid and more repeatable orthopaedic expertise supported and guided by objective physical measurements. It opens a broad potential for new orthopaedic business ideas, from shop-based to Internet-linked services, from pure customization via mass-customisation over to database-supported best-fit selection of footwear with a matched foot bed.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3696-None]

Innovative Aids in Rehabilitation and for the Disabled

Session Chair

Kraft, Marc (Berlin DE) | Prof. Dr.- Ing.
Technische Universität Berlin - Fachgebiet Medizintechnik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg239374

Symposium: Innovative Aids in Rehabilitation and for the Disabled
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3698-None]

Control Method for End Effector Based Reha Robotic in Combination with Electrical Stimulation in Gait Therapy after Stroke

Author
Schmidt, Henning (Berlin DE) | Dipl. Ing.
Fraunhofer-Institut für Produktionsanlagen und Konstruktionstechnik (IPK) - Automation Technology Division Rehabilitation Robotics Group

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg239374/cg240001

Symposium: Innovative Aids in Rehabilitation and for the Disabled
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3699-762]

Compact Assistive Motion Therapy Devices with Rotary Soft Fluidic Actuators

Author
Ivlev, Oleg (Bremen DE) | Dr.
FWBI Friedrich-Wilhelm-Bessel-Institut Forschungsgesellschaft mbH

Coauthors
Wilkening A., Baiden D., Koch C., Frank E., Haas H.-D., Kaufhold D., Mahner M., Reize P.

Abstract
On the market existing patient-cooperative devices for motion therapy and rehabilitation are very expensive and designed for clinical use only. Compact, low-cost and light-weight assistive devices, fit also for ambulant use, can be realized using novel soft pneumatic actuators of direct rotary type.

Introduction
Several studies have shown that patient-cooperative or assistive motion therapy devices will cause a much higher effectiveness after stroke or surgical intervention compared to continuous passive motion (CPM) machines [1]. Assistive treatment should facilitate muscle reconstitution and accelerate the healing process whereby effectivity increases and costs of medical care are reduced.
Existing assistive rehabilitation devices are really complicated, voluminous and expensive due to the usage of conventional electrical drives with sophisticated force/torque feedback [2]. The inherent compliant actuators like linear pneumatic muscles, well suitable to achieve the desired assistive behaviour, have restricted working area and require more or less complex transmissions for realizing revolute joints [3].
New soft fluidic actuators with rotary elastic chambers (REC-actuators) [4,5] allow modular design of motion therapy devices for lower and upper extremities, cooperating with patients.

Methods
The key idea of “soft” motion therapy devices is the replacement of electromechanical drives by pneumatic REC-actuators to achieve passive inherent compliance. Therefore the advanced assistive control strategies can be realized without expensive torque sensors.
The chambers of new “slim-line” REC-actuators are manufactured from pieces of flat hose with hermetically sealed ends and integrated inlet/outlet pipe are clamped to the ends of two moving parts, connected by a revolute joint. If pressurized, the hose tends to stretch, generating torque of several tens of Newton-meter.
First prototypes of “soft” motion therapy devices have been designed based on common CPM-machines with exoskeletion-like mechanics. For lower extremities such solution provides satisfied range of motion in knee and hip, while for upper extremities the shoulder motion is kinematical restricted. Advanced shoulder therapy with full range of motion can be realised using free linkage (i.e. robot arm) solutions.

Results
Recently a prototype for assistive knee motion therapy, shown in Figure, has been developed and successfully tested with healthy people aged between 24 and 60 years. The prototype is equipped with two “slim” REC-actuators in knee joints, having diameter of 150 mm and width of 60 mm. The angel area from 0° to 130° covers full ranges of motion in knee as well as in hip joints. Due to the usage of redundant sensors, various safety features, audio-visual feedback and assistive control a soft and safe treatment

is ensured. Because actuator torques are estimated on pressure measurements, no expensive torque sensors are necessary. The implemented assistive controller only generates force to assist the patient in case of insufficient movement. Audio-visual feedback is meant to motivate and thus effectuate larger success of medical treatment. Displayed current muscular effort is detected with recently developed airpad-sensors inside foot shell. A user interface offers self descriptive settings, whereby a comfortable handling of the device, even for elderly people, is assured.
Initial researches toward robot arm based motion therapy have shown proper results using a planar robot arm with two soft actuators and an artificial human arm with a revolute joint as a test-bed. Experimental results using assistive controller in Cartesian coordinates have offered a gentle assistive behaviour, tends to further performance examinations in three-dimensional space.

Conclusion

Initial trails using the prototype have demonstrated a really convenient assistive behaviour without expensive sensors and confirm the effectiveness of the soft fluidic actuator used in robot aided rehabilitation. Low-cost, light-weight and portable motion therapy devices can be used in hospitals and at home. Prospective tests and analyses with patients in the Clinical Center Stuttgart will show the grade of patient's acceptance.
This work is supported by the German Federal Ministry of Education and Research (BMBF) through the grant 01EZ0769 within the cooperative research project KoBSAR "Compact assistive/restorative motion therapy devices of new generation, based on fluidic soft actuators with rotary elastic chambers".
The authors gratefully acknowledge the contribution of Erwin Wendland and Elke Sorgenicht in mechanical design and thank Heinz Weißig for technical support.

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Symposium: Innovative Aids in Rehabilitation and for the Disabled
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3707-814]

Estimating Risk Situations in Daily Living of Amputees with Bone Anchored Exoprostheses

Author
Bunke, Sebastian (Berlin DE)
Technische Universität Berlin - Fachgebiet Medizintechnik

Coauthors
Kraft M

Abstract
We describe theoretical and biomechanical analysis of risk situations in the daily life of amputees. Our aim is to provide an opportunity to develop risk reducing mechanisms for amputees with bone anchored Exoprostheses, with focus on fall situations.

Introduction
Amputees experience different critical situations in daily using of their prosthesis [2]. Falling over is definitely one of the most significantly dangerous situations for lower limb amputees [2][3][4]. Possible risk situations of amputees accommodated with bone anchored exoprostheses have not been described accurately so far. Further risks are associated with the usage of bone anchored exoprostheses. Regarding this an extended characterization of known critical situations along with further possible danger situations is essential.

Methods
The risks were analyzed according to ISO 14971 [1]. We used results from different studies [2][3] to become aware of surroundings of possible critical situations regarding activities in the daily live of amputees. The statistical data of known dangerous situations is crucial as a background to draw conclusions about the occurrence probability of possible future risk situations. As specified in ISO 14971 we gathered information about the severity of an injury resulting from dangerous situations. To estimate the characteristics of possible injuries, we applied data from [2] and biomechanical analysis as well as statements of prosthetic experts. We analyzed the biomechanical properties of the bone-implant interface in four-point bend, axial load and torque testing machines. The results of the testing are used to rate the risk of up to 200 multimodal possible dangerous situations. In a multi-body-simulation specific fall situations were analyzed.

Results
The analysis of danger situations turns out to be remarkably complex. The load characteristics of an injury – which is possibly the worst consequence of a danger situation – are distributed stochastically through every listed danger scenario. The results from the fall simulation, the results in [2] and statements from oral interviews of prosthetists encourage the assumption that the characteristics of falling during level walking cannot be determined completely in advance. For this reason the possibilities of characterizing the injury loading condition regarding load level, loading direction and the temporal order in possible load sequences are limited. However, falling during level walking may always lead to one of the scenarios in Fig. 1 - with serious to catastrophic severity level – because the applied energy has almost the same level as the deformation and fracture energy of the bone implant interface. We found out that the measured failure loads of the of bone-implant interface lie in the range of bending loads during falling.

The quality levels of probability and severity were chosen according to ISO 14971 Annex D. Beside fall situations amputees discover further critical situations – with third party attendance for example [2] - which may also lead to high injury loads.

Conclusion

The results in this work emphasize the necessity of performing risk management and developing risk reducing mechanisms for bone anchored exoprostheses. The described qualitative risk analysis, with focus on fall situations, is only the initial phase in this development process. To improve the risk management and to develop a more quantitative risk analysis, future work will include statistical data on accidents and surveys of amputees with bone anchored prostheses. The biomechanical load capacities of the diverse types of the bone-implant-interface will have to be analyzed more closely in future studies.

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Symposium: Innovative Aids in Rehabilitation and for the Disabled
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3134-332]

Hybrid Upper Limb Orthosis

Author
Schmitz, Bastian (DE)

Coauthors
Schulz S, Wiegand R, Schmitz B, Schill O, Reischl M, Eck U, Rupp R

Abstract
The project aims at the development of a portable system for the upper extremity, that combines joint stabilisation, external power from fluidic actuators with inherent compli-ance, FES and a natural control system that allows the tetra-plegic user to regain independence.

Introduction
In Europe every year 11.000 new patients suffer from a spinal cord injury resulting in a life long dependency on caregivers. The objective of modern rehabilitation medicine is to at least partly restore the individual functional deficits. Today, in acute patients a task-oriented, function-specific training of high intensity is performed soon after the lesion to restore the function to a certain extent by enhancing neu-roplasticity on spinal and supraspinal levels. Up to now most therapeutic systems are stationary floor-mounted ro-botic systems and their application is limited to the clinical environment due to their size and complexity. There is a lack of portable home-use training systems for the upper extremity that support patients during activities of daily living. Functional Electrical Stimulation (FES) is one viable option for restoring the grasping function. However, its application is limited to maintain the upper limb against gravity due to muscle fatigue.

Methods
Grasping can be generated by pairs of surface electrodes for stimulation of the finger extensors (M. ext. digitorum com-munis EDC), the thumb extensors (M. ext. pollicis longus EPL) and one pair for common stimulation of the finger (M. flex. digitorum superficialis FDS und profundus FDP) and thumb flexors (M. flex. pollicis longus FPL). Realignment of the custom made (double sided self-adhesive conductive gel) surface electrodes and their connection to the stimulator is simplified by the use of an elastic textile sleeve with integrated cable structures and arrays for contacting the stimulation electrodes. For electrical stimulation a Motionstim 8 stimulator with biphasic constant current pulses with a magnitude of 30 mA, a stimulation frequency of 20Hz and a pulse width of 200µs were used. The elbow joint is supported by pairs of antagonistically working miniature fluidic actuators. The residual activity of weak muscles is monitored by an array of surface EMG electrodes.

Results
The custom made double side adhesive electrodes showed good electrical properties to be used for long term monitoring of weak EMG signals.
An artefact free EMG signal for real-time processing is needed to control the orthosis. Therefore, an existing EMG amplifier has been modified detecting the onset and end of a stimulation pulse generated by stimulation electrodes near the recording site, suppressing the artefacts by switching the amplification factor and the cut-off frequencies of the filters and amplifying the EMG activity within the stimulation pulse pauses.
The flexible fluidic actuators generate an elbow joint moment of 6 Nm and allow for elbow flexion within one second.

Conclusion

The basic concept for a novel hybrid orthosis for both training and functional support is presented for patients suffering from high spinal cord injury, which will combine both FES and additional external force generating components namely flexible fluidic actuators. Safety is ensured by inherent compliance of the actuators, by mechanical stops and by careful limitation of the maximal moments that are applied to the upper limb. The first prototype of an elbow flexion orthosis serves as a testbed for a modular system to be developed that will also include adjacent upper limb joints, such as shoulder and wrist. The overall aim of the project is to design a portable training device for the whole upper limb that meets the requirements of being light-weight, compact, and inexpensive. The upcoming clinical tests of the device with selected patients with preserved shoulder but missing hand and elbow function will provide information about its basic functionality and usability.

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Image: Hybrid Orthosis_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg239374/cg38728

Symposium: Innovative Aids in Rehabilitation and for the Disabled
Thursday 2010/05/13 | 15:00 - 16:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3748-818]

TExoPro - Antimicrobial Surface Coatings for Permanent Transcutaneous Passage in the Concept of Endo-Exo-Limb-Prosthesis

Author
Calließ, Tilman (Hannover DE) | Dr. med.
Medizinischen Hochschule Hannover - Orthopädischen Klinik im Annastift

Coauthors
Windhagen H

Abstract
The clinical implementation of bone anchored transcutaneous limb prothesis is still limited due to infections at the side of the pericutaneous passage. Therefore we have designed antimicrobial, but biocompatible polymere surface coatings. First results of in vitro and in vivo experiments are presented.

Introduction
The concept of bone anchored transcutaneous exoprosthesis appears to be a promising technology to improve the quality of life and mobility of amputees over the conventional socket attached devices. However, the clinical implementation of these Endo-Exo-Prosthesis is still limited due to infections at the side of the pericutaneous passage. In our concept of a bone anchored exoprosthesis we address this issue by designing antimicrobial, biocompatible surface coatings for a permanent aseptic transcutaneous passage. Foremost the antimicrobial impact and biocompatibility has to be evaluated in vitro and in vivo experiments.

Methods
Different copolymers with surface active phosphate groups and antimicrobial cationic groups are designed and coated on titan samples. The surface coating is characterized via ellipsometry and contact angle analysis. The coated titan samples are cultured in vitro with five different pathogen bacterial strains for one or five hours. The antimicrobial impact is evaluated in a live/dead assay imaging the reduction of bacterial adherence. The biocompatibility is displayed by fibroblast proliferation and morphology. Human dermal fibroblasts are cultured on the samples for 72h, electron microscopy is performed as well as measurements of the LDH concentration levels in die culture medium. Furthermore, an in vivo animal model with transcutaneous pin samples is developed. As for the in vivo imaging of the pericutaneous passage an optical coherence tomography (OCT) technology is established. The bacterial load on the implants in displayed via confocal laser scanning microscopy an in classical histological analyses.

Results
To date, three generations of copolymer surface coatings have been developed and characterized. The 1st generation copolymer coatings already show a bactericide capacity but no reduction in the bacterial load. The 2nd generation as well as the 3rd generation show a reduction of adherent bacteria up to 95% compared to blank titan samples in vitro. Similar results can be reproduced in static and dynamic culture systems. The adherence of human fibroblasts shows a slight decrease compared to the control titan samples, but was not significant.

For the in vivo tests on an animal model with percutaneous titan pin samples is established. Via the OCT surface scan it was possible to illustrate the cutaneous interface over the time. The so far implanted blank titan pin samples in mice showed a clinical capable infection between day 16 to 52. At this time it was possible to display the adherent bacteria on the samples as well as the migration in the depth.

Conclusion

In our study at least two promising copolymers for the surface coating of transcutaneous devices were designed. We can demonstrate the basic antimicrobial capability of the polymers without a negative influence on the biocompatibility. Furthermore, a transcutaneous animal model is established for the ongoing in vivo experiments. The OCT scanning technology turns out to be auspicious novel method for the in vivo imaging of the dermal-implant-interface.

In the context of the Endo-Exo-Prosthesis we estimate our polymer surface coatings to be a promising technology to overcome the infection problem on the cutaneous passage.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg239374/cg362850

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3839-None]

Open Forum 6

Session Chair
Heim, Winfried (Toronto CA)
Sunnybrook Health Sciences Centre - SCIL

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg620167

Session: Open Forum 6
Thursday 2010/05/13 | 17:00 - 18:30

Congress Lecture [3840-895]

Load Distribution Features and Association between Primary Cognitive Ability Level and Balance Function in Post Stroke Patient

Author
Li, Jibin (Guangzhou CN) | Load distribution features and the association between primary c
Sun Yat-sen University - rehabilitation medicine

Coauthors
Shao-zhen Chen

Introduction

Abnormal posture in stroke patients is largely induced by the abnormality of normal sensory input of visual, vestibular, and proprioceptive systems, resulting in paresthesia which a healthy person never has [1,2]. Because low nerve center loses the control from high nerve center, stroke patients always exhibit balance hyporeflexia and physical balance-controlling problems. Balance dysfunction is one of the main obstacles, and is also regarded as an item comparatively difficult to be recovered in stroke patients. The Postural Equilibrium analyses system has been widely adopted clinically in rehabilitation. However, research studies that further explore the influences of cognitive factors on balance function in stroke patients have been limited. The aim of this study was to discuss the characteristics of balance function in stroke patients, and analyze the associations between different cognitive ability levels and balance function using an effective, quantitative method.

Methods

Nine stroke patients were recruited according to the inclusion/exclusion criteria and measured balance function and primary cognitive ability using the Postural Equilibrium analyses system and the software of primary cognitive ability respectively. Balance function was measured under 6 testing conditions in all subjects (Fig.1). According to the published reference standard [3] and the score of cognitive ability, stroke patients were categorized into two groups. Patients with score #30 (4 female, 1 male) and <30 (0 female, 4 male) were classified as Group 1 and 2 respectively. Two independent-samples t-test was used to compare the differences in genders, and the two cognitive ability level groups. Differences of center of pressure (C.o.P) in X and Y axis, time distributions in different quadrants (Each testing condition 51.2s) and distributions of loads were compared using paired t-test. Statistical significance was $P<0.05$.

Results

Score of cognitive ability: the score of spatial representation was the lowest while the score of memory recognition was the highest in stroke patients, and the score of memory recognition and total score of cognitive ability were higher in female than those in male($P<0.05$). Under the conditions of open-eyes/ focus, closed-eyes/focus and open-eyes/repeat asked numbers, the value of C.o.P in Y axis was larger than that in X axis($P<0.05$). In all of the 6 conditions, anterior distributions of load was more than that of posterior ($P<0.05$). The duration for the center of pressure in quadrants # and # was longer than that in quadrants # and # ($P<0.05$). (Table1)
The SKG-Length in group 1 (score#30) was shorter than that in group 2 (score<30) under open-eyes/ focus, open-eyes/repeating asked numbers and closed-eyes/repeating asked numbers conditions, the

results was the same as the SKG-Ellipse area in open-eyes/focus, closed-eyes/focus, open-eyes/watching provided video and closed-eyes/watching provided video, both of which were statistical significance. (Table2)

Conclusion

Stroke patients had varying degrees of cognitive problems; Center of Pressure and distributions of loads in stroke patients mainly concentrated at the plantar forefoot. It seems that the higher the cognitive ability score, the stabler the center of pressure and the better the balance function will be in stroke patients. It is concluded that the cognitive ability plays an important role in balance function, and if cognitive ability training and exercise therapy were used together for rehabilitation training during the recovery period of balance function in stroke patients, the better the recovery of balance function will be in stroke patients. This will reduce the sequelae caused by stroke, and improve patients' ability of daily life and quality of life. There is a very important social significance.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg620167/cg620992

Session: Open Forum 6
Thursday 2010/05/13 | 17:00 - 18:30

Congress Lecture [3842-905]

Comparison of Plantar Pressure between Weightlifters with Flatfeet and Normal Feet

Author
Feng, Beibei (CN) | Comparison of plantar pressure between weightlifters with flatfe
The Hong Kong Polytechnic University - Department of Rehabilitation Sciences

Introduction
To get an initial understanding of the incidence of flatfeet among weightlifters. Specifically, the present study was designed to explore the effect of foot type on the distribution of the plantar pressure via testing the differences in plantar pressure between subjects with flatfeet and normal feet as well as to examine how flatfeet interact with the very sport of weight lifting.

Methods
Thirty-eight weightlifters were recruited in this study and they were divided into two groups-the flatfeet group (14 subjects) and the normal feet group (24subjects) using the three-line foot print method. These subjects were then asked to stand in a neutral position on the pressure platform of the HR Mat system. Parameters including force percentage, contact area, contact area percentage, contact pressure, peak contact pressure were measured.

Results
The force percentage in midfoot and the first metatarsal for the flatfeet group were greater than that for the control group, while the force proportion in the heel area for the flatfeet group was smaller($P<0.05$). The midfoot contact area and its proportion for the flatfeet group were significantly greater compared to the control group, while the contact area percentage at medial heel and the third metatarsal for the flatfeet group were smaller ($P<0.05$). As for the pressure parameters, subjects with flatfeet generated higher pressure at the first metatarsal area but lower pressure at the lateral side of the heel in contrast with the control group($P<0.05$).

Conclusion
Flatfeet could influence the normal plantar pressure distribution. The loading patterns of flatfeet subjects during stance and weight-bearing shifted medially to the midfoot and medial forefoot. In flatfeet group, the contact area of midfoot and the pressure at the first metatarsal significantly increased.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg620167/cg621406

Session: Open Forum 6
Thursday 2010/05/13 | 17:00 - 18:30

Congress Lecture [3844-859]

Ischial Containment Negative Cast Taking System - Socket Abarca-UDB

Author
Castaneda, Monica (SV)

Introduction
This document, is a proposal to use a standardized system of ischial containment negative cast taking, applying a three points force system (making system ischial containment negative mold Socket Abarca-UDB) that allows the Prosthesis to get a bunch sciatic anchor in a practical, simple, affordable and standardized approach, which does not require the use of support systems and complex equipment during cast taking.

Methods
Tests were conducted to a user, by adjusting transfemoral ischial containment, prepared with three different prosthetic systems: the manual ischial containment system, the SIT-CAST and the system "Abarca-UDB “

Results
In the comparison of the processes we noted:
-Maximization in time to cast a negative mold. (The time of making the mold was reduced by 70% compared to the other systems)
"That requires less control in areas with greater emphasis on taking action.
"By x-rays that have been taken, it shows that the ischium is located in the right position.
"That a low cost system can provide a socket with equal or better fit.

Conclusion
The system Abarca - UDB in relation to other systems is easy to use allowing the technician to work individually and conduct molds making in less time and with good results and lower costs, resulting in a socket with very good adaptation.

Image: Abarca_859.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg620167/cg621820

Session: Open Forum 6
Thursday 2010/05/13 | 17:00 - 18:30

Congress Lecture [4017-874]

Sudanpro is an Alternative High Tech BK Prosthesis to the High Priced Ones

Author
Ismail, Mohammad (SD)
Tawsol Al Amal Charity Organization for the Treatment and Care of Wounded and Disabled - Prosthetics and Orthotics

Introduction

Poverty and disability is almost a brother and a sister, most of the amputees in the developing countries, hardly can afford to feed themselves, not to mention their dependants. Sudanpro is an easy technology that does not require exceptional tools and machineries, yet it can put an amputee back on her/ his feet for less than $ 100. Taking into consideration the limited number of well trained personnel in the field of prosthetics, Sudanpro doubles the productivity of the practioners and enables them to meet the high demands of their services. Although it is a very cost effective and suitable for the developing countries, it can be applied in the industrial world for characteristics other than the cost.

Methods

The production of the Sudanpro is determined by two major factors:
1. Techniques
2. Materials

Techniques

Planning of the project starts immediately after the initial evaluation of the stump, once the stump is ready for fitting, the first thing to bear in mind is the alignment of the prosthesis as a final product, in other words, it like constructing a building out of the blue prints, construction workers have a limited abilities to change the blue prints and have to execute the project as it has been designed by the engineer. Final alignment is to be decided during the very first stage of the casting process.

Materials

Thermomolding plastics PP or HDPE can be used in the production of the shell, and LDPE or any relevant cheap material in the form of rods of 60 mm diameter, available in the markets for production of cart wheel can be used for the production of the adaptors and molds

Results

Since the begging of the application of the Sudanpro technology in the Sudan, 678 amputees were fitted with 682 prostheses, at very low cost, that encourages me to claim the technology as a salvation for those desperate amputees who can afford the high cost prostheses, and to find themselves obliged to wear far less secure prostheses offered by international NGOs. This technology may be transferred to any country where, there is a high demand for good prostheses at low cost for the beneficiaries or their service providers.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg620167/cg2057946

Session: Open Forum 6
Thursday 2010/05/13 | 17:00 - 18:30

Congress Lecture [4094-925]

The Clinical Application of RGO to Patients Suffering from T4 to T10 Spinal Cord Injuries

Author
Tang, Dan (Guangzhou CN) | Dr.
Guangdong Provincial Work Injury Rehabilitation Centre

Coauthors
Liu Hao

Introduction
52 patients with complete paraplegia participated in this study. All the patients suffered complete spinal cord injury from T4 to T10. According to the patients' demand, they were divided into 2 groups, including RGO group (42 person) and control group (10 person). All the patients received 8 weeks basic rehabilitation treatments which include muscle strengthening exercises, balance training, transferring training, wheelchair using training and ADL training. At this period, the body parameters were measured to customize the RGO for RGO group subjects. After 8 weeks, 6 weeks standing and walking training with RGO were given to RGO group patients and control group was trained as before. During the whole process, Barthel Index (BI), Functional Independence Measurement (FIM) and WHOQOL-BREF were given before rehabilitation treatment, before fitting RGO and after 6 weeks RGO application to evaluate the change in ADL and QOL.

Results
After 8 weeks basic training, the abilities of ADL and QOL in physical health domain and psychological health domain are markedly increased in both groups#P<0.01##the QOL in environment domain is also increasing in all patients(P<0.01 in RGO group, P<0.05 in control
group), but no significant difference (P>0.05) in the social relationships domain. After RGO training, there is significant difference in ADL and QOL in physical health domain and psychological health domain in RGO group (P<0.01), but there has no statistical difference in ADL and QOL for control group patients. Comparing the two groups, there is no significant difference in ADL and QOL at pre and post basic treatment (P>0.05). There is significant difference in ADL between two groups after 6 weeks RGO training, the RGO group was better than control group (P<0.01).

Conclusion
The using of RGO can improve the abilities of ADL and QOL for complete paraplegia people with T4 to T10 spinal cord injury, especially has more prominent effects in ADL improvement.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3664-None]

Lower Limb Prosthetics - Functional Knee Components 3

Session Chair

Pusch, Martin (Duderstadt DE) | Dipl.-Ing.
Otto Bock HealthCare GmbH - Strategic Technology Management

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222392

Session: Lower Limb Prosthetics - Functional Knee Components 3
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3058-256]

Microprocessor Controlled Prosthetic Knee Joints: Designs and Performances

Author
Bellmann, Malte (Göttingen DE) | Dipl.- Ing. (FH)
Otto Bock HealthCare GmbH - Research Biomechanics

Coauthors
Schmalz T, Blumentritt S

Abstract
The linear hydraulic system of the C-Leg in combination with the control algorithm provides functional advantages in many everyday situations. Compared to other knee components, it offers the user reliable and predictable function during challenging motion patterns and in safety-critical situations.

Introduction
A broad range of new technologies has been integrated in prosthetic knee joints, thereby improving the function of prostheses for rehabilitation of above knee amputees. Microprocessor and sensor based concepts now allow the identification of specific walking situations and provide internal resistances to control both swing and stance phase. 1 Movements imitating the physiological gait pattern, reduced loading of the residual locomotor system and reliable safe function in different walking situations are the main requirements for a technically sophisticated prosthetic knee joint. Within the group of current available microprocessor controlled knee joints, there are differences in sensor technology and the units generating internal resistances.
Fig. 1 (from left to right): C-Leg (linear hydraulics), Rheo Knee (magneto-rheological principle), Adaptive2 (hybrid design with linear hydraulics/pneumatics), Synergy knee (hybrid design with rotary hydraulics/linear pneumatics)

Methods
A biomechanical study was conducted under real-world conditions in a gait lab with 9 unilateral above knee amputees (7m, 2f; 76±14kg; 36±11years; 177±7cm; activity level 4 = 7 patients; activity level 3 = 2 patients) investigating safety relevant aspects. The situations investigated were walking on level ground, walking down stairs and descending ramps. 2 In addition a defined safety test battery was conducted. 3 Kinematic and kinetic data and time-distance parameters were recorded. Measuring equipment consisted of an optoelectronical six camera system (VICON 460, Oxford Metrics, GB) in combination with two force plates (type 9287 A, Kistler, CH) to measure kinematics and kinetics. To eliminate the influence of different prosthetic alignments and prosthetic foot designs, identical conditions were created for all test prosthesis considering the patients' individual optimum alignment. 4

Results
Level ground walking: One attribute for swing phase quality is the extension stop at the end of swing phase. A quick and hard stop is identifiable with the Hybrid Knee even at moderate walking speeds. A strikingly low extension velocity can be observed with the Rheo Knee.
Walking down stairs: Internal flexion resistances supporting single limb stance on the prosthetic side and relief of the contralateral side during weight acceptance differ considerably. With the hybrid design

Adaptive2 the sagittal external flexion moment appears to be too low. Unnaturally high vertical ground reaction forces are generated, causing high loading of the contralateral side. The highest external flexion moment was measured with the linear hydraulic system C-Leg. During walking down ramps similar effects can be observed.
Safety tests: When the gait cycle is suddenly interrupted, activation of high stance flexion resistance to load the prosthesis is of particular importance, especially in pre-flexed condition. Stepping on an obstacle with the heel and stopping on the prosthetic side was inconsistent with the Adaptive2. This knee joint collapsed several times as the high internal flexion resistance was not activated. Provoked stumbling during swing phase extension confirmed that the C-Leg offers the highest potential to protect the amputee from falling.

Conclusion
The functional goal of swing phase control is to reach terminal extension at all walking velocities. The Rheo Knee shows relatively slow extension movements that may lead to safety-critical situations, for example when walking on stairs. With the C-Leg, the flexion resistance reverts to a high value during swing phase extension. In combination with the integrated extension spring, exact positioning of the prosthetic foot on the step becomes easier and the danger of knee joint collapse is reduced. Additionally, compensating movements with the hip joint to support extension of the prosthetic knee joint while walking down stairs are reduced. The C-Leg offers a high safety potential in critical situations like stumbling. After having detected disturbances of the gait cycle, this knee joint allows either active extension by the amputee against a low resistance, or safe loading in a flexed condition.

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Image: Bild zu Abstract Bellmann MPC Knee_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222392/cg36434

Session: Lower Limb Prosthetics - Functional Knee Components 3
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3428-603]

Clinical Evaluation of the Second Generation Microprocessor Controlled Prosthetic Knee with Artificial Intelligence

Author
Johansson, Sven (Jönköping SE)
Össur Nordic AB - Össur Acadamy

Coauthors
Johansson S

Abstract
This study investigated amputees subjective experiences of the second generation of a user-adaptive micro processor controlled knee. This was evaluated using a questionnaire with Likert designed questions. The results indicate that the use of microprocessors enhances the users performance.

Introduction
Micro processor controlled knees (MPK) knees have been on the market for many years and several publications has shown their benefits compared to mechanical knees (Kaufman et al 2008). The advantages increased even more when the microprocessor controlled unit was combined with artificial intelligence and magnetorheological-based system that supplied user adaptivity (Johansson et al 2005, Herr and Wilkenfeld 2003). This might increase the amputees possibilities to walk with an increased level of biological realism compared to when using traditional mechanically prosthetic knee systems. The apparent benefit for the amputee in terms of functional outcomes of few falls, improved performance on an obstacle course and walking down stairs and hills is obvious.
The aim of this study was to clinically evaluate the functions of the second generation microprocessor knees from the users perspective.

Methods
Present study evaluates how the transfemoral prosthetic users experience the different functions of micro processor controlled knees. Several different everyday situations have been evaluated with a questionnaire containing Likert designed questions. Subjective questions of the knee function during different circumstances in different environments were asked. The answers from all questions were cumulated to form an all-over score for each user. The study was designed as a pre-post evaluation with the user as his own control.
During February 2009 until august 2009, 12 transfemoral and 2 knee disarticulated prosthetic users, fitted with the second generation Rheo Knee were evaluated. Mean age was 46.9 years (R 19-79). 10 of the users had previously been fitted with a micro processor controlled knee (5 C-leg and 5 Rheo Knee) and 2 were using mechanical knees. The questions were asked before fitted with the new knee and then after using the new knee for four weeks.

Results
The maximum score for each question was 5 making the maximum total score 50.
The answers for question 7 and 8 for participants' number 1, 8 and 14 were given the alternative NA (not applicable), to make the total cumulative score comparable between the participants those answers have

been given the average value for that question. The results of the cumulative scores for all 14 users and all 10 questions are showed in diagram 1.
Nine of the users got a higher cumulative score after fitted with the new knee compared to the score before. One user had the same cumulative score and four had a lower score after fitted with the new knee. The result differs when examining the groups based on type of knee used pre-fitting. Users previously fitted with mechanically knees all gave higher cumulative score after fitted with the new knee compared to the score before. Four of five previous Rheo Knee users got a higher cumulative score after fitted with the new knee. One user had a lower score after fitted with the new knee. One previous C-leg user got a higher cumulative score after fitted with the new knee compared to the score before. One user had the same cumulative score and three had a lower score after fitted with the new knee.
The question most users gave higher score was “I am satisfied with the knee while walking indoors”. Nine users rated it to higher score, four rated it to the same score and one got a lower score after the fitting.

Conclusion

This study examined users’ subjective experience when using the second generation of self-adaptive microprocessor controlled prosthetic knee. The results indicate that the use of microprocessor controlled knee enhances the user’s performance which other studies also have confirmed (Kahle et al 2008). Especially in functional areas beyond level walking like descending hills and stairs the results from this study indicate that microprocessor controlled knee excel over the mechanical knees which also was found by other studies (Hafner and Smith 2009).
The limitations with this study are the limited number of participants and that the questionnaire is not tested for validity and reliability. These biases could influence the results.

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Image: Picture Result Question ISPO 2010 S Johansson_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222392/cg44013

Session: Lower Limb Prosthetics - Functional Knee Components 3
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2930-128]

Novel Safety Concepts for Microprocessor Controlled Knees

Author
Kampas, Philipp (None AT) | Dipl.-Ing.
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Seyr MM, Pop CL, van Vliet JW

Abstract
Microprocessor controlled knees shut down in cases of malfunction, increasing the risk for the user. Intelligent concepts can be used to maintain electronic support in these cases, which enables the user to safely use the device to “drive to the garage”. Trials confirmed the ideas developed.

Introduction
Microprocessor controlled knee prostheses (MPK) are mainly preferred over mechanical ones, because of an electronic control of damping from stance to flexion damping. By use of electronic sensors a more intelligent form of control is possible, which increases the safety, in terms of preventing stumbles and falls, for the user. What happens however, when the sensors, or the electronics malfunction? In case the prosthesis is able to detect the malfunction, state of the art micro-processor controlled knees will initiate a “controlled” shutting down of the entire system. In this “safe” mode, the knee joint is primarily an ordinary hinge. If the knee is default “stance”, the hinge will be stiff, which can increase the risk for the user in critical situations. If the knee is default “swing”, the hinge is free, making every step risky. The idea presented in this work is to use the electronics to deal with malfunctions to maintain the highest level of support possible under the circumstances.

Methods
The following known causes of malfunction were analysed in this work:
1. sensor failure (no signal available, or signals outside of calibrated boundaries)
2. mechanical overload of the system, leading to critical plastic deformations
3. overheating of the system when too much energy needs to be dissipated (e.g. with steep walks downhill for a longer period of time
A prototype microprocessor-controlled knee prosthesis has been build to verify concepts developed to deal with these type of malfunctions. In patient trials these malfunctions where provoked, to test the adaptive behaviour of the prosthesis.

Results
To deal with sensor failure a control strategy for the knee has been developed that incorporates signals from n sensors, where n > 2. State of the art MPK’s use 2 sensors. The additional sensors enable higher level control in more daily activities and form a redundancy. This redundancy is used in case of sensor failure. As long as 2 sensors are functioning the control strategy can be maintained, be it in a simplified form: basic microprocessor-controlled support is still possible, additionally the user can be informed through the prosthesis feedback system. Efficacy of this concept could be proven in patient trials.
The mechanical load on the prosthesis (body weight) is measured with sensors. The same sensors can be used to detect an overloading of the system. If by this further use of the sensor signals is no longer possible, the strategy of general sensor failure can be applied. This concept was verified successfully.

Temperature sensors that are required to be able to deal with correction of signal deviations of sensors used for the control scheme, can be used to detect overheating. Since electronic components in have limits regarding maximum temperature, overheating must be prevented. Ventilation of the prosthesis is commonly hindered significantly by the cosmesis (foam cover). To reduce it´s danger, prior to overheating the control strategy is changed gradually to reduce the dissipation. In this manner trials showed that overheating could be postponed severely.

Conclusion

If the sensors of an electronic prosthesis are designed in a way so that they can detect overloads outside of the range the prosthesis was tested for, they can be used as an indicator of critical overloading of the prosthesis. It is possible to design control strategies to prevent further temperature rise of the prosthesis by limiting the dissipated energy. If a multiplicity of sensors is used in an electronic prosthesis, it is possible to design safety modes that allow safe detection of swing phase with a subset of sensors. The wearer can therefore still walk with stance control and swing phase to get home or out of a critical situation.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222392/cg34734

Session: Lower Limb Prosthetics - Functional Knee Components 3
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3084-282]

Who Framed Gravity? A Novel Microprocessor Controlled Knee Supports Alternating Stair Ascent

Author
Pusch, Martin (Duderstadt DE) | Dipl.-Ing.
Otto Bock HealthCare GmbH - Strategic Technology Management

Coauthors
Seyr M, Kampas P

Abstract
Alternating stair ascent as a TF amputee without the use of external power is described. The technical, cosmetic and sound limb relief aspects of the solution are explained. The residual limb and socket conditions essential to achieve the technical solution are discussed.

Introduction
Symmetry in gait is known to be protective with regards to loading and helps the individual to not be recognized as an amputee because of their movement pattern. Both criteria are addressed by walking upstairs step over step. Using residual limb muscles to extend the hip on the prosthetic side also relieves the contralateral limb by deactivating the sound limb and related hip muscles.
Microprocessor controlled knees determine variable stance- and swing-resistances by the interpretation of sensor signals. The capabilities of this technology are used to support step over step stair ascent as well. To achieve this goal, a knee joint has to control stance and swing phase differently than while walking on level ground. In the presented design, the control for stairs ascent is activated prior to each step. Switching back to level walking is as fast and fluent as stair initiation. A step “upstairs” is also able to provide the possibility to overcome obstacles lying on level ground.

Methods
By analyzing the loading condition of the foot, a stable signal is available to distinguish between level walking and walking up stairs step over step. In “upstairs” mode, the swing phase resistance is lowered significantly below that appropriate level for walking. This allows the foot to be moved around the edge of the stair. Having placed the prosthetic foot one step higher, the patient applies hip extension moments to lift the bodyweight. This can be supported by a hand on a handrail and/or by plantarflexion of the contralateral foot. The hand on the handrail adds rotational stability around the longitudinal axes of the flexed residual limb. To prevent the knee system from extending too quickly, the extension damping is also controlled.

Results
Early observations of more than 25 TF amputees who are mobility grade 3 or 4, to whom the possibility of step over step stair ascent by use of their own power was offered, show two different reactions. About half of the group wants to use that function every time when a stair step or obstacle “appears”. The other half uses it when it seems to be important or only in special situations because of limb conditions which do not allow sufficient hip extension power to be put in to the prosthesis. Some amputees needed some exercises for the residual limb muscles or for coordination. Overall more than 3/4 of the amputees could use the additional functionality beginning with the first fitting.

Conclusion

For the majority of MG3 and MG4 TF Amputees, it is possible to walk up stairs step over step without external power, and so to “frame gravity”. A fast and reliable controller which can distinguish between level walking and up stairs walking allows the amputee to train residual limb muscles which were not used for that actively before. The patients who are not capable of applying the necessary hip extension moment because of stump length or muscular deficits, could benefit from active lightweight externally powered solutions not mentioned in this presentation.

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WO2007128299A1 CONTROL OF A PASSIVE PROSTHETIC KNEE JOINT WITH ADJUSTABLE DAMPING

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Session: Lower Limb Prosthetics - Functional Knee Components 3
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2937-135]

Smart Mobility - a New Microprocessor Controlled Knee Specifically Supports Activities of Daily Living

Author
Kampas, Philipp (None AT) | Dipl.-Ing.
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Seyr MM, Pop CL, van Vliet JW

Abstract
The potential to extend the range of activities of daily living supported by microprocessor controlled knees has been evaluated. A prosthesis has been developed that automatically detects and supports activities beyond the basic support for walking, standing and sitting.

Introduction
Design of leg prostheses principally focuses on their primary function, i.e. to provide support for walking, standing and sitting. However, the activities of daily living comprise more than those primary functions. In particular if the patient has a mobility grade level of 3 or 4. Therefore it is of interest to widen the range of activities supported by a leg prosthesis.

Methods
An instrumented prosthesis has been used to find smart control strategies that support activities of daily living apart from standing, walking and sitting. The possibilities of a programmable remote control are used to personalize the prosthesis to the activities of the wearer.

Results
A microprocessor controlled knee has been developed that incorporates smart control strategies to support activities of daily living. These can be classified as "functions" and "modes". "Functions" can be enabled and disabled. A function is activated by the wearer via a pattern of movement which is not unnatural, but the natural pattern of abled body persons. For instance, the function for locking the knee while standing is activated everytime the wearer is standing without the need for a specific activation. Functions have been developed for standing, sitting and walking up stairs. If certain functions are unwanted, they can be disabled (e.g. by the CPO). "Modes" have to be activated deliberately by the wearer e.g. by changing the mode via a remote control or by a specific activation pattern. The new microprocessor controlled knee allows to have up to 5 additional modes installed. These modes support activities of daily living that cannot automatically be covered with a function, for instance modes for sporting. With the new prosthesis it is possible to configure the type, sequence and numbering of the modes individually to suit the needs of the wearer.

Conclusion
The possibilities of microprocessor control of prostheses allow to extend the range of activities of daily living beyond the basic requirements of walking, standing and sitting. It is possible to automatically cover specific activities without demanding particular patterns from the wearer. Other activities can be supported by modes that have to be activated deliberately.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg222392/cg34768

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3665-None]

Lower Limb Prosthetics - Biomechanics 1

Session Chair
Heitzmann, Daniel (Heidelberg DE) | Dipl. Ing. (FH)
Orthopädische Universitätsklinik Heidelberg - Ganglabor

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223038

Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3119-317]

Hip Moment after Trans-femoral Amputation - Comparison of Isometric and Auxotonic Hip Moment in Amputees and Normals

Author
Guenther, Michael (Parey DE) | Dipl.-Ing. (FH)
Guenther Bionics GmbH

Coauthors
Wolf S

Abstract
The presented results allow a good assessment of muscle changes associated with an amputation its late effects. The comparison of isometric and auxotonic measurements shows which hip moments occur during gait, and which isometric maximums are possible.

Introduction
As a result of arterial occlusive disease, trauma, infection or tumors amputation of a limb can become necessary. The irreversible loss of a limb confronts the patient with a high level of psychological distress and a decrease in his/her physical integrity. In the interest of further improving the prosthesis design, it is necessary to fully and objectively investigate and evaluate the specific situation after an amputation. This paper deals with an objective assessment of hip kinetics of amputees using the new measuring system Hiptor [1,3]. A study performed with a total of 20 volunteers provided information on the trends and magnitude of differences between amputees and non-amputees with respect to the torques and forces at the hip.

Methods
In order to capture the physical measure, in this case the hip moments, instrumental gait analysis [2] and the Hiptor equipment was used [1.3]: the former for the auxotonic measurements, and both combined for the instrumental gait analysis to determine the isometric hip moment. To achieve the goal of this investigation, two groups were included, the first group consisting of subjects without physical disabilities, the second of patients with unilateral trans-femoral amputation. The calculation method for determining the isometric forces and moments used three segments. The first segment, pelvis, was determined using the same method as in PlugIn Gait [1,4,5]. The two other segments, left and right thigh, were generated by using two additional markers. The hip joint centers were also determined along the lines of the calculation methods in PlugIn Gait. Wilcoxon test was conducted.

Results
The study focused on ten patients and ten able bodied volunteers. Isometric and auxotonic muscle forces and joint moments were averaged and normalized, yielding the values listed in the appendix. According to the isometric measurements there are significant differences in the abduction, adduction and flexion force development between healthy and amputated participants, whereas the differences in extension are smaller (figure 2). The results from the gait analyses measurements were compared with the respective isometric maximal values. The differences are shown in figure 1. Only during the flexion, the isometric level of force is achieved, whereas no adduction moment was observed during gait. Those results were compared with typical gait analysis data of Normals. It was found that all measured torques were lower in

the amputee group, most notably for the adduction. The lowest differences with about ten per cent were found for the flexion direction (figure 3). All graphical representations demonstrate the severe variance within the measurement groups. Irrespective of that, the relative deviation in most principal movement directions is considerable.

Conclusion

After an amputation in general, a change in muscle balance or force balance arises, caused not only by the loss of muscles directly acting on the hip, but also the entire lower leg segments and their associated biomechanical functions. Without having to consider the complex muscle interactions in detail, It is obvious that the forces in a healthy person are well balanced. However, this does not mean that all muscles are equally strong as one as evident from our findings for the control group. With a change in the boundary conditions due to an amputation, establishing a new balance is required. The gait measurements of the hip moments in the patient group showed that in flexion the level of the isometric measurement was reached. This was not the case for the other directions, as for the adduction only 2.5%, for the extension movement 45.8% and for the abduction 53.9% of the isometric maximum was reached.

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Image: results figure 1-3_None.JPG (see online)

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Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3153-351]

Comparison of Maximum Isometric Hip and Knee Joint Moments in Trans-tibial and Trans-Femoral Amputees with Moments During Gait

Author
Heitzmann, Daniel (Heidelberg DE) | Dipl. Ing. (FH)
Orthopädische Universitätsklinik Heidelberg - Ganglabor

Coauthors
Alimusaj M., Becher B., Braatz F., Wolf S.I.

Abstract
Maximum isometric moments of transtibial (TT) and transfemoral (TF) amputees were tested at the residual limb hip and knee. Compared to controls, TF showed hip strength deficits in all motion directions while TT had knee and hip strength deficits in all directions but in hip adduction and extension.

Introduction
The decrease in muscle strength, volume and allocation of the different fibre-types of the residual limp is a common finding in TF [1] [2] and TT [3]. This weakening can be explained by the loss of muscle insertions due to amputation, changed activation-pattern and contraction-amplitude of muscles and an unsymmetrical loading-distribution on both limbs during ambulation. The aim of this study was to evaluate to which extent isometric strength deficit induces compensatory mechanisms in gait of amputees. These mechanisms could be e.g. enhanced lateral-trunk-tilt in TF by means of weak abductors [4] or co-contraction of quadriceps and hamstrings in TT in order to stabilize the knee joint [5]. A new measurement device for testing maximum isometric joint moment (MIJM) was established by combining optical 3D motion capture with a static force measurement. The intention of this method is to get information of segment orientation and force direction next to the force magnitude.

Methods
10 TF, 7 TT (trauma caused, unilateral amputation), and 12 healthy controls (NORM) underwent a conventional 3D gait analysis (12 camera Vicon system; 120 Hz; kistler force plates) and were tested for MIJM of the hip and the knee (TT, NORM only). The isometric strength was recorded using the new device “OpTIMo” (Optical Testing of Isometric Moments) developed in the laboratory. During hip MIJM measurement the subjects stood supported at the trunk inside a rigid frame equipped with skin mounted markers (PlugInGait markerset, Fig. 1). The measured segment was connected to a force transducer fixed to the frame through a cuff and a rope. For measurement of knee MIJM, the thigh was also supported. Analogue force data and optical data were simultaneously captured by the Vicon system. Lever arm and force direction were obtained using additional markers placed on the cuff and rope. Joint moments were calculated via cross products. To check repeatability, all controls were tested twice.

Results
A good reproducibility between sessions was verified with an ICC of 0.765. MIJM for hip flexion, abduction and knee flexion, extension in TT and for all four movement directions of the hip in TF were significantly smaller than those in controls (Fig. 2).Comparing MIJM with the according maximum moments during gait the MIJM should be higher in order to assure stability. In controls, the maximum isometric moments always

exceeded by far their maximum joint moments during gait whereas in TT and TF this was not always the case. Comparing MIJM of TT and TF with physiological maximum joint moments during gait the isometric/ gait moment ratio is even smaller. In this assessment only one of the TT could exceed physiological knee extension moment with isometric performance. TF didn't reach physiological joint moments during gait with their in MIJM in hip abduction and flexion. For hip extension 7 out of 10 TF reached the physiological extension moments during gait with their MIJM.

Conclusion

According to Fosang et al. [6] maximum isometric hip and knee joint moments in controls are larger than maximum joint moments during gait which is supported by our findings. The fact that TT and TF develop joint moments in gait which are closer to their maximum isometric joint moments compared to controls suggests that compensatory mechanism during gait are induced at least partially by strength deficits besides other parameters like e.g. prosthetic alignment [7] socket design and prosthetic components. These results suggest that the standard rehabilitation protocol of lower limb amputees should include strength training of the involved limb. Further investigation of strength in TT and TF after strength training should be performed to prove the theory that an enhanced isometric/gait moment ratio can reduce compensatory mechanisms of amputees and improve stability.

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Image: Abb.Comparison of maximum isometric ...._351.png (see online)

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Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2969-167]

Increased Walking Habits and Decreased Energy Cost with Osseointegrated Transfemoral Prostheses – Prospective Results from the OPRA Study

Author
Hagberg, Kerstin (Göteborg SE) | PhD
Sahlgrenska University Hospital - Dep. for Prothestics and Orthotics, Centre of Orthopaedic Osseointegration

Coauthors
Brånemark R

Abstract
This prospective study on 20 patients treated with osseointegrated transfemoral prostheses show decreased energy cost and increased walking habits at 2-years follow-up as compared to the preoperative situation when using conventional socket prostheses.

Introduction
Increased energy cost among patients using conventional transfemoral (TFA) prostheses has been frequently reported. Today bone-anchored prostheses have become an alternative treatment. One outcome of specific interest is whether such prostheses affect the energy cost and whether walking habits change after treatment.
Prospective outcomes on patients treated with bone-anchored prostheses are of significant importance, but have so far been sparse. One paper from the Swedish OPRA-study have reported improved quality of life and prosthetic function in 18 patients with TFA treated with osseointegrated prostheses (OI-prostheses) [1]. The treatment consists of two surgery sessions and rehabilitation [2]. The OPRA-study includes 51 patients and each one is followed for two years. The aim of the current report is to investigate prospective outcome of energy cost and self-reported walking habits among a subset of patients included in the OPRA study.

Methods
All patients in the OPRA-study with unilateral TFA that have performed the Physiological Cost Index (PCI) test preoperatively and that have passed the 2-year follow-up until May 2009 are included. Assessments were performed preoperatively, at 1-and 2-year follow-up and included answering the Questionnaire for Persons with Transfemoral Amputation (Q-TFA) and testing PCI. Those not using prostheses at any of the assessments were excluded.
The Walking Habit score (in Q-TFA) ask questions on walking distances performed outdoors the last three months. It results in a score 0-100 in which 0 means never walked 50m and 100 means daily walking distances of 5km [3].
The PCI is based on the linear relationship between oxygen consumption and heart rate (HR) [4]. Our test included registration of HR at rest and during 5 min walking in comfortable speed (CWS) on a 90m floor track. The normal walking-aid was used. The PCI formula used was (Mean last 3 min HR walking – Mean HR rest)/CWS m/min.

Results

Twenty patients (8 male, 12 female) had performed the two assessments at all three occasions. Those excluded were; 6 bilateral TFA, 9 not yet followed for two years, 8 not using prostheses preoperatively, 6 PCI test not performed preoperatively and 2 not using OI-prostheses at follow-up. Mean age of the study group at inclusion was 45 yrs (Sd 13.2) and at amputation 31 yrs (Sd 14.9). The cause of amputation was in 65% trauma (20% tumour, 15% other). Five had an additional impairments affecting gait.

Both measures were statistically significantly improved at follow-up compared to the preoperative situation (Table 1). Patients reported more walking outdoors resulting in a higher Walking Habit score at 1- and at 2-years. A non-stopping walking distance of 500 m performed at least several times/week was reported among 30% preoperatively and among 65% at follow-up. The energy cost, estimated by the PCI, was lower at 2 years follow-up as compared to preoperative. The mean HR at rest was not different between assessments (beats/min; 76, 75, 77 resp.), mean HR while walking was decreased at follow-up (beats/min; 118, 109, 112 resp.) and the mean CWS was increased at 2-years (m/min; 56, 55, 59 resp.).

Conclusion

This is the first study to show statistically significantly decreased energy cost when walking with bone-anchored TFA prostheses compared to conventional socket prostheses. In the current study the decrease of energy cost is not obvious until two years after treatment. However, the results show that statistically significantly more walking outdoors was performed already one year after treatment. The improvement of self-reported walking habits confirms already published results on improved prosthetic function with OI-prostheses [1]. Further analyses of energy cost and walking habits after treatment with OI-prostheses will be reported when all patients in the prospective OPRA-study have been followed for 2 years.

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Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3420-595]

Instrumented Motion Analysis and Trans-tibial Prosthetics: a Systematic Review

Author
Rusaw, David (Jönköping SE) | MSc
Jönköping University - School of Health Sciences - Rehabilitation

Coauthors
Ramstrand N

Abstract
A systematic review was conducted to critically evaluate methods used during three dimensional motion analysis of trans-tibial amputees. Presented is a critical review of the level of evidence, quality of research design, and summary of dependent and independent variables utilized by researchers.

Introduction
Joint kinematics is one of the most commonly reported outcomes from motion analysis and is often used in combination with temporospatial and kinetic variable to describe human movement. While a large number of studies have investigated kinematics of trans-tibial amputees performing a range of different activities, there appears to be a great deal of variability in the methods of data capture, the description of these methods, reporting of joint kinematics and in the interpretation of research findings.
The aim of this review was to critically examine the methods used by researchers in collecting and reporting three dimensional kinematic data related to trans-tibial amputees. We further aimed to review specific independent and dependant variables that have been investigated in studies of trans-tibial amputees and to propose recommendations relevant to future research in this area.

Methods
A literature search was conducted in June 2009 of the Medline, Cinahl, and Cochrane databases incorporating the search terms: “kinematic”, “biomechanics”, “amputee”, “prosthesis”, and “foot”. The search was limited to English language publications within the period spanning January 1984 to June 2009. Papers were deemed fit for inclusion in the analysis if they: utilized an experimental research design, collected three dimensional kinematic data and included trans-tibial amputees as experimental subjects. The literature search yielded 661 individual articles (597 Medline; 78 CINAHL;1 Cochrane; some articles appearing in multiple databases). After an initial review 69 papers remained, each of which was reviewed and classified according to the evidence hierarchy outlined by Bhandari et al., 2006. Articles were further evaluated for methodological quality using the Critical Review Form for Quantitative Studies developed by Law et al., 1998.

Results
Of the 69 studies included in this review, 3 were classified as Level II (sub-category B; poorly designed RCT), 23 were classified as level III studies (sub-category A; case-control studies) and 43 as level IV studies (34 sub-category A, case-series studies; 9 sub-category B, case-report studies). Sample sizes in the reviewed publications ranged from a single-subject case-study design to 43 subjects. The mean number of subjects across all publications was 8.7 (SD 6.4). In articles where it was possible to determine, pooled mean age of subjects in all articles was 42.4 years (SD 13.7), with 393 males and 71 females

(a proportion of 0.85 to 0.15). The methodological quality (Law et al., 1998) of the papers (maximum possible=16) showed considerable variability (mean score of 10.1; SD=2.5; range = 2-15). A review of data capture techniques used in studies involving trans-tibial amputee kinematics revealed a great deal of variation in the specific methods used. Of note are the differences in the placement of marker for capturing three dimensional motion of limb segments, the activity amputees were required to undertake and the velocity at which subjects were required to ambulate. Of the 69 studies, 33 stated that the markers were positioned on the prosthesis by estimating the location of the points from the intact limb and 36 studies did not state how they determined the positions of the markers. Sagittal plane kinematics of foot and ankle were the most documented variables.

Conclusion

A number of methodological problems were repeatedly identified in the studies reviewed. As such, the authors recommend the following practices to those intending to conduct research on trans-tibial amputees in the future.

• Clearly state the model and model number of prosthetic components used
• Clearly state how you determine the location of reflective markers on the prosthesis
• Axis of rotation for plantarflexon/dorsiflexion should be investigated for different types of prosthetic feet as this is another source of systematic variation specific only to amputee gait.
• When reporting kinematic and kinetic data be very clear whether you are presenting data from the sound or affected side.
• If reporting ankle kinematics, report both foot dorsiflexion and plantarflexion from a zero point defined as the position of the foot relative to the shank when the foot is unloaded.
• When possible use a control group.

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Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2965-163]

Stability Parameters: Intact and Prosthetic Limbs

Author
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Coauthors
Kendell C, Lemaire ED, Kofman J, Dudek Dr. N

Abstract
Plantar pressure data were collected while unilateral transtibial prosthesis users performed six walking tasks. Six dynamic stability parameters were extracted for each limb. The intact limb compensated for instability, enhancing stability during stance-phase on the prosthetic side.

Introduction
The incidence of falls among individuals with lower-limb amputations highlights the need for research on dynamic stability in this population. While studies have attributed falls to intrinsic, environmental, and prosthetic factors [1, 2], biomechanical factors affecting stability have largely been ignored. Clinical tests used in a rehabilitation setting are observational, subjective, and rarely assess dynamic stability. Laboratory-based systems cannot assess dynamic stability in the community. Recently, Lemaire et al. [3] identified six dynamic stability parameters, derived from plantar pressure data. An increase in each parameter value corresponded to an increase in dynamic instability. The current study used these six parameters to investigate dynamic stability in unilateral transtibial prosthesis users. Differences between the intact and prosthetic limbs were examined.

Methods
Plantar pressure data were collected from 20 unilateral transtibial subjects (F-Scan Mobile, 120Hz) as they walked over level ground, uneven ground, upstairs, downstairs, upramp, and downramp. Six parameters were calculated: AP: number of shifts in anterior/posterior center of pressure (CoP) trajectory beyond a preset threshold; ML: number of shifts in medial/lateral CoP trajectory beyond a preset threshold; CellTrig: maximum number of times a sensor turns on, normalized by number of frames per stride; MaxLat: distance between the medial edge of the sensor and the most lateral CoP value, normalized by sensor width; ST: stride time (foot strike to foot strike on the same foot); DST: double support time (with both feet contacting the ground). For each subject and condition, average values for each stability parameter were calculated for the prosthetic and intact limbs. Paired t-tests ($p < 0.05$) were used to compare means for the intact and prosthetic limbs.

Results
In 29 out of 36 cases (6 parameters, 6 walking conditions), values for the intact limb were greater than the prosthetic limb. AP, ML and CellTrig were greater on the intact limb for all conditions. In terms of significant differences, AP values for the intact limb were significantly greater than the prosthetic limb for all conditions. ML values for the intact limb were significantly greater than the prosthetic limb for level and downstairs conditions. CellTrig values for the intact limb were significantly greater than the prosthetic limb for downramp and downstairs. DST values for the intact limb were significantly greater than the prosthetic limb for upramp, upstairs, and downstairs. For MaxLat and ST, there were no significant differences between limbs. While values for the prosthetic limb were greater than the intact limb for seven cases,

these values were never significantly greater. Significant differences between limbs mainly occurred for downstairs (four of six variables).

Conclusion

Higher values on the intact limb indicated an higher dynamic instability on that side. The intact limb has the musculature and motor control required to sense and correct for disturbances to equilibrium that occur during walking. Higher AP, ML, and CellTrig values are indicative of shifts in CoP to control the body center of mass [4, 5]. Fewer shifts occur on the prosthetic limb, likely due to reduced range of motion, designs that promote controlled forward progression, and/or a motor pattern optimized for stability during prosthetic weight-bearing.

Lack of significant differences for MaxLat and ST were likely due to high inter-subject variability. DST was typically greater on the intact side, maximizing time on the intact limb. Although higher stability parameters reflect instability, higher values on the intact limb may contribute to an increase in overall stability, as long as peak values on the intact limb do not approach the limits of an individuals threshold of stability.

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Image: Table 1-Difference Between Limbs_None.PNG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223038/cg34943

Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3317-492]

Knee Kinematics Measurement on Above-knee Amputees during Gait in Real-life Environment using Inertial and Magnetic Measurement Units

Author
Raggi, Michele (Vigorso di Budrio IT) | B.Sc.
INAIL Centro Protesi - Motion Analysis Laboratory

Coauthors
Cutti AG, Raggi M, Davalli A

Abstract
Evaluation of the accuracy of Inertial and Magnetic Measurement Units when measuring prosthetic knee kinematics was presented. Furthermore, a new kinematic coupling method to improve the accuracy and to correctly represent the kinematics of a C-Leg prosthetic knee was tested.

Introduction
A protocol was developed to easily measure on amputees the thorax-pelvis and lower-limb 3D kinematics during gait in free-living conditions [1], by means of Inertial and Magnetic Measurement Units (IMMU), such as MTx (Xsens Technologies, The Netherlands). The evaluation of the accuracy was carried out on healthy subjects, but the presence of ferromagnetic materials inside of the lower limb prostheses may limit the use of the IMMU for representing the proper prosthetic limb kinematics. Moreover, the evaluation of the unimpaired limb is also important for supporting the rehabilitation treatment and the design of prostheses. The aims of this work were to (1) evaluate the dynamic accuracy of MTx compared with Vicon, assumed as gold standard, when above-knee amputees are fitted with a C-Leg (Ottobock, Germany) electronic knee and (2) test a new method for improving the dynamic accuracy and correctly representing the knee kinematics of the prosthetic limb.

Methods
An above-knee amputee fitted with a C-Leg electronic knee prosthesis participated in the experiment after giving his informed consent.
Combined acquisitions of 5 walking trials were measured inside of the laboratory, running Xsens and Vicon simultaneously [2]. For both the limbs, segment kinematics in terms of quaternions were compared as described in [3].
A previous verification excluded potential magnetic disturbances in the laboratory environment.
Furthermore, 130 walking strides were acquired through the Xsens system out of the laboratory and knee joint kinematics was represented applying C.A.S.T. [4] to the Xsens data, following [2]. 3D kinematics was automatically subdivided in gait cycles using the SEAG algorithm [5]. Confidence bands of joint kinematics pattern were then created following [6].
For (2) a new method developed by Xsens, named KiC (Kinematic Coupling), soon to be released, was applied to the MTx orientations of the prosthetic limb, obtaining new confidence bands.

Results
Segment kinematics comparison among the 5 walking trials between Xsens and Vicon showed mean RMSE values for thigh and shank segment of the prosthetic limb of respectively 2.4° ± 1.2° and 2.3° ± 1.8° .

It is important to notice that these results are related to the individual segments: the error in the relative orientation kinematics can be amplified by the combination of the errors in the two segment orientations. Mean values of coefficient of correlation [3] are close to 1. Hence, the high values of RMSE are explained by the presence of an offset between the orientations provided by the two systems.
Out of the laboratory, knee kinematics of the unimpaired limb, resulting from the application of CAST to Xsens presented patterns consistent with results from literature [7].
For the prosthetic limb, knee kinematics presented large confidence bands for ab-adduction and internal-external rotation angles, respectively from -12.5° to 12.5° and from – 15° to + 15° .
When applying the kinematic coupling method, the bands for ab-adduction and internal-external rotation were restricted to [-2° , 0.7°] and [-2.3° , 1.7°] .
In the figure, differences in knee joint angles when comparing Xsens and Xsens after applying KiC, sharing the CAST technique, are presented during the outside walking trials.

Conclusion

In order to accomplish aim (1) the following hypotheses needed to be verified: 1a) the prosthetic side is affected by magnetic disturbances in dynamic conditions and 1b) the magnetic disturbances in 1a) do not affect the measurement of the unimpaired limb during walking.
Outside walking measurement showed that the prosthetic limb does not affect the knee kinematics measurement for the unimpaired limb.
Results for the prosthetic knee during the outside walking confirmed the inaccuracy problems found in the segment kinematics. Although knee flexion-extension angle seems to be well represented, it is worth to notice that the prosthetic knee joint is designed as an hinge joint, i.e. ab-adduction and internal-external rotation angles must be theoretically null.
KiC method was proved to be effective in improving the accuracy of knee kinematics representation during gait.

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Image: Figure_Garofalo et al_ISPO 2010_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223038/cg43890

Session: Lower Limb Prosthetics - Biomechanics 1
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2935-133]

CAA - Computer Aided Alignment: A Novel Method of Electronical Measuring for Improved Leg Prosthesis Alignment Based on Objective Criteria

Author
Seyr, Martin (AT) | Dipl.-Ing. Dr.
Otto Bock Healthcare Products GmbH - R&D

Coauthors
Schneider GLS, Kampas PA, van Vliet JW

Abstract
A method has been developed to give component dependent bench alignment recommendations on a PC screen. For this, sensors in a knee prosthesis compute components and position of the static ground reaction force relative to the prosthesis. This method allows objective alignment without a gait-lab.

Introduction
Alignment of leg prostheses is treated as a high art performed by the CPO. CPOs rely on their experience to fit the prosthesis to the need of the wearer. Yet, in the typical setup feedback on the success is limited to visual impressions and the remarks of the wearer, and therefore imprecise by nature. To date, objective data could only be retrieved in a gait-lab. Commonly, patients are not fitted in a gait-lab. Goal of this work is to provide means that help the CPO to see "inside the prosthesis" how it is actually loaded and how forces pass critical landmarks of the prosthesis. Through a PC software, optical feedback of the actual reaction forces is given and optimization recommendations are computed. These recommendations help the CPO to improve the result of the fitting.

Methods
Internal sensors of a microprocessor controlled knee prosthesis are used to measure the ground reaction force. The inputs of the sensors are processed to provide information on the position of the ground reaction force relative to critical landmarks of the prosthesis as well as the cartesian components of the ground reaction force relative to the ground. This information is prepared for a visual display and has been compared to experts opinions for an optimization of the alignment. Based on the experts opinions rules for optimization recommendations have been found.
Since the prosthetic foot influences the allignment, characteristics of different feet have been measured to give an individual bench alignment recommendation based on the foot actually used.

Results
Computer aided alignment has been realized in form of a microprocessor controlled knee prosthesis and a PC software. The PC software gives an individual bench alignment recommendation based on the components used in the prosthesis. It also displays the cartesian components of the ground reaction force and the position of the ground reaction force relative to the prosthesis online. The information is used to give optimization recommendations to the CPO.

Conclusion

A tool has been developed to aid the CPO in aligning a leg prosthesis. It measures objective data of the loading situation of the prosthesis. The data is used to give a visual feedback of the loading condition and to give optimization recommendations to the CPO. By integration of the tool in the prosthesis and the PC software to set it up, high quality data can be obtained without the need of a gait-lab.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223038/cg34766

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3813-None]

Comprehensive Overview of Proximal Femoral Focal Deficiency (PFFD)

Session Chair
Crandall, Robin (Minneapolis, Minneasota US) | MD
Shriners Hospital for Children, Twin Cities

Abstract
Proximal femoral focal deficiency is a rare disorder but commonly seen in pediatric limb deficiency centers. Decision making for this problem is complex and multifactorial. The purpose of this symposium is to present a comprehensive look at this malady. This seminar will cover diagnosis, classification, conservative treatment, operative treatment both complex and simple, long-term follow-up, bilateral cases, genetics and complication of treatment. An in-depth discussion of appropriate femoral length, rotationplasty, and prosthetic fitting will be emphasized. A panel discussion will follow with audience participation encouraged.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg496743

Symposium: Comprehensive Overview of Proximal Femoral Focal Deficiency (PFFD)
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Children

Congress Lecture [4051-885]

Femoral Deficiency Syndromes (PFFD): A Comprehensive Review of Classification Systems and Treatment Options

Author
Crandall, Robin (Minneapolis, Minneasota US) | MD
Shriners Hospital for Children, Twin Cities

Abstract
Femoral deficiency syndromes are rare anomalies often referred to as proximal femoral focal deficiency (PFFD). They are frequently seen in busy pediatric centers and often create the most difficult decision making problems.

Introduction
This paper will review classification systems and overview useful methods for decision making considering the different clinical presentations. A discussion of genetics, review of surgical and nonsurgical options, and bilateral cases will be presented. This talk will serve as a useful introduction to papers given by Dr. Krajbich, Dr. Watts, and Eugene Banziger, CPO.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg496743/cg2460962

Symposium: Comprehensive Overview of Proximal Femoral Focal Deficiency (PFFD)
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Children

Congress Lecture [4052-889]

PFFD - Surgical Treatment

Author
Krajbich, Ivan (Portland, OR US) | MD
Shriners Hospital for Children

Introduction
Hip joint deficiency can be addressed by proximal femoral restoration osteotomy plus/minus acetabuloplasty in Aitken's type A & B deficiencies while hip treatment in Aitken's type C & D remains controversial. The knee joint is best addressed by rotationplasty as long as ankle and foot have sufficient functionality. It is combined with knee fusion to provide stable, solid one-bone thigh. The Symes amputation combined with knee fusion is reserved for patients with nonfunctional ankle/foot. Rotationplasty prosthesis or above-knee like prosthesis for patients with Symes amputation is used for length restoration.
Classification based on hip reconstructability and presence of functional ankle/foot complex is used as algorithm for recommended treatment.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg496743/cg2461598

Symposium: Comprehensive Overview of Proximal Femoral Focal Deficiency (PFFD)
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Children

Congress Lecture [4053-893]

Fusing the Knee in Children with Severe Femoral Deficiency (PFFD): Getting the Appropriate Stump Length

Author
Watts, Hugh (Los Angeles, CA US) | MD
Shriners Hospital for Children

Introduction
Problem:
usual result is the stump ends up too long for proper fitting of a knee joint.
Causes:
- many children with severe femoral deficiency (PFFD) have hip flexion contractures, so taking measurements from AP films rather than lateral gives a falsely short estimate of ultimate length
- In 95% of such children, the tibia on the short-side will end up at 95% of the length of the long-side tibia
-leaving both physes intact for fear of too short a stump
-thinking that the x-ray of the bone-end is equivalent to the end of the stump.

Conclusion
In most cases, one (or both) physes (distal femoral and proximal tibial) should be ablated at the time of the knee fusion.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg496743/cg2461853

Symposium: Comprehensive Overview of Proximal Femoral Focal Deficiency (PFFD)
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Children

Congress Lecture [4054-892]

Rotation Plasty Prosthetics - A prosthetist’s Perspective

Author
Banziger, Eugene (Kelowna CA) | CPO

Coauthors
Eugene Banziger, CPO

Introduction
Femoral Deficiency Syndrome (PFFD) can result in a rotation plasty procedure, (Van Nes Rotation Plasty). Rotation Plasty Prostheses are rare and challenging and not too many prosthetists are exposed to it or have extensive experience in the fitting of prostheses for this type of client.

Results
The presentation will contain aspects of assessment, biomechanics, including some design and fabrication issues. The results will encompass designs for everyday use and recreational needs.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg496743/cg2462235

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3683-None]

Open Topics 2

Session Chair
Gibeault, Amanda (Montréal, Québec CA)
Cetco Capital (OrtoPed) - Research

Session Chair
Roßdeutscher, Wolfram (Berlin DE) | Dr.-Ing.
TU Berlin - Fachgebiet Medizintechnik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [2891-89]

Stimulation System for the Influencing of the Posture – A Case Study

Author
Roßdeutscher, Wolfram (Berlin DE) | Dr.-Ing.
TU Berlin - Fachgebiet Medizintechnik

Coauthors
Vonnemann A, Vonnemann D, Herrschaft S

Abstract
For a woman with hemiparesis a stimulation system for the influencing of posture and gait has been developed. The system stimulates in a way that the deviation to horizontal position of shoulders can be perceived and the disabled person is able to correct this independently.

Introduction
Disabled persons with a hemiplegia - in particular with reduced sensitivity – have great difficulties to influence the posture. This is mostly possible only through optical control for example with a mirror or through the feedback of a supporting person. A positive influencing of the posture and the gait can be achieved by physiotherapy and continuous training with a corresponding feedback.
For a disabled young woman a stimulation system that provides her with the feedback information, necessary for the correction of the posture, has been developed.

Methods
The system supplies the muscle groups that correct the position of the shoulders (here: Rise shoulder) with the needed information by stimulation for motor activity as well as sensory perception. The position of the shoulders is measured with sensors. Depending on the deviation to the normal horizontal position of the shoulders the system stimulates in a way, that the deviation can be perceived and the disabled person is able to correct the position independently. The stimulation must be able to be adapted both to the current perception and to the different sensory sensitiveness of both (left/right) sides.

Results
In the beginning the stimulation device was used in a testing phase for 18 days in each case for 30 minutes, having an outdoor walk. From the second day on there were a clear improvement of the posture which increased constantly in the following training days. In comparison to the first day the shoulder position improved at least three degrees within the 18 days phase. After about a week training time a possible placebo effect appeared: After putting on of the electrodes the shoulder was brought into the horizontal position without support of the device. Right now, after one year of use the sensitivity of the measuring system had be decreased from 15 degrees to 5 degrees, because the posture is much better now. There is a measurable, clear improvement of the shoulder position.

Conclusion
The test person, a young woman, to whom the use of a wheelchair has been predicted for the rest of her life, has been used the stimulation system now for more than one year and the system has

become indispensable to her. She is still highly motivated and would like to present the system live in the presentation.

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Gutmann, Anna: Verfahren und Gerät zur Haltungs- und/oder Bewegungskorrektur von Körperteilen

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg33897

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3267-442]

Device for Calibration of Sensors for Prosthetic Socket Interface Pressure Measurement

Author
Bryant, Tim (Kingston, ON CA) | Dr.
Queens University - Human Mobility Research Centre

Coauthors
Bryant JT, Hernandez KM, Towsley LL, Castanada MG, Guevarra ME, Trebbin KH
Queens University, Kingston, CANADA; Universidad Don Bosco, San Salvador, EL SALVADOR

Abstract
A new apparatus was designed for the calibration of thin film socket pressure sensors based on an inflatable bladder replicating the geometry of a representative transtibial residual limb. Average pressure measurement errors of 15-20% were demonstrated using two different calibration protocols.

Introduction
The purpose of this study was to develop and evaluate a new apparatus for calibrating sensors used in prosthetic device fitting under conditions similar to those experienced with patient use. A bladder and a residual limb phantom were used based on the method of Dumbleton et al. (2009). Two methods of calibration were compared: 1. A custom technique developed at the Universidad Don Bosco involving pre- and post-test measurements; and 2. A manufacturer-recommended technique using equilibration and calibration. Variation in sensor precision and accuracy was examined with respect to the calibration method, age of the sensors, sensor location, and order of calibration.
Tekscan™ 9811 sensors with a 1-25 psi (6.9- 172 kPa) operating range (76.2 mm by 203.2 mm sensor matrix, consisting of 6 columns and 16 rows, or 96 sensels).
Sensors were divided into four areas of 4 rows of 6 columns and the average pressure in each area (AVG1) computed as the measured variable.

Methods
An inflatable bladder was formed using silicone rubber caulking and polyester fabric residual limb based on a plaster form of typical transtibial residual limb length of 20 cm. An air inlet allowed attachment to a precision-regulated air supply. During calibration, sensors were placed on the anterior and posterior surfaces of the bladder and a 3mm thick Pelite™ liner placed over the sensors. Two methods were used:
1. Sensors were calibrated for five equally spaced pressures over the range 0-30 psi (0 – 207 kPa) before and after each test session. A scaling factor was determined using linear regression using the ten measured values and forcing the data through (0,0).
2. Two techniques were used: (a) 1-point equilibration and a 1-point calibration were done at 138 kPa (20 psi); (b) a 3-point equilibration was done at 138, 86 and 34 kPa (20, 12.5 and 5 psi), and a 2-point calibration was done at 138 and 69 kPa (20 and 10 psi).

Results
In test sessions, Raw sensor data for twenty random pressures over the operating range were recorded and subsequently converted to pressure units according to the calibration method. In both methods, sensors

were completely removed after one session prior to placement in the subsequent session. In Method 1, test data were obtained between the two calibration sessions, while in Method 2 test data were obtained after equilibration and calibration.
Errors were determined by using the method of Bland and Altman (1999) in which the mean difference between the measured and test values (bias) estimated the accuracy, and the standard deviation of these differences estimated the precision.
No differences in accuracy or precision were observed based on calibration method. Using new sensors, bias ranged from 7 – 20 kPa and the standard deviation of measurement differences ranged from 12 – 18 kPa. A significant difference was observed in sensors that had been used for more than 50 test cycles in which these errors were approximately twice these values. The areas most proximal on each sensor were significantly less accurate and precise than the other three regions.

Conclusion

A method of calibration for socket pressure measurement instrumentation has been descried that is based on the use of a reference lower limb simulator. The study design was intended to replicate measurement conditions involving patients. Of particular concern was the effect of sensor placement after calibration. Results indicated that typical errors were in the range of 15-20 % of full scale when sensors are repositioned after calibration. Precision and accuracy of average pressure measurements obtained using a custom pre- and post calibration were equivalent to those using equilibration. However, measurement errors rose significantly with aging of the sensors.
It is recommended that a pressure-based method be used for socket sensor calibration using either custom or equilibration techniques. Whenever possible, new sensors should be used; however future work should develop guidelines for the number of acceptable test cycles for these devices.

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Image: Calibration Bryant_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg43536

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3038-236]

A Gap in Disability Studies Writing: Analyzing References to the Prosthetics and Orthotics Professions

Author
Gibeault, Amanda (Montréal, Québec CA)
Cetco Capital (OrtoPed) - Research

Abstract
This study analyzes the limited references to the prosthetics and orthotics professions in disability studies literature, proposes reasons for this, and relates this to the prosthetics and orthotics professions.

Introduction
To analyze the limited discussion of prosthetics and orthotics in disability studies literature, and discuss the relevance for the prosthetics and orthotics profession. Disability studies is an interdisciplinary field of scholarship that grew out of activism. It aims at understanding disability in order to further the goal of social inclusion or liberation of disabled people. The lack of discussion of the prosthetics and orthotics profession in disability studies warrants analysis for at least two reasons. First, policy decisions are often affected by members of the disability studies community (Bickenbach 2008, Peters 2003, Ustun 2001). Second, contact with disability studies may enable increased understanding of concerns for both disability studies and for prosthetists and orthotists. Greater understanding can lead to even better care for patients.

Methods
This study describes the references to the prosthetics and orthotics profession in four recent central disability studies anthologies (Albrecht 2005; Swain et al 2004; Ingstad and Whyte 2007; Kristiansen, Vehmas, and Shakespeare 2008), three books by prominent scholars (Mercer 2003, Shakespeare 2006, Snyder and Mitchell 2006), and the seminal journal (Disability and Society). The study also tracks recent social science articles published in Prosthetics and Orthotics International (POI) for comparison of focus. The study tracks key terms: rehabilitation, rehabilitation professionals, prosthetics and orthotics. Analysis will proceed along two axes. First, the quantity of references will be tracked. Second, the positive and negative valence of references will be analyzed. These results will be incorporated into a discourse analysis, which involves an analysis of the socio-cultural features of discussions of disabled persons, both in disability studies writing, and in POI.

Results
Prosthetics are rarely discussed warrant limited attention (Albrecht 2005, 102, 1012; Ott 2002, 2; Tyjewski 2006, 120). Orthotics are only directly mentioned in Albrecht (2005, 1098). Rehabilitation professionals have historically been perceived negatively in disability studies writing, with some change recently (Shakespeare 2006, 185-198; Swain et al 2004, 201-264). Orthotics and prosthetics profession are neglected in this literature for two reasons. First, writings on the history of disability have been focused on historical abuses of people with disabilities through rehabilitation therapies ; in the literature, all rehabilitation-related professions have been grouped together. Second, the different object of study in disability studies and in prosthetics and orthotics research may have inhibited professional, scholarly interaction the nature of the prosthetics and orthotics profession, which must focus on technologies for individuals, and disability studys focus on social and cultural features of

disability .

Conclusion

The prosthetics and orthotics profession is largely overlooked in disability studies writing.
Greater contact between disability studies and the prosthetics and orthotics professions is desirable because of the possibility for greater understanding of disability and of patients, as well as the possibility for encouraging the inclusion of the prosthetics and orthotics profession in discussions of disability and rehabilitation. Given some recent trends in disability studies research towards interactive theories of impairment (Shakespeare 2006, 54-55), further investigation of topics of mutual concern is warranted and may be timely.

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Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3078-276]

Incidents with Medical Devices for Massage and for Physical Exercises

Author
Behmann, Ilka (DE) | Dr.
Federal Institute for Drugs and Medical Devices (BfArM) - Medical Devices

Abstract
The Federal Institute for Drugs and Medical Devices (BfArM) is Germany's Competent Authority for assessing incidents with medical devices.
BfArM presents a survey about incidents with products for massage and physical exercise: Treatment-tables, units for physical exercise and for mobilisation.

Introduction
BfArM assessed 66 incidents with these products from 1998 to 21.08.2008.
35 cases involved treatment-tables, 27 units for physical exercises and 4 devices for mobilisation.
Most cases (34) were reported by the manufacturer, his Authorised Representative or importer.
21 reports came from users (medical practices, hospitals).
11 reports had different origins, e. g. further companies or authorities.
The majority of the incidents (56) involved mechanical problems like tilting of the product or of parts of it, fractures of the construction and entrapment in the product.
10 reports concerned various defects like patient falls, further injuries, failures of the electrical system and other malfunctions.
Mostly, no or just small injuries (bruises, lacerations) occurred (37).
However, 12 incidences resulted in severe injuries (ligament rupture, fracture, phalanx amputation) and 4 incidences had critical or fatal consequences.
13 reports did not mention concrete information about consequences.

Methods
17 incidents were caused by faulty design and 17 emerged from faults in manufacturing process.
Faulty design includes insufficient dimensioning of constructional elements and connections with insufficient capacity as well as inadequate product documents.
Manufacturing faults were mostly deficient welding and assembly errors.
21 incidents were related to external factors (patient's disease, mechanical overload).
11 incidences revealed no concrete cause, e.g. if investigation of the product was not possible.
Corrective actions to eliminate product-related flaws were taken in 33 cases.
Incidences with medical devices for massage and for physical exercises can result in serious injuries, caused by functional equipment: The devices have engine-driven components and suspended weights to support and mobilise the patient and to offer physical exercises.
Caused by the power of the engine and the construction's weight, severe injury can result from mechanical impact of the device on a person.

Results
Prevention affects the following scopes:

- Construction
Construction should be dimensioned sufficiently solid and component parts should be connected securely. Sufficient protection against entrapment in moving parts should exist. Entrapment zones should to be avoided or inaccessible.
Inadvertently activation of the system should be prevented. BfArM recommended a respective corrective action in 2004.
Instructions for use should show correct working position and contain warnings of hazardous zones.
Product's particular operating status should be visible clearly.
- Manufacturing
Manufacturing should provide careful processing (namely welding) and appropriate control.
- External factors
Manufacturer's instructions of use, servicing and maintenance should be followed.
Use of a pre-damaged device may suddenly result in an adverse event and should be avoided.
Interactions with a ready-to-operate device should be limited to treatment: Leaning on control elements, dangling legs into the range of product's motion or tying shoes on the floor within the range of the height adjustment system can lead to accidents.
Safety installations (e.g. locking functions) should be engaged consistently when the device is not in use.
The device's motion range should be kept free. Within its range, no obstacles, persons or limbs should be positioned.
Patient's state of health and physical condition should be considered (osteoporosis, circulatory disorder) to decide if use of the product is acceptable.

Conclusion
High Forces are present in medical devices for massage and for physical exercises which can result in serious injury during an adverse event. Particularly, this concerns unexpected mechanical impacts on persons, e.g. by sudden tilting of load-bearing units.
Due from the product, prevention results from sufficient dimensioning of the construction as well as from proper manufacturing and methodical production control.
On the part of the user, he should be aware of the forces that exist in the product and of their possible impact during an accident.

References
Internal Database

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg37358

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3365-540]

Issues in Repairs of Powered Wheelchairs and PAPAWs (Power-Activated-Power-Assisted Wheelchairs)

Author
Behzadi, Ganjali (IR)
JMERC - Biomedical Department

Coauthors
Mostafa,Allami
Vahidian,Mohammad Reza
Samavati,Hasan

Abstract
A suitable wheelchair can be a vital means of mobility. A better understand-ing of the types of wheelchair repairs positively affect wheelchair use. This study was undertaken to demonstrate the differences of failures between PAPAWs and powered wheelchairs.

Introduction
Mobility is very important for participatioin self-care , home, work, school, and leisure activities. A suitable wheelchair can be a vital means of mobility, enabling participation in family and community activities, from income generation to advocacy of human rights. However, daily use exposes wheelchairs to assaults from various environmental and user factors. Wheelchair failures often result from exposure to extreme weather conditions and topographic obstacles .Some wheelchair parts require periodic repair and replacement.Repair and replacement of components can extend the life of wheelchair and make using it much easier. A better understand¬ing of the types of wheelchair repairs needed will lead to improved wheelchair design and thereby positively affect wheelchair use and community participation.

Methods
A descriptive cross sectional study was undertaken to demonstrate the differences of failures between PAPAWs (n = 20) and powered wheelchairs (n = 36). Repair forms were completed for all wheelchairs were referred to a wheelchair repair center in 2008. There were included wheelchairs with mechanically, electronically and electro mechanically failures, independent of the model and manufacture. There were excluded those which that could not repair. The form was used to record the wheelchair repair data was designed specially. It records two domains related to them: seating and propulsion system. The data were analyzed using the software SPSS.

Results
In PAPAWs, 55%of failures was for seating system, 20% was for electronic system and 25%was for electromechanic system . In powered wheelchairs 15% of failures was for seating system , 40%was for electronic system and 45%was for electromechanic system . In PAPAWs and powered wheelchairs about 15%of repairs were perfornable by user or instructed bicycle merder. In avarage in PAPAWs batteries ,electronic boards and chargers were failed and in powered wheelchairs electronic boards and motors were failed more than others.

Conclusion

Powered wheelchairs in comparison with manual wheechairs have more complexities and usually it is failures need intervention of proffesional mender .

Usage of PAPAWs on manual wheelchairs cause incresing of failures in seating system and because these failures are violent (like deflection or fracture) , teaching essential instructions to user is urgent.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg43938

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3320-495]

Storage Systems as an Alternative Fixed Position - Away from the Plaster Cast

Author
Raabe, Jens (Aschau DE) | Dr. med.
Behandlungszentrum Aschau - Orthopädische Kinderklinik

Coauthors
Pohlig-Wetzelsperger C., Döderlein L.

Abstract
The standard of the postoperative procedure after oseotomy is a uncomfortable plaster cast.
We were looking for a comfortable stabile system, what gives us the possibility to unit the advantage of the stability of a plaster cast and the flexibility of a specific physiotherapy.

Introduction
The definition of Orthopaedics as a science was found in the year 1741 by Nicolas Andry (1658 – 1742). In 1829 Ernst August Carus opened the first orthopedic ward in Leipzig. This was continued in 1843 by Daniel Gottlieb Moritz Schreber . Dr. Schreber invented devices rather a lot to tie children, e.g., with belts, so that they kept to certain postures and did not bend.
The first plaster cast was used during the prehistoric senturies. In 1834 Luis Seutin used Linen bandages, rails and strength to cure fractures. But it needs 2 days to became dry and solid.
In 1851 Antonius Mathijsen (1805–1878) had the idea to combine plaster and cotton. Till today this kind of plaster cast is used as a standard of conservative therapy of fractures and also for the fixation of osteotomies . In our modern times we can also take synthetic material fibres with synthetic resin.
But since the time of Schreber the fixation of a limb or what ever often is very uncomfortably.

Methods
In our hospital we cure children with different diseases, syndromes and deformities. Our portfolio contains osteotomies of the hip like Tönnies, Chiari, Pempberton and Dega. Also osteotomies of the axis of the lower limb. And last but not least we take care diplegia and spastic.
The standard of the postoperative procedure mostly is a plaster cast. Often this torture fixed the patient to the bed and bring than less quality of life. Because we treat children with handicaps and retardations, so it is not less of problems to handle the postoperative procedures between the necessary of stability, nursing, motor activities.
Our plan was to bring the patients more quality and more flexibility - less compromise of stability. We try to demonstrate modern possibilities and alternatives for quiet positions. We will show you some examples of storage systems.

Results
At the recommendation and the guideline it is describe how to do after osteotomy. Because we know that the cure of bones need 6 to 12 weeks we recommend a dispensation or a laod with reduced weight. Most of the postoperative patients can get an early mobilisation. But this is not possible with a plaster cast.

During the weeks of fixation the range of motions decreases and the muscles became less of mass and circumference. The consequence is that the plaster cast does not fit any more. So you have to change the plaster regulary. For our little patient this means stress or sometimes a narcosis. And often we saw pressure points in the plaster cast.
We were looking for a comfortable stabile system, what gives us the possibility to unit the advantage of the stability of a plaster cast and the flexibility of a specific physiotherapy.
After osteotomy of the upper limb we use the upper limb storage.
After hip-procedures we need an abduction wedge. In the case of need sometimes we had to find special systems like the side moulding, also the supine position storage, front position storage or the side position storage. So we can use the storage also for the patients with tetraplegia, spastic and storage-conflicts.

Conclusion
To safe quality of life it is not only necessary to do well planed surgery. It is inevitable to plan the fixation. The problems of laying and fixation often are pressure points, the comfort, the daily hygiene.
The storage systems are an alternative fixed position, not only after surgery – also patients with a handicap like motor function disorders or disorders of the skeleton system.
The plaster cast has a lot of indications, the storage system mostly is the better alternative for fixation, comfort and with the possibility of mobilisation and physiotherapy.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg43893

Session: Open Topics 2
Thursday 2010/05/13 | 17:00 - 18:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Congress Lecture [3366-541]

Issues in Repairs of Manual Wheelchairs

Author
Vahidian, Mohammad Reza (IR) | CPO
JMERC - Biomedical Department

Coauthors
Allami,Mostafa
Behzadi,Ganjali
Samavati,Hasan

Abstract
A better understand¬ing of the types of wheelchair repairs positively affect wheelchair use. Many of the failures are performable by instructing user and taking of instructed bicycle menders. This study was undertaken to demonstrate the differences of failures in manual wheelchairs.

Introduction
Mobility is very important for participatioin self-care , home, work, school, and leisure activities. A suitable wheelchair can be a vital means of mobility, enabling participation in family and community activities, from income generation to advocacy of human rights. However, daily use exposes wheelchairs to assaults from various environmental and user factors. Wheelchair failures often result from exposure to extreme weather conditions and topographic obstacles .Some wheelchair parts require periodic repair and replacement.Repair and replacement of components can extend the life of wheelchair and make using it much easier. A better understand¬ing of the types of wheelchair repairs needed will lead to improved wheelchair design and thereby positively affect wheelchair use and community participation.

Methods
A descriptive cross sectional study was undertaken to demonstrate the differences of failures between standard (n = 24) and active (n = 110) manual wheelchairs. Repair forms were completed for all wheelchairs were referred to a wheelchair repair center in 2008. There were included manual wheelchairs with mechanical failures, independent of the model and manufacture. There were excluded those which that could not repair. The form was used to record the wheelchair repair data was designed specially. It records two domains related to them: seating and propulsion system. The data were analyzed using the software SPSS .

Results
60% of failures in standard wheelchairs was in propulsion system and 40% in seating system ,whereas in active wheelchairs 75%of failures was in propulsion system and 25% was in the seating . In propulsion system of standard wheelchairs 8% of repairs was performable by user and 40% by instructed bicycle mender and these amounts in the seating were 5% and 15%. In propulsion system of active wheechairs 5% of repair was performable by user and 30% by instructure bicycle mender and these amounts in the seating were 3% and 10%. Most of failures in manual wheelchairs (standard and active) observed in armrests, legrests and rear wheels however these repairs were more in active wheelchairs in average.

Conclusion

In spite of enjoying technology in fiting of acvtive wheelchairs relation to standared wheelchairs but becuase of frequent usage of active wheelchairs this kind of wheelchairs met failures.Many of the failures are performable by instructing user and taking of instructed bicycle menders. We can assign principal part of wheelchairs repairs to them and save in cost of repairs and maitaining .

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg233596/cg43939

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3948-None]

Wheelchair Provision in Less Resourced Settings

Session Chair
Horvath, Rob (US)
USAID

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1012815

Symposium: Wheelchair Provision in Less Resourced Settings
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3991-924]

Development of the WHO Training Package on Wheelchair Service Delivery

Author
Khasnabis, Chapal (Geneva CH)
World Health Organization

Introduction
Considering the need and realities, WHO is developing the Training Package on Wheelchair Service Delivery in three modules:
• Component 1: Wheelchair Service Provision for Managers - 1 Week duration
• Component 2: Basic Wheelchair Service Provision for practitioners - 2 Weeks duration
• Component 3: Intermediate Wheelchair Service Provision for practitioners - 2 Weeks duration
Basic Wheelchair Service Provision for practitioners module is currently ready for field trial. Soon it will be piloted in India, Solomon Islands and Tanzania. Other two modules are in process of development and will be field tested in 2011.

Results
The key objectives of the training packages are to support health care providers from a broad range of backgrounds in less-resourced clinic and community settings to make an appropriate wheelchair service provision - right matching among wheelchair, users (person with duisability), and users environment. It is also to ensure that wheelchair users have enhanced mobility, and thus for enhanced dignity and productivity. Guiding principles for development of all training package materials are to keep the wheelchair users in the forefront as an active participant in their care, and enhancement of their mobility and productivity. It is also to orient wheelchair service providers to respect need, human rights and dignity of people with disabilities while delivering wheelchair. To ensure this, training package will be supported with a video with standardized and language-neutral visual demonstrations of clinical best practices (including active collaboration between wheelchair users and wheelchair service providers).
WHO Training Package on Wheelchair Service Delivery will come with a DVD, a CDROM, set of posters, PowerPoint Penetrations, and training manual. The symposium will give an update on the development process and its salient features. All the three components of the Training Package on Wheelchair Service Delivery including the video of best practices will be launched on 3rd December 2011.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1012815/cg1854969

Symposium: Wheelchair Provision in Less Resourced Settings
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3992-913]

Impact of Wheelchair Guidelines

Author
Constantine, David (Bristol GB)
Motivation

Introduction
The impact of the WHO Guidelines on the Provision of manual wheelchairs in less resourced settings has been profound. The Guidelines have raised the bar of provision by recognising that the chair alone is not enough to meet the needs of disabled people in less resourced settings

Results
The Guidelines state that wheelchair provision require the three key aspects of products, service set up and training to fully cater for users needs.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1012815/cg1855226

Symposium: Wheelchair Provision in Less Resourced Settings
Thursday 2010/05/13 | 17:00 - 18:30 | Subtopic/Track: Rehabilitation

Congress Lecture [3994-916]

Worldmade - A New Approach to Wheelchair Provision

Author
Rushman, Chris (Bristol GB)
Motivation Charitable Trust UK

Coauthors
Chris Rushman

Introduction
Worldmade is a global programme to help organisations establish or upgrade wheelchair service provision through the supply of appropriate mobility products and training of wheelchair service personnel.
The main features of Worldmade include:
- Supply of a range of appropriate wheelchairs
- Training courses on wheelchair clinical and technical skills
- Support and advice on wheelchair service set up and management

Results
In accordance with the WHO Guidelines on the provision of Manual Wheelchairs in less resourced settings, Worldmade aims to increase access for wheelchair users to good quality wheelchairs and professional wheelchair services. This is achieved through:
• Delivery of training to local staff in the clinical and technical skills required for wheelchair provision.
• Supply of Worldmade wheelchairs and mobility products shipped for local assembly and fitting
• Technical support to local organisations (NGOs, INGOs and governments) to establish or upgrade existing wheelchair service facilities.
In common with local production of prosthetic or orthotics components, local production of wheelchairs is of varying quality, cost and quantity. Worldmade offers an alternative to wheelchair services that do not want to establish local production or where local production is challenging.

Conclusion
Worldmade has been introduced to countries of Asia, Africa, Eastern Europe and South America. Both ICRC and HI have run field trials on the products and are distributing Worldmade wheelchairs through their partner programmes.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg1012815/cg1855740

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3609-None]

Disarticulation Prosthetics

Session Chair
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg98882

Basic Instructional Course: Disarticulation Prosthetics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3610-712]

Ankle Disarticulation

Author
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Introduction
Ankle disarticulation was first performed by James Syme in Edinburgh 1842 before anaesthesia and antiseptics were routinely used in the operating theatres. This presentation will highlight the advantages and disadvantages of ankle disarticulation commentating on the surgical, socket design and functional outcomes.

Results
Discussion: A range of prosthetic solutions will be discussed along with current developments in prosthetic foot design which have sought to overcome the problems of the limited space available between the end of the residuum and the floor. Although ankle disarticulation is a relatively rare operating procedure (Nasdab, 2009) it still has a place in the management of children with congenital abnormalities including congenital longitudinal deficiency of the fibula and proximal femoral focal deficiency.

Conclusion
The history of ankle will be discussed along with the current trends in prosthetic management and rehabilitation.

References
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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg98882/cg99127

Basic Instructional Course: Disarticulation Prosthetics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3611-724]

Hip Disarticulation

Author
Bellmann, Malte (Göttingen DE) | Dipl.- Ing. (FH)
Otto Bock HealthCare GmbH - Research Biomechanics

Introduction

This presentation will provide a general overview of the possibilities of fitting patients with hip disarticulation and hemipelvectomy with prostheses. General biomechanical aspects on pelvic socket prostheses are explained, possibilities of preparing plaster models, technical solutions for shaping the pelvic socket, a method for aligning pelvic socket prostheses as well as the use of prosthetic components according to indication are described. Selected examples from clinical practice are presented.

Results

Only a few number of lower limb amputations are conducted in the pelvic region (Baumgartner, 2008). The most common indications are trauma, tumours and infections in the pelvic regions (Denez, 1997). In recent years, prosthetic fitting of patients with hip disarticulation and hemipelvectomy has progressed significantly. Among others this is ascribed to a more anatomical shape of the pelvic socket. Containment of the ischial tuberosity (Baumgartner 2008) and pubic ramus (Ortiz, 2009) to reduce the mediolateral shift of the pelvis in the socket has been established. The use of modern materials such as carbon-fibre re-inforced plastic in the regions of force transmission in combination with soft materials, e.g. silicone, ethylene vinyl acetate (EVA) and polyurethane, offer the wearer improved comfort. In addition, increased quality is attributed to an improved understanding of the biomechanical relations between standing and walking on this amputation level and especially with a neutral pelvic tilt.

Conclusion

Advanced component technology supports the prosthetic user increasingly in managing demanding movements of daily life (Blumentritt 2008) such as walking on uneven ground and descending stairs and inclines.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg98882/cg99180

Basic Instructional Course: Disarticulation Prosthetics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3612-770]

Knee Disarticulation

Author
Jarasch, Rolf (Göttingen DE)
Otto Bock Competence Centre

Introduction
Compared to transfemoral amputations, the number of knee disarticulations is relatively low. Historically knee disarticulation was the preferred surgical option, however, from the perspective of orthopaedic technology, there were relatively few adequate treatment alternatives.
With the development of new materials and new prosthetic knee joints, the fitting quality of this patient group has been significantly improved. Old prejudices have disappeared, so that today knee disarticulation effectively competes with transfemoral amputation.

Conclusion
The presentation deals with socket fit, component selection and prosthetic alignment considered to be the three factors critical for success. Using patient examples, different fittings are presented and discussed. In addition, the importance of prosthetic alignment is shown and recommendations for static alignment as well as optimization during dynamic trial fitting are explained.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg98882/cg99233

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3604-None]

Rehabilitation of Amputees II

Session Chair
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Abstract
Rehabilitation of amputees is a real challenge. A multidisciplinary approach in an indisciplinary working team is the base to overcome impairments and to reduce disabilities. The use of the ICF is of basic importance. The instructional courses gives an overview of the possibilities of rehabilitation in these patients.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg97852

Basic Instructional Course: Rehabilitation of Amputees II
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3605-812]

Physiotherapy in the Rehabilitation of Lower Limb Amputees

Author
Kaiser, Helga (Bad Rothenfelde DE)
Klinik Münsterland der Dt. Rentenversicherung Westfalen

Abstract
Physiotherapy following amputation surgery is one of the most important tasks in rehabilitation. It is an important part in the necessary inter- and multidisciplinary treatment. In the beginning treatment is focused on the reduction of the postoperative edema, strengthening of the upper extremities and the remaining limb.

Introduction
In the later phases of rehabilitation the physiotherapeutic gait training is described, beginning with training of doning and doffing of the prosthesis, standing inside bars, walking inside bars, gait-training parcours, walking on flat floors, outside gait-training and -allways donetraining of accident situations as for instance falling down and coming up again. This program is completed by stump care training.
The typical rehabilitation and training program is descibed and the results of a study looking on the participation of amputees after rehab are presented.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg97852/cg98046

Basic Instructional Course: Rehabilitation of Amputees II
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3606-692]

The Role of Sports Therapy in Rehabilitation of Lower Limb Amputees

Author
Kaiser, Wilhelm (Bad Rothenfelde DE)
Klinik Münsterland der Dt. Rentenversicherung Westfalen

Abstract
In the first period following an amputation the patient shows severe psychic problems in understanding and acceptance of the situation, there is a large number of patients who fear to be cripples and a load for relatives. As well there is skepsis how to solve the somatic challenges they need to recover and learn upright walking again.

Introduction
In the later phases training of the remaining muscles, learning to use stump muscles and strenghtening programs are dominant.
In the lates rehabilitation phases sports-activities with a wide variaty of training and sports methods should give back joy, enthusiasm and the feeling of self-importance. This is a very important step in overcoming handicaps and disabilities.
Sports therapy is an important member of the rehab-team, it sees itself as a life-long assisting help for handicapped.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg97852/cg98097

Basic Instructional Course: Rehabilitation of Amputees II
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3607-718]

Gait Problems in Amputated Patients

Author
Brückner, Lutz (Bad Klosterlausnitz DE) | Priv.-Doz. Dr. med. habil.
Moritz-Klinik Gmbh & Co. KG - Orthopädie / Unfallchirurgie

Coauthors
Gertrude Mensch, Hamilton (Canada)

Introduction
Gait deviations are arrhythmic walking patterns which repeatedly differ from the norm.They increase the amputee`s energy requirements as they need extra muscular counterforce to bring the body back into balance.To the amputee deviations are tiring, at times physically stressful.They can also be unsafe.It is often difficult to analyze gait deviations correctly as all gait faults-regardless of their cause(s)-are expressed posturally.

Results
3 factors (acting either independently or together)are the root(s)of postural gait deviations.These are:
1. the amputee
2. the prosthesis
3. the environment

Amputee factors can include: health status,s tump length, co-ordination, muscle strength, range of motion, contractures, body weight, spinal rotation,s tump pain, neuroma. Prosthetic factors can include: length of the prosthesis,s ocket pressure, alignment errors, component selection, suspension problems, inappropriate linersystems. Environmental factors: ground conditions, weather extremes.

Conclusion
Selected gait deviations will be assessed and the nature of their cause(s) analyzed ,so that corrective actions can be implemented.

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Gertrude Mensch, Wieland Kaphingst:
Physiotherapie und Prothetik nach Amputation der unteren
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Springer-Verlag,Berlin Heidelberg 1998

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg97852/cg98148

Basic Instructional Course: Rehabilitation of Amputees II
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Rehabilitation

Congress Lecture [3608-745]

Rehabilitation of Amputated Patients - Music as a Helping Factor

Author
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Introduction
Not only sports, but musics are excellent helps for amputees, too. From the first physical therapy lessons, rythms faclitiate exercises for both upper and lower limb amputees. Human locomotion and dancing are nothing but repetitive motion patterns which are easier to perform with musical support.

Methods
Amputees participate in dancing and wheelchair dancing competitions. Famous tap dancer Peg Leg Bates admits he never would have made his life, hadn't he lost his leg in an accident when he was a boy.
A series of musical instruments which need only one hand or none at all are presented. As in sports, technical aids may be necessary in order to play the instruments.
The Austrian piano player Paul Wittgenstein has lost his right arm in World War I. He nevertheless continued his career and asked composers to write piano music adapted to his handicap.

Results
One result is the French composer Maurice Ravel's piano concerto for the left hand.
Singing enables amputees to make music without the need of any hand at all. The most famous example is the German bariton Thomas Quasthoff, with congenital deformities on all extremities caused by thalidomide.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3733-None]

The Discussion of Pressure Distribution Measurements in Orthopaedics

Session Chair
Peikenkamp, Klaus (Steinfurt DE) | Prof. Dr.
Fachhochschule Münster - FB Physikalische Technik, Abt. Biomechanik

Session Chair
Drerup, Burkhard (Münster DE) | Prof. Dr.
Klinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg313134

Basic Instructional Course: The Discussion of Pressure Distribution Measurements in Orthopaedics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Miscellaneous

Congress Lecture [3734-728]

Applications of Pressure Distribution Measurement in Prosthetics and Orthotics

Author
Drerup, Burkhard (Münster DE) | Prof. Dr.
Klinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Abstract
Pressure distribution measurement is used to prevent diabetic foot ulceration, control of load transfer from socket to stump, avoiding impeded blood circulation in the stump and control of seating pressures. Here, focus is put on applications in the diabetic foot and in fitting prosthetic sockets.

Introduction
In the diabetic neuropathic condition bony prominences or structural deformities of the foot may lead in the foot to pressure induced breakdown of the skin. In preventing these lesions pressure reduction has come out to be an effective measure which must be monitored by pressure distribution measurement.
In fitting a socket for an amputation stump a stable fit is achieved, if the normal pressure together with the friction between the contacting surfaces is sufficient to hold the tangential forces. However, localized high pressures are painful and may lead to tissue damage and an improper gait pattern. Pressure measurement provides respective information to cure harmful pressure concentrations during the course of a gait cycle. Furthermore in critical regions, e.g. in the femoral triangle conditions producing pressure induced inhibition of blood supply of the stump can be checked.

Methods
Pressure reduction in preventing injuries of the diabetic foot aims at a locally smooth distribution of the load under the foot to avoid pressure peaks. Typically this is achieved by a foot bed. Also the time domain opens up a way for pressure reduction in avoiding temporal peaks. This may be achieved by shoe modifications like forefoot rockers and heel rockers. The effect of pressure reduction measures can be supervised by plantar pressure distribution measurement and analysis in terms of peak pressure, pressure gradient and velocity of the COP.
In fitting a socket the ideal situation is to completely cover the whole stump with a pressure sensing mat. However, for practical and geometrical reasons, this can only be approximated by a regular distribution of local sensors. In analysing the measurement data the localization of the sensors, the gait phase and particularities of the patient and the socket must be accounted for.

Results
Examples are given in interpreting pressure distributions in persons with diabetes, where different shoe modifications, different insoles and gait patterns are exercised.
Application of pressure measurement in fitting a socket is exemplified in a quadrilateral and ischial containment socket.

Conclusion
Pressure distribution measurement is a valuable tool for different applications in prosthetics and orthotics. It is indispensible in fitting shoes for diabetic persons with neuropathic complications. It gains acceptation in the manufacture and fitting of amputation sockets.

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Basic Instructional Course: The Discussion of Pressure Distribution Measurements in Orthopaedics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Miscellaneous

Congress Lecture [3735-787]

Analysis of Pressure Distribution Measurements

Author
Peikenkamp, Klaus (Steinfurt DE) | Prof. Dr.
Fachhochschule Münster - FB Physikalische Technik, Abt. Biomechanik

Abstract
A deep knowledge of the relationship between the physical variable and the attributes of the measured patient or user is important when analysing data of pressure distribution measurements. Some theoretical aspects for developing appropriate analysing procedures and parameters will be presented.

Introduction
Modern sensor technology and a continued increase of computers' capacities had and still have a major influence on pressure distribution measuring systems. Consequently, both platforms consisting of several thousands sensors and insoles with a few hundred sensors are available. So each measurement consists of many data and the problem occurs how to analyze these data adequately. For this analysis often a standard procedure is used. This method discounts the fact that the parameters extracted from pressure distribution measurements always depend on the problem to be solved. E. g. peak pressure is not always the parameter which addresses the problem optimal. Sometimes even the use of a more dimensional parameter is necessary. The purpose of the paper is to focus on the dependency between the scientific problem and the appropriate parameters in the analysis' procedure.

Methods
The following typical fields of application for pressure distribution measurements are considered:
1. skin damage, especially diabetic ulceration, on the foot, the buttocks and the back.
2. fitting of a socket.
3. spine support during reclining and sitting.
4. insoles and foot-orthoses.

Several parameters obtained from pressure distribution measurements are analysed with respect to their informative value to the field of application mentioned above:
1. peak pressure
2. average pressure
3. duration of pressure
4. pressure momentum (integral of pressure)
5. time between load
6. loaded area
7. curve of the center of pressure (COP)

Results
Ulceration is usually caused by a microcirculation of the affected tissue which leads to an undersupply. To avoid this effect a reduction of critical pressure values is necessary. Therefore, peak pressure is only one parameter which may lead to microcirculation but also the duration of pressure and the alteration between loading and unloading periods are important. These two parameters are also important for the evaluation of the fitting accuracy in prosthetics. The influence of the amount of pressure and its duration was already analyzed by Kosiak (1961).

In reclining the mattress should not produce high pressure value but also support the lumbar lordosis. Therefore, a more dimensional parameter for the classification of mattresses is needed. This parameter should be independent of the body weight and it should address the ration between peak pressure (which usually occurs at the buttocks) and the pressure under the lumbar spine.
The curve of the COP is calculated by the weighted average of all pressure values. Nevertheless this curve is mostly analyzed in a qualitative manner only. Examples of a quantitative analysis will be presented, which can be used to evaluate the influence of insoles and foot-orthoses.
More examples with respect to the area of conflict between ‘fields of pressure distribution‘ and ‘appropriate parameters’ will be presented in the Instructional Course.

Conclusion
Pressure distribution measurements allow a deeper insight in several fields of technical orthopaedics. To use this benefit an accurate choice of parameters is indispensable. These parameters are often closely related to biological, biochemical and biomechanical conditions of patients and users. Consequently, the best parameter is not always represented by one physical variable but can be more dimensional. For some scientific problems it can be needful to develop new parameter instead of using standards. Further investigations are necessary to define critical values for the analyzed parameters.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg313134/cg313766

Basic Instructional Course: The Discussion of Pressure Distribution Measurements in Orthopaedics
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Miscellaneous

Congress Lecture [3736-778]

Introduction in Pressure Distribution Measurements – Demands and Restrictions for the Data Collection

Author
Natrup, Jörg (Münster DE) | Dr.
Gesellschaft für Biomechanik Münster mbH

Abstract
Pressure measurement systems consist of a number of single sensors, which are distributed over the interesting contact area between a part of the human body and its surroundings. In orthopaedics there are three main measuring situations, which will be discussed in the present paper.

Introduction
Pressure measurements are made using a number of sensors, which are distributed over the interesting measuring area. The aim of the present paper is to describe the demands as well as the restrictions of such measuring systems for different situations.

Methods
There are three methods to measure the pressure distribution in orthopaedics. For the measurement on stiff, plain surfaces platforms are used. More complicated is the measurement between surfaces which are not plain. An example is the in-shoe pressure measurement. To determine the pressure between two soft surfaces measuring mats are used.

Results
One important aspect for the quality of a pressure measurement system is the reliability, which depends on the type of the sensor. For all sensors the characteristics change during the use. Therefore, a calibration has to be done from time to time. Other important qualities are the resolution in space and the resolution in time.
A pressure measurement platform is integrated into the floor. It may be used to determine the pressure under the foot during barefoot walking in order to get information about deviations of the foot. The main restriction of this measurement is the problem to walk across the platform in a normal gait without interference. To minimize this problem the platform should have a great measuring area.
A typical application for the in-shoe pressure measurement is the control of the insole construction of an orthopaedic shoemaker, like it is important for the treatment of the diabetic foot. In the shoe there is only small space for the measuring device, and furthermore, the contact areas are not plain. Therefore, the measuring system should be as thin as possible, and secondly it should be highly flexible.
Pressure measurement mats are used in sitting situations, e.g. in wheel chairs. For this application it is the aim to avoid decubitus or to control the effect of sitting surfaces. The demand on the flexibility is even higher as it is for the in-shoe measurement. On the other side the buttock bones are greater. Therefore, the space resolution is less important.

Conclusion
The paper presented three methods of pressure measurements and discussed its specific demands and restrictions. Summarizing both depend on the special application.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg313134/cg313927

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3826-None]

Friction Management for Neuropathic Foot Problems

Session Chair
Michael, John (Portage, IN US)
CPO Services, Inc.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg557410

Basic Instructional Course: Friction Management for Neuropathic Foot Problems
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3827-758]

Repetitive Loading Skin Trauma Science and the Role of Friction

Author
Payette, Mark J. (Blaine, MN US) | CO
Tamarack Habilitation Technologies, Inc.

Coauthors
Marty Carlson, CPO, FAAOP

Abstract
The need for pressure management to reduce soft tissue trauma is intuitive and the materials and techniques well established. However, high peak pressure repititions are damaging primarily because they enable/facilitate high peak friction/shear forces.

Introduction
That friction plays a role in generating dermal trauma was first established by Dr. PDF Naylor in the 1950s and verified by Dr. Marion Silzberger, et.al. ten years later. Precise additional knowledge has been slow to come because of difficulty in obtaining accurate measurements of friction/shear loads without introducing artifacts.

Results
Clinical experience and laboratory evidence have been accumulating in the recent years. This additional knowledge is slowly building a very strong case in favor of clinical application of the friction management technologies and techniques which are becoming available.

Conclusion
Skin and soft tissue trauma may be reduced by strategic management of the coefficient friction (CoF) in at-risk locations in addition to managing peak pressure.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg557410/cg557911

Basic Instructional Course: Friction Management for Neuropathic Foot Problems
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3828-808]

Clinical Considerations and Decisions for Protecting the Neuropathic Foot from Friction

Author
Kuffel, Charles (Blaine, MN US) | CPO, FAAOP
Arise Orthotics & Prosthetics

Coauthors
Charles Kuffel, CPO, FAAOP

Introduction
Clinical management of the neuropathic foot requires a thorough understanding of the shear and perpendicular forces applied to plantar tissues and the resultant trauma on the insensate foot. The thoughtful design, fabrication and application of orthotic devices using biomechanical principals and various shear reducing materials increases the margin of safety for the neuropathic patient.

Results
The increase in the margin of safety allows individuals with neuropathy to ambulate for extended periods of time while limiting the severity and extent of tissue degradation. This lecture focuses on the evaluation, clinical considerations and management of neuropathic foot problems and their outcomes. It includes case studies that highlight outcomes when biomechanical principals and orthotic design are included in a clinical setting.

Conclusion
Management of neuropathic foot complications requires a thorough understanding of plantar forces (shear and perpendicular)and resultant trauma on delicate tissue. Limited plantar sensation necessitates an increase in the margin of safety to help manage trauma and prevent further complications.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg557410/cg558512

Basic Instructional Course: Friction Management for Neuropathic Foot Problems
Friday 2010/05/14 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3829-807]

Technical Aspects of Friction Management

Author
Payette, Mark J. (Blaine, MN US) | CO
Tamarack Habilitation Technologies, Inc.

Coauthors
Mark Payette, CO

Introduction
Participants will learn how to apply low friction materials into a variety of orthotic, pedorthic, and prosthetic devices through photo and video presentation and lecture.

Results
The background science and clinical basis for friction management have been summarized in the first two lectures. There is one product, a low friction interface patch material, available for orthotists, pedorthists, and prosthetists to strategically manage friction.

Conclusion
The low friction patches must be properly sized and installed to conform to three dimensional contours with minimal wrinkles and edge effects. Several installation methods are available utilizing heat and vacuum forming or manually forming.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3789-936]

Technology, Rehabilitation, Outcomes, Sports and Specialization; The Future of Prosthetics is Here

Keynote Author
Gailey, Robert (Miami US) | PhD, PT
University of Miami Miller School of Medicine - Department of Physical Therapy

Abstract
What was once considered to be the future of prosthetics is here and now. The combination of microprocessor controlled and bionic prosthetics is becoming more prevalent. With new prosthetic platforms, such as neural interface sockets, the field is moving ever closer to thought-controlled neuroprosthetics. Rehabilitation methods have also become more innovative in an effort to promote maximum performance of the advanced prosthetic devices. Likewise, the use of appropriate functional outcomes measures is demonstrating the clinical and functional value of these recent advances. As both prosthetic technology and training techniques come of age, so have the athletic performances of athletes with limb loss who continue to break performance barriers not previously thought possible.

Introduction
The days where technology, advanced training and elite level sports performances were considered unique, or perceived as the exception, have passed. Today, the return to a full active life after limb loss, including sports participation, is now an expected and realistic goal. For clinicians to assist their clients in reaching these goals, understand the appropriate clinical application of advanced surgical, prosthetic, rehabilitative interventions and sports training are critical. This address will briefly present the prosthetic innovations that will impact the future care of people with limb loss, as well as discusss the rehabiliation treatment implications and the need to quantify rehabilitation outcomes and sports performance.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg415886

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3675-None]

Orthotics - Technical Topics

Session Chair
Lemaire, Edward (Ottawa CA) | PhD, Associate Professor
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Session Chair
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2975-173]

Load Evaluation of a Hydraulic Stance-Control Knee Orthosis

Author
Samadi, Reza (Ottawa, ON CA) | PhD.c
The Ottawa Hospital Rehabilitation Centre - Institute for Rehabilitation Research and Development

Coauthors
Samadi R, Lemaire ED, Goudreau L, Kofman J

Abstract
This paper presents an evaluation of the loading capacity of the Ottawalk-Speed Stance-Control Knee Orthosis (SCKO), which employs an angular velocity control approach to switch between free motion and flexion resistance modes.

Introduction
The Ottawalk-Speed Stance-Control Knee Orthosis [1] uses hydraulic pressure to provide knee-flexion resistnce during locomotion. An adjustable angular-velocity-activated valve closes when a threshold knee angular-velocity has been reached. Once closed, the joint resists knee flexion as the joint chamber pressure increases. The specialized check valve permits free knee extension. A new valve assembly design that uses a ball to restrict fluid flow through the check valve was implemented. Fluid flow around the ball creates a pressure differences around the ball and drag forces that push the ball into a cone-shaped seating area. Once the ball is seated, fluid flow through the valve ceases. An adjustable spring provides a resistive force on the ball, thereby permitting joint activation threshold adjustment. Design improvements were also made with wiper seal placement. Mechanical testing was required to evaluate maximum flexion resistance with the revised design.

Methods
The Ottawalk-Speed joint was connected to 20 cm long proximal and distal steel uprights. A custom jig was fabricated to fix the uprights in an Instron 4482 material testing machine. The testing machine provided a constant linear loading speed of 508 mm/min, the maximum loading speed for the test machine. Knee-joint resistive moments were calculated for two settings: open valve (high angular velocity threshold setting at which the valve does not activate) and closed valve (low threshold setting at which the valve closes). The initial joint angle was 10 deg flexion. Five trials were performed for each valve setting. (10 trials total).

Results
The mean maximum resistive moment achieved was 68 Nm for a single trial, which occurred at an angle of 17 degrees. The range of peak moments across trials was 56 – 68 Nm. As shown in Figure 1, a resistive moment above 50 Nm was sustained throughout the 8.5 second loading period after initial loading. For the unlocked position, the maximum resistive moment was 3.0 Nm. This peak moment occurred at the start of the trial (11.5 degrees). The average moment for the disengaged-valve trials was 2.3 Nm.

Conclusion
The hydraulic SCKO joint was capable of sustaining 50 Nm flexion resistance over a period during which a user would be able to recover from a stumble. A peak moment of nearly 70 Nm is appropriate to resist the initial phase of rapid flexion for an 80 kg person. Larger flexion resistive moments would be achievable with a faster load rate, therefore the peak moment capacity for the Ottawalk-Speed joint is likely underestimated

by these loading tests. The residual moments in the valve open trials are likely due to fluid flow resistance through the valve channel. The small moments would be negligible for the end-user. These results support continued development and clinical testing for the Ottawalk-Speed SCKO joint.

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Image: hydraulic-test-Apr-2009_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630/cg35028

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3037-235]

Development of MRF (Magneto-Rheological-Fluid) Brake Installed Lower Limb Orthosis

Author
Morimoto, Shoji (Shijo-nawate, Osaka JP) | Professor
Osaka Electro-Communication University - Department of Biomedical and Rehabilitation Engineering

Coauthors
Tomiyama H, Hashimoto Y, Ise M, Ishii M, Yoshida H, Furusho J

Abstract
An intelligently controlled compact MRF (Magneto-Rheological Fluid) brake was developed and installed in ankle-foot orthosis. The Effectiveness of the device was proved based on the gait analysis of hemiplegia patients.

Introduction
For the people with paralyzed lower extremities after the stroke, dorsal bending moment of ankle joint is necessary for smooth motion at heel contact of the stance phase, and for holding ankle joint at dorsal position of the swing phase. But, conventional AFO(Ankle-Foot-Orthosis) has only fixed visco-elastic parameter on ankle joint by spring or dumper, and could not change the parameter according to the walking condition. To improve these problems, a compact MR brake was installed at the ankle joint of AFO, and was controlled to adapt the brake torque accommodating to walking conditions. To assist the parameter values to control the MR brake, a subsystem was developed in which gait of the subject wearing the orthosis was measured and evaluated. The results were displayed on the graphic screen in real time as the animation of ankle joint moments of human and orthosis.

Methods
Key technologies were developed at the first step, and the functions and safety were examined by normal subjects at the second step, and clinically evaluated by the patients at the final step. Risk assessment was done at the second step, and the protocol for clinical evaluation was examined before the final step.

Results
Development of flow type MRF brake: The yolk structure and liquid seal mechanism were designed by using FEA software and trial manufactured on flow type MRF brake. The flow type brake is 140[g] weighing and 56[mm] width, 56[mm] high and 35[mm] thickness, and could be installed in the usual ankle-foot orthosis. The range of the brake torque was from 1.2[Nm] to 10[Nm] in proportion with the electric current of 0[A] to 1.0[A].
Real-time measurement system for ankle joint moment: A real-time measurement and control system was developed for assisting the prosthetists to adjust the AFO to each patient. A data accumulation, data analysis and real-time display system was completed on RT-LabVIEW system of measurement and control software developing environment. Data from the real time three dimensional coordinates (MAC3D), shear-force/bending-moment sensor in the orthotic shank and potentiometer in ankle joint were gathered on a computer, and ankle joint moment was calculated. The motion of the subject was displayed in real-time as the moving stick-picture on a graphic display. The amount of ankle moment was displayed on the ankle joint of the stick-picture as a small circle in which radius is proportional to the amount of bending moment

and blue/red color indicates plantar/dorsal moment. The control program of MRF brake was integrated in the above software, and control parameters can be easily changed and evaluated in a short period.

Conclusion

The right weight and compact size MRF brake for AFO of hemiplegia subjects after stroke was developed, and effectiveness of the AFO system was proved by clinical evaluation. To establish the safety use of the developed orhosis in daily living environment, structural strength test methods of lower limb orthosis in ISO, JIS or any criteria used in the manufacturers of orthotic components was surveyed and ISO22675, a structural strength test method of prosthetic foot-ankle-joint and its technical report ISO TR22676 was found to be applicable to orthotic foot-ankle part. The testing machine was constructed and precise test method has been under examination.

References

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Image: MRF brake AFO_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630/cg35431

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3421-596]

Patella Kinematics are Controlled by a Novel Knee Brace: an In-vitro Evaluation of the PatellaTrack Orthosis

Author
Brüggemann, Gert Peter (Köln DE) | Prof. Dr.
Institut für Biomechanik und Orthopädie - Deutsche Sporthochschule

Coauthors
Potthast W,Remitzki I,Ellermann A

Abstract
The PatellaTrack orthosis (Otto Bock HealthCare GmbH)was evaluated in an in-vitro study. Bone pins screwed into Tibia and Patella of six cadaver legs indicate the biomechanical efficacy of the brace in regard to re-positioning and medial transition of the Patella during knee extension and flexion.

Introduction
The dislocation or the medio-lateral shift of the Patella during knee joint extension is related to lateral knee instability and to non physiological loading of the patello-femoral joint and the Patella insertion. The novel knee orthosis PatellaTrack (Otto Bock HealthCare GmbH) was designed and engineered to control the medio-lateral shift of the patella and thus the patella location within the femoral channel during knee extension and flexion. The purpose of the study was to evaluate the technical device and to quantify the efficacy of the brace to re-locate and control the patella position relative to the femur during knee extension and flexion. The research question was approached by an in-vitro study with fresh frozen cadaver legs in a specially designed knee simulator.

Methods
Six fresh frozen cadaver legs from female and male donators were studied. A custom engineered knee simulator was used to quantify the relative location of the Patella in relation to Femur and Tibia during knee extension and flexion. Specimens were amputated at the level of the proximal femur and soft tissues were carefully removed from the proximal portion of each specimen. The foot and the tibia were embedded in an alignment apparatus to ensure consistent vertical orientation of the tibia. The major muscular stabilizers of the Patella the Mm. vastus lateralis, vastus medialis and rectus femoris were connected by special clamps to and driven by pneumatic actuators. The locations and movements of Tibia, Patella and Femur were measured using bone pins (3 mm Apex, Stryker, 20-60 mm length) screwed into the three bones. The bone pins were instrumented with arrays of retro reflective markers. A 6 camera Vicon 624 system (Vicon Motion Systems, Oxford, England) was used for motion analysis.

Results
The motion analysis studied the relative Patella position (a) without a brace in the natural condition, (b) with the PatellaTrack orthosis and (c) with a control brace applied to the knees. Five knee joint extension/flexion cycles were performed under each of the experimental conditions. The position and motion data of the Patella relative to the Femur during knee extension and flexion showed significant differences between the experimental conditions with significant greater effects for the PatellaTrack condition. The novel orthosis PatellaTrack initiated a more medial Patella positioning during knee extension than the control brace. This indicated that the mechanical principle of the medio-lateral control of the Patella by the PatellaTrack worked

properly. The medio-lateral re-positioning through the brace was related to the knee flexion angle and thus in line with the underlying technical concept of increasing medial transition of the Patella as a function of knee extension angle.
The application of muscle forces appeared to have a big effect on Patella positioning. As expected increasing force transmitted by the M. vastus medialis stressed the Patella to a more medial position in knee extension. When co-contracting (through pneumatic actuators) all three muscles (Mm. vastus lateralis, vastus medialis, rectus femoris) the muscles worked like a belt system and decreased the impact of the orthotic devices.

Conclusion

From the results we conclude that the potential of the M. vastus medialis to produce force and tensile stress to the Patella plays an important role in the proper positioning of the Patella relative to the femur during knee joint extension. The novel PatellaTrack orthosis and its underlying mechanism have the potential to control and re-position the Patella during knee extension medially. The evaluated brace provides a progressive re-positioning and offers a technology which can efficiently contribute to both the prevention and the rehabilitation of overuse injuries of the knee due to Patella misalignment.

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Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3265-441]

Biomechinical Evaluation of One-way Clutch-type Stance-control Reciprocating Gait Orthosis with a Spinal Cord Injury

Author
Jang, Dae-Jin (Incheon KR) | Ph.D
Korea Orthopedics and Rehabiliation Engineering Center - R&D 1 team

Coauthors
S.J. Kang, S.K. Kim, M.S. Mun

Abstract
The puopose of this study was to determine gait differences in three subjects ambulating with a conventional RGO with a locked knee and a RGO with a stance control knee. The subjects ambulated in doubled walking speed and stride length with stance control orthosis because of knee flexion.

Introduction
Patients with spinal cord injury spend for a long time in the wheelchair. The most common device of those walking aids the Reciprocating Gait Orthosis (RGO) consisting of a hip-knee-ankle-foot orthosis which controls hip extension while assisting reciprocal hip flexion. These devices stabilize the lower limbs and the trunk both in the sagittal and frontal plane. However, RGOs lock the knee in swing phase, and do not permit a natural gait pattern. Characteristic of a RGO gait pattern is a lateral lean or vault to clear the swinging limb from the ground. In addition, the patient is forced to use upper body and greater energy to assist with the vaulting and clearance of the swinging limb. Recently, a new type of KAFO has developed to solve problems of conventional RGO walking in the name of the stance-control orthosis (SCO). This study showed if a RGO with a new designed SCO could enable a patient with SCI to walk more efficiently than a traditional RGO with a fixed knee (Fig. 1).

Methods
We studied 3 patients with motor complete SCI. The patients were fitted with a RGO with a stance control knee joint that allowed flexion of the knee in the swing phase and locked the knee joint in stance phase. Stance control knee joint is operated with new designed one way roller clutches. One way roller clutches are composed of an outer ring which formed cam face, a roller cage, as well as rollers (Fig. 2). We connected a cable between a roller cage and rocker bar band to flex the knee joint after they had started ambulation with fixing the knee joint without a cable. After a period of training and accommodation, the patients used a RGO with a stance control knee joint three times a week. Gait analyses were performed using a 3-dimensional motion analysis system. Assessments for two conditions, RGO with a fixed knee and a controlled knee, were performed at self selected walking speed. Gait analysis for RGO with a fixed knee was performed first, and data of 3 trials were collected.

Results
Table 1 presents a results of the patients temporal-spatial gait in the two knee conditions. Data from the self selected walking speed trials indicated that subjects walked significantly faster two times approximately in the controlled knee compared with the fixed knee. Stride length and cadence in the controlled knee was increased compared with in the fixed knee. Patients walked with larger stride length and higher cadence in the controlled knee.

In the two knee conditions, subjects presented their pelvis tilted anteriorly, their hip joint did not flexed, because they must use their upper body for spine cord injury (Fig. 3). In the fixed knee, flexion of hip joint and extension of knee joint are absent, because the subjects must lean their body to one side or elevate their body to clear the swinging limb from the ground with the fixed knee. However, in the controlled knee, they could flex their knee in the swing phase and therefore the range of their hip joint motion was larger and their step length was longer. In the fixed knee, the knee angle remained in approximately 8#of flexion throughout the gait cycle. At toe-off, the knee was in 10#of flexion at 80% of the gait cycle, and there was the maximum knee flexion of 35#at 87% of gait cycle.
In the both knee, the subjects showed increased sagittal anterior pelvic tilt and pelvic excursion, but the flexion of pelvic tilt was more higher in the controlled knee. In contrast, pelvic obliquity presented similarly in both knee.

Conclusion
As body weight drops on to the limb during the loading response. This results in a torque of 51Nm by the end of loading response. Knee assembly of stance control orthosis using one way roller clutches could resist knee flexion at any angle in stance phase and was designed to support knee torque up to 60Nm. The subjects could ambulate in doubled walking speed and stride length with stance control orthosis, because energy efficiency is increased by knee flexion. Though this stance control orthosis resist knee flexion at any angle, it can induce instability in swing phase, but it is effective with someone with no lower extremity control and spinal cord injury. RGO capable of controlling knee have considerably receptible advantage compared to traditional RGO with a fixed knee.
For future research, a robust performance of this orthosis in multiple patient group must be verified. Stance control orthoses which uses under various environments such as stair climbing and standing are needed.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630/cg43468

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3114-312]

Laboratory Testing and Assessment of Knee Braces

Author
Hochmann, David (Berlin DE) | Dipl.-iIng.
Technische Universität Berlin - FG Medizintechnik

Coauthors
Kraft, M.

Abstract
Ensuring functionality, durability and usability of technical aids is crucial for both manufacturers and health insurance providers. This paper describes the properties and usage of novel testing devices for functional, fatigue strength and microclimatic testing of knee braces.

Introduction
Prefabricated knee braces, used for preventing knee injuries or treatment of patients with knee disorders, are among the most utilized orthopaedic aids. The assessment of technical aids using in-vivo trials shows a number of methodological difficulties. In-vivo trials are costly in terms of time and money because high sample sizes are required to ensure the statistical power. One possibility to reduce the costs and to decrease the high variability is the use of standardized mechanical surrogate models. This approach allows a comparative parametric assessment of knee braces with reliable and repeatable results. However, the main challenge is to assure the validity of the surrogate model. Only in the case that the model is considering all the relevant factors, the characterization obtained by laboratory testing is of clinical relevance. Existing laboratory test methods for knee braces have mostly been insufficiently validated.

Methods
As there are little quantified data on interactions between brace and soft tissue, for proper modelling they have to be measured in-vivo. For this purpose, an instrumented knee brace was built, mounted with tensile force sensors, pressure distribution sensors, flexion/extension moment sensors and goniometers. The brace was then used in a clinical trial on ACL-deficient patients and healthy volunteers, who underwent a movement analysis during different functional tasks using a gait analysis system synchronized with instrumented brace. The data obtained in clinical trials and laboratory experiments were then used for development and validation of testing devices [1].

Results
The concept for functional testing specifies the assessment of stabilization effect during isolated movements (A/P-translation, varus/valgus and tibiofemoral rotation), which was implemented in a device based on a material testing system. It also includes a surrogate leg model with controllable muscle activity, soft tissue layer and an artificial skin cover. The model has no artificial knee joint to ensure that the mechanic properties of the brace alone are assessed. To eliminate the offset error the results of unbraced condition measurements are used.
A fatigue strength testing device was also developed to simulate the loads affecting the long-term stability, including flexion/extension, rotation and cyclic expansion of the thigh. The movements are applied by pneumatic actuators in load control mode. The loads measured in clinical trial were simplified to fit the requirements of accelerated testing. The device includes a compensation mechanism for polycentric brace joints to avoid constraining forces.

A microclimate testing device simulating the heat and humidity output was also developed, which can be easily adapted to different shapes. Heated water from a temperated reservoir is flowed using a high-precision microprocessor-controlled micro-dozing syringe pump to a transpiration pad, which is attached to the brace. The development of temperature and humidity is continuously measured with integrated sensors.

Conclusion

First performed testing trials show that consistent, reproducible and reliable results are obtained by testing devices. With functional testing device, even small performance differences between products can be detected, which is also very important for comparison of prototypes during design process. First results of fatigue tests deliver realistic damage patterns. Microclimatic tests show, however, that most knee braces are unable to satisfactorily dissipate humidity, even if low sweating rates are assumed.
After further optimization and formal qualification according to ISO 17025 our test procedures can be used for proof of quality requirements of German index of technical aids.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630/cg38302

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2951-149]

Assessing Orthopaedical Aids Using an Open Bore Vertical MRI Scanner – Sequences, Measurement Techniques & Software –

Author
Tettke, Martin (Berlin DE) | Dipl.-Ing.
Technische Universität Berlin - FG Medizintechnik

Coauthors
Wegener U, Kraft M

Abstract
This abstract presents a method which delivers an insight into the “patient - orthopaedic aid” system using three dimensional image acquisition methods in an open low-field MRI scanner under physical loading conditions controlled by self-built MRI compatible measurement techniques.

Introduction
Used in clinical settings for years, magnetic resonance imaging (MRI) is still uncommon for studies concerning the influence of orthopaedic aids on the human anatomy. Up to now, methods like gait analysis or fluoroscopy were often used for kinematic studies. While gait analysis yields the big problem of migration of soft tissue, fluoroscopy uses ionizing radiation and is therefore unsuitable for ongoing evaluation of therapeutic effects.
With the introduction of modern low-field MRI scanners, a possibility to evaluate and characterise the interaction between patient and orthopaedic aid, like orthoses, has become available. In this paper, we will present a workflow consisting of special MRI sequences, measurement techniques and self-build software, allowing insight in the interaction between patient and orthopaedic aid using a strict three-dimensional approach.
The research project is founded by the Otto Bock foundation and the foundation Oskar-Helene-Heim.

Methods
Starting with the orthopaedic aids “knee orthoses”, “patellar stabilizing braces”, and “orthoses for patients with gonarthrosis”, we used a modern MRI scanner (ESAOTE G-Scan) with 0.25 T which allows to acquire data in vertical position under physical loading conditions.
As the patient’s position should be as physiological as possible, defined imaging conditions (load distribution between the feet, flexion angles) were used instead of guiding techniques. A self-constructed MRI-compatible force-control application with patient feedback and a S700 MRI joint angle sensor (measureand technologies, Canada) were used to monitor and record load condition and flexion angle during the MRI acquisition process.
A steady state 3D-sequence acquiring 52 slices with 1.9 mm slice thickness creating a non-isotropical volumina of 200 x 200 x 100 mm in 1:30 min was used. A consistent chemical shift giving borders around the bony structures increases the precision of the following segmentation process.

Results
Great efforts have been made to develop the MRI compatible force control application. We use strain gauges with carrier carrier frequency amplification at 4.9 kHz, shield all cables with a common copper

meshwork and feed them through a HF-tube into the MRI scanner room. We found a load of 20 to 40 % of body weight on the bent knee achievable for patients in every state of flexion.
The position of the orthopaedical aid is measured using a self-built high visible MRI coordinate-system on every part of the device.
For guided manual segmentation, we adapted a 2-dimensional livewire approach developed by the medical image analysis lab in Canada [1] to a self-developed Matlab application, giving the ability of generating three dimensional objects while keeping all DICOM3-data intact, thus allowing a geometrical reference in space for all extracted objects.
Using the helical axes algorithm [2-4] to calculate knee axis using a displacement matrix generated by registrating extracted femur and tibia objects, we found a rising error of the functional axis with smaller rotation angles. As this is known for the helical axes algorithm [5], we defined a minimum flexion angle of 15° between two steps of flexion.
Beyond the calculation of helical axes, our software is able to determine the center of gravity for every object and the principal axes [6-7], allowing the calculation of translations, rotations between objects itself and between objects and orthopaedical aids like knee orthoses.

Conclusion
Using modern non-ionizing imaging technology, fast sequences, MRI adapted measuring techniques, and a consistent 3D-workflow, it is possible to evaluate some parts of the interaction between orthopaedical aid and patient. Understanding the basic principles of the way of interaction and the inter- and intraindividual differences, is necessary to design adequate aids.
We started with the validation of the whole process (image acquisition, segmentation, registration, axes calculation) using a self-built MRI-knee-phantom that is able to simulate muscle, fat and bone and can be adjusted to known flexion angles.
After that, a patient study with 5 to 10 patients for each aid is planned.
Besides knee orthoses, the lumbar spine is in focus too. In March 2009 a project concerning the influence of orthopaedic aids on the lumbar spine under physical load was launched, using a workflow similar to the one described above.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg228630/cg34837

Session: Orthotics - Technical Topics
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [4067-902]

Carbon Fiber Spring AFOs for Active Push-off

Author
Braatz, Frank (Heidelberg DE) | Dr. med.
Orthopädische Universitätsklinik Heidelberg

Coauthors
F. Braatz, T. Dreher, M. Alimusaj, S. Wolf

Introduction
Patients with calf muscle insufficiency and a calcaneus gait are often dependent on ankle-foot orthoses (AFO). The orthosis is intended to improve walking and posture and should prevent structural deformities. AFOs are often manufactured with a dorsiflexion stop. The design of this type of orthosis has been investigated in several previous studies. In the current study, orthoses with a dorsal carbon fiber spring were compared with the classic design.

Methods
Five patients with Spina Bifida took part in the current study. All participants underwent a 3D gait analysis including kinematic (VICON infrared cameras) and kinetic (Kistler force plates) data collection.

Results
It was found that the use of a carbon fiber spring significantly increases the energy return during the 3rd rocker, simulating the natural push-off action ($p<0.05$). The measurements also showed that the carbon spring was able to support the patient during the complete stance phase. Analysis of the kinematics and the kinetics revealed that the orthosis contributed to a more physiological gait which was verified by an analysis of the norm distance? ($p<0.05$).

Conclusion
The more physiological value of ankle and knee kinematics implies a functional improvement from the carbon springs compared to classic orthosis. This investigation showed, further, that the alignment needs to be done carefully during the fitting process. The spring kinematics and kinetics during stance phase were influenced significantly by the alignment. The functional benefit may be lost by an incorrect positioning.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3490-None]

Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications

Session Chair
Schneider, Urs (Stuttgart DE) | Dr. med.
Fraunhofer-Institut für Produktionstechnik und Automatisierung IPA

Session Chair
Johnson, Chris (Fraser US)
College Parc Industries Inc.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [3491-None]

Introduction: Tomorrows Solutions depend on Knowhow in Materials and Systems

Author
Schneider, Urs (Stuttgart DE) | Dr. med.
Fraunhofer-Institut für Produktionstechnik und Automatisierung IPA

Abstract
An introduction to innovation chances for prosthetics and orthotics.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg46274

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [3493-847]

Computational Simulation of Wear – How can This be Done?

Author
Browne, Martin (Southampton UK) | Dr.
University of Southampton

Abstract
How wear of components can be simulated during development. Project example: knee implant.

Introduction
Wear of hip and knee replacements is an important issue in the orthopaedic field. There have been many instances of wear induced osteolysis or bone death, and consequent failure of the replaced hip or knee, due to poor implant design or material choice for example. Historically, it has been difficult to gain accurate predictions of implant wear performance through computational modelling; this is because it is crucial that the model is based on a representative wear law derived from authentic experimental testing. In this talk, an overview is presented of how computational modelling of wear has progressed from a simple unidirectional wear law, to those that incorporate more realistic cross shear. To illustrate how models have developed over time, the example of wear in the polyethylene component of a metal on polyethylene knee replacement is presented.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg46348

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [3494-709]

Machining, Molding, Rapid Manufacturing - When to Use What?

Author
Lätchen, Manfred (Bestwig DE)
Tital GmbH

Abstract
Investment castings and rapid manufacturing for medical systems

Introduction
Human tissue exhibits an excellent tolerance of titanium and titanium alloys. These materials are therefore highly suitable for use as implants for replacement of damaged bone elements. We have been producing investment castings in titanium materials for a range of different types of prostheses and implants for many years. Demand is also growing for our investment castings for instruments to be used in heart and eye surgery.

Results
Investment castings performed with the lost wax process meets the standards and demands of modern technology. Cast parts guaranty an optimized use of material, give the ability to create complicated parts, a high level of precision, low wall thicknesses as well as a high level of cost savings on each part.
The ideal areas of application for investment castings are those where complicated inside contours, under cuts, hollow structures or bent surfaces cannot be produced or are too complicated to produce with other technologies. In addition, assembly components can be cast as one monolithic part, avoiding material handling and assembly costs at the customer.
Batch sizes of one are no longer just a dream. We provide our customers with a convenient, high-speed solution for prototype and small lot production of titanium or aluminium investment castings.
The wax model needed for the casting process is replaced by a laser generated stereolithography or SLS pattern that allows our customers to significantly reduce the development time and associated costs. The rapid prototype casting goes through the same production process with no sacrifice in product quality. In addition, we have a separate production line for rapid prototype castings that allows for maximum speed and flexibility to meet the customers aggressive development timelines.

Conclusion
Due to the wide array of product configurations and complexities available using the investment casting process, castings are truly an economical alternative to other manufacturing methods. Significant savings are available when several structural components that are either welded or mechanically connected are replaced by a single investment casting.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg46367

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [3495-None]

Magnesium - only Burning and Brittle?

Author
Kussmaul, Bernd (Weinstadt DE)
Bernd Kußmaul GmbH

Abstract
Experiences with magnesium in high end automotive components.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg46386

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [3497-827]

Functional Metals – Will There be Interesting Solutions in the Near Future?

Author
Holeczek, Harald (Stuttgart DE)
Fraunhofer IPA

Abstract
The lecture gives a summary of new plating technologies and how these technologies can lead to a functionalization of surfaces.

Introduction
Plating technologies offer a wide range of operation parameters. Hence, they offer also a wide range of resulting material parameters. Modular plating systems such as mulitlayers ore dispersion coatings offer the possibility to expand the classical properties such as hardness or corrosion resistance into specific functionalization.

Methods
Discussed methods are electroplating and carbon nano tube (CNT) based plating technologies.

Results
Proof of concept shows that a wide range of functionalized coatings can be developed. These are coating materials which combine the advantages of ductile materials with abrasion resistant materials. Also liquid ingredients can via nanocapsules be packed into metallic matrices. Quite new processes will lead to applications that will bring the performance of plasma based plating technologies to the economical superior electrochemical processes. CNT based coatings can be used as actors.

Conclusion
The questions will not longer be whether functionalized coatings are available or not. The question will be which kind of functions should be implemented. For example, electrochemical dispersion coatings with nanocapsules as ingredients will be able to bring active pharmaceutical ingredients into metallic matrices.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg46433

Symposium: Let’s Talk Technology - Aluminium, Titanium, Magnesium – Light Weight Metals for Orthopaedic Applications
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Miscellaneous

Congress Lecture [4097-None]

Melt-spinning: the Enabling Technology to Make Aluminium as Strong as Titanium

Author
Senden, Roger (Delfzijl NL)
RSP Technology

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg46224/cg3266149

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3540-None]

Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment

Session Chair
Preisler, Benedikt (Egelsbach DE)
Pro Walk GmbH - Patient Care

Session Chair
Matthews, Martin (Redruth UK) | M.Phil
DM Orthotics Ltd.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57533

Symposium: Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3541-733]

The Treatment of Young Children with Low Trunkal Tone, as a Result of Various Diagnoses, with Dynamic GPS Soft Orthoses - Cases Studies

Author
Preisler, Benedikt (Egelsbach DE)
Pro Walk GmbH - Patient Care

Author
Eves, Karen (Egelsbach DE)
Pro Walk GmbH

Coauthors
Benedikt Preisler PT, Bobath und Vojta Therapist.
Karen L. Eves Bsc, Bobath Therapist
Benedikt Preisler PT, Bobath und Vojta Therapist.
Karen L. Eves Bsc, Bobath Therapist
Benedikt Preisler PT, Bobath und Vojta Therapist.
Karen L. Eves Bsc, Bobath Therapist

Abstract
The aim of these case studies was to select specific patient group and look at the effect of wearing Dynamic GPS Lycra Orthosis on them. As seen by ourselves, the therapists involved and the family/carers.

Introduction
The group of patients where we have thought the orthosis should be most successful are those with trunkal hypotonia . This hypotonia results in instability of the trunk, which can hinder the child’s development. We have therefore decided to carry out case studies of several young children who have been supplied with a Dynamic GPS Lycra Orthosis.

Methods
The needs of each patient were individually assessed, and the orthosis was provided to improve the child’s core stability. At the initial assessment, all of the children supplied with an orthosis, were between 18 months and 3 years old. The children were supplied with a Dynamic GPS Lycra Orthosis, with or without arms.
Photographs of the children were taken before and after supply, with the orthosis.
Developmental changes, which have been noted by the physiotherapists involved in the children’s treatment, were obtained.
Along side this we will ask the families of the children supplied, to ask their views, as to how the wearing of the lycra orthosis has affected their child’s, physical development, handling throughout the day and general wellbeing.

Results
The photographs and documentation from the therapists involved show that the orthosis provides the child with more trunk stability. The child’s posture is improved by the use of the orthosis. Functional changes

have occurred after the continual wearing of the orthosis for several months, were noted by the therapists and the childs family/carers.

Conclusion

Supply of this group of young children with a Dynamic GPS Lycra Orthosis, provides very much needed stability in the trunk. This enables the progression of their motor development, and therefore positive outcomes, in the quality of their daily lives.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57533/cg57612

Symposium: Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3542-723]

Effect of a "SNUG" Sensory Dynamic Orthosis on Gross Motor Function in Children with Cerebral Palsy

Author
Fisher, Kathryn (Redruth UK)
DM Orthotics Ltd.

Coauthors
Edward Dabrowski MD, Gretchen Backer PT, Ronald Thomas PhD, Jeffrey Kraus OTR,
Carolyn Mancin PT, Patricia Nizio MA SLP-CCC,Theresa Ricketts PT MS,Kathryn Fisher MSc MCSP
Nikki Salter MCSP3, Sara Wasser OTR2, James Chinarian MD1, Charles Pelshaw MD1,Kathryn Fisher MSc MCSP

Introduction

“Body suits” or Dynamic Elastomeric Fabric Orthoses, have been used for children with CP and other disorders resulting in neuromotor sensory deficits and/or affecting muscle tone.Such orthoses come in different styles, are made of a variety of materials, and may include rigid stays or elastic straps. Theoretically, these orthoses improve a child’s static and dynamic postural stability by giving proprioceptive (sensory) feedback.The “SNUG” Sensory Dynamic Orthosis (SDO) is customized to each individual, made to measure, and constructed of multi-directional stretch cotton Lycra® material. For a child with abnormal muscle tone, this creates a supportive, full-body bracing system.
The specific aims of this multi-centered study were to:
1.obtain an objective assessment of gross motor abilities prior to and following 12 weeks of use of the SDO
2.determine if significant functional changes occur over this time period
3.describe functional changes by GMFCS level

Methods

Two identically constructed, simultaneous studies were conducted. Studies received Institutional Review Board (US) or Local Research Ethics Committee (UK) approval, parental consent was obtained for all participants, and assent was obtained for participants over 7 years of age, as appropriate. Convenience samples of 21 voluntary participants from Children’s Hospital of Michigan in the United States (US) and 10 voluntary participants from the East Lancashire NHS Hospital Trust United Kingdom (UK) were included. Participants ranged in age from 1 to 23 years (average= 7 years), with 21 males and 10 females. Diagnoses included cerebral palsy and other neuromuscular disorders affecting muscle tone. Participants were each evaluated prior to, and following, 12 weeks regular use of the SDO by trained physiotherapists. Statistical analysis was conducted using paired sample T-tests at baseline and following 12 weeks of SDO wear, comparing total GMFM-88, as well as each GMFM-88 dimension

Results

Comparison of mean GMFM-88 change scores for each dimension, as well as the mean total GMFM-88 score demonstrated significant differences between baseline and following 3 months use of the SDO. Statistically significant changes were found for the total test population across all GMFM-88 dimensions. Likewise, statistically significant changes were found for GMFCS levels II, III, and V. GMFCS level IV demonstrated a trend towards significant improvement (p=0.079).Total mean GMFM-88 change score was not statistically different for GMFCS level I (p=0.423).

Conclusion

In summary, the data from this study demonstrates that, over a 3 month period, children wearing the SNUG Sensory Dynamic Orthosis made functional gains as demonstrated by change in GMFM-88 scores. Clinically and statistically significant changes were noted for each GMFM-88 dimension, as well as total GMFM-88 score. Likewise, significant improvements were found specifically for GMFCS levels II, III, and V. Limiting factors influencing these results may include: sample size, variability in the CP population studied, and length of follow-up. Longitudinal, multi-center evaluation with increased sample size (at each GMFCS level) and a matched control group is necessary to evaluate: compliance, long term benefits, carryover and retention of functional improvements. Further study is also needed to determine the possible mechanisms by which Dynamic Elastomeric Fabric Orthoses influence the nervous system and impact function.

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Symposium: Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3543-735]

Dynamic Lycra Orthoses Treatment for Shoulder Instability

Author
Matthews, Martin (Redruth UK) | M.Phil
DM Orthotics Ltd.

Coauthors
Payne,C; Watson,MJ

Abstract
There are numerous orthotic intervetions specifically designed for the supporting shoulder instability, however, most are cumbersome, often hot to wear and not necessarily fit for purpose. This is often due to the diagonal lines of pull provided by the orthoses. In contrast, the condition requires vertical force to re-locate the shoulder joint and re-align the musculature. The use of a unique dynamic shoulder stability orthoses appears to have overcome some of the reported experiences shown by the use of repeated radiographical images.

Introduction
Shoulder instability has remained a challenge to orthotic intervention due to the functional requirements of the condition and the orthotic options available(1,2). The search for improved methods of rehabilitation training has become increasingly relevant, particularly in this age of minimal intervention(3). This is particularly pertinent in the field of physiotherapy where orthotic intervention is required but range of movement comprimises have to be made. Most orthoses prescribed for the shoulder provide support, stability, but are unable to accommodate the extreme ranges of movement required at the gleno-humeral joint or reduce pain management(4). This can lead to further deterioration of the condition through non use.

Methods
A seventeen year old, competitive archer, presented with continuing pain in his left shoulder, caused by an acute episode as a result of pushing an archery target. The client's radiographs showed an inferior glenohumeral joint subluxation of the left shoulder with ligamentous laxity, a positive sulcus sign and a full range of assisted movement. The archer was unable to mobilise his shoulder and found the "Polysling" of some limited assistance, however muscle atrophy and left arm dysfunctional was apparent.
The dynamic Lycra shoulder stability orthosis was designed and produced using a polyester /cotton Lycra® based fabric with reinforcements of Powernet® to provide compressive forces. These forces applied an inferior (upward) acting force on the humerus, coupled with posterior acting protraction of the shoulder and downward compression of the scapulae to initiate improved biomechanical effect of the shoulder complex. The rear reinforcement provided a further compressive force to compress the winged scapulae

Results
Check x-rays confirmed that the glenohumeral joint was intact, although presenting as partial dislocation and therefore safe for physiotherapy to continue. The follow up radiographs three months later showed that the orthosis had relocated the humeral head into the socket. The experienced pain had also subsided. Six months later the x-rays showed that the glenohumeral joint was still intact without the orthosis in use allowing for full rehabilitation of the client.

Conclusion

The design and use of new materials provides an interesting insight into the long term possibilities of dynamic Lycra® orthotic treatment in a whole variety of applications and not just the area of neurological dysfunction.

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Image: shoulder stability orthosis_735.pdf (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57533/cg57733

Symposium: Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3545-747]

Case Study: Developing a Dynamic Elastomeric Fabric Orthosis to Manage Pregnancy-Induced Pelvic Pain

Author
Sawle, Leanne (Redruth GB)
DM Orthotics Ltd.

Abstract
Case study: Subject in her 30's; first contact was made in the fifth month of gravida 2. She had been suffering from anterior and posterior pelvic pain and bilateral hip pain since early pregnancy. A pelvic belt helped pain, but proved uncomfortable.

Introduction
Problem: Incidence of posterior pelvic pain in post-partum women is 20% (Vleeming et al 2008), whilst symphysis pubis dysfunction (SPD) affects 1:36 to 1:300 (Jain et al 2006). Muscles and ligaments provide force to aid lumbopelvic stability through force closure. With loss of force closure linked with pelvic pain, pelvic belts have been used to increase force closure.
DEFO's are now playing a role as orthotic supports, and are used in several domains.

Methods
Intervention: To address the subjects' pain by using compression to increase force closure, a customised DEFO was constructed. DEFO's were developed through the pregnancy, to reflect changes that occurred with growth. The DEFO was worn every day, and was used for all activities including swimming.

Results
Results: From an entirely subjective perspective,the DEFO enabled the subject to engage in activities that she was previously unable to do, due to better pain control.
She was further able to mobilise without the use of bilateral crutches.

Conclusion
Conclusion: Two DEFO's were successfully developed, which reduced pelvic pain and improved quality of life. Utilising the same principles as pelvic belts, the DEFO's proved more flexible, and were tolerated better.
An RCT is needed to objectify these findings.

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Symposium: Dynamic Elastomeric Fabric Orthoses - A New Concept in Orthotic Treatment
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Orthotics

Congress Lecture [3546-736]

A Pilot Study of the Effects of Dynamic Elasticated Fabric Foot Orthoses on Gait in Subjects with Chronic Hemiplegia

Author
Matthews, Martin (Redruth UK) | M.Phil
DM Orthotics Ltd.

Abstract
This paper describes a novel, proof of concept, combined intervention utilising functional foot orthotics, dynamic elastomeric fabric orthoses and functional electrical muscle stimulation on a child with hemiplegic cerebral palsy. Using five video films in both sagital and coronal planes the natural evolution of change proceeds from bilateral toe barefoot walking to bilateral heel strike all recorded in one session. The combination presents an opportunity of a possible insight for the future of orthotics, particularly in the provision of early orthotic intervention in the children with cerebral palsy.

Introduction
The use of dynamic elastomeric fabric orthoses (DEFOs) is becoming a recognised treatment option for children for both children and adults with cerebral palsy and other neurological dysfunction. The orthoses are reported to provide proprioceptive feedback and dynamic muscular assistance to assist in gait re-education(1;2). Combining DEFO use with conventional orthoses like ankle foot orthoses are recognised. However,there is no evidence for combining this particular combination as a treatment modality to date.

Methods
The subject; a male (aged 7 years) with a diagnosis of right sided, hemiplegic cerebral palsy. Clinical feedback had high lighted concerns over using functional electrical stimulation on children due to the discomfort experienced when electrical currents were applied to the skin. In this case study, the child underwent 3 months of muscle strengthening using a muscle stimulator at a 20htz current to tibialis anterior to normalize the sensation, prior to gait analysis and FES application.
Gait analysis provided for five single walk tests in both frontal and sagital planes investigating possible effects and changes in gait whilst walking. The subject walked repeatedly across the gait laboratory in the following order: barefoot; wearing DEFO dorsiflex assist sock; sock, functional foot orthosis (FFO) and heel raise; functional electrical stimulation to tibialis anterior and the combination of all orthotic inventions.

Results
The results, recorded on Quintec video, show effects in real time for each of the different interventions. The barefoot baseline showed bilateral toe walking with marked hip retraction. Intervention of the dorsiflex assist DEFO sock showed immediate change to the left side which began heel strike although the right side was still toe walking. The effect of heel raise, FFO and shoe provided a slightly improved gait although no marked change to heel contact on the right was apparant. The application of the FES without the sock showed clear heel strike on both sides, but increased hip retraction; however the application of the sock combined with the FES initiated bilateral heel strike with reduced hip retraction resulting in larger stride lengths.

Conclusion

The early evidence of using a combination of orthotic and functional electrical stimulation using DEFO socks suggests an alternative to the historic usage of ankle foot orthoses. Coupling with heel raises to remove the forefoot dynamic catch could suggest an alternative management for early stage walking dysfunction in children with cerebral palsy. Obviously this subject requires further inverstigation.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3534-None]

Latest Developments in the Treatment with Sport Shoes

Session Chair

Milani, Thomas (Chemnitz DE) | Univ.-Prof. Dr.
Technische Universität Chemnitz - Institut für Sportwissenschaft Lehrstuhl Bewegungswissenschaft

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57123

Symposium: Latest Developments in the Treatment with Sport Shoes
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3536-786]

Methodological Aspects of Sensory Measurements

Author
Schlee, Günther (Chemnitz DE) | M.A.
Chemnitz University of Technology

Coauthors
Thomas L. Milani

Abstract
This series of studies had the objective to evaluate intra- as well as inter-day reliability of plantar foot vibration thresholds. The very good repeatability found in the intra-day measurements suggests that treatment studies on foot sensitivity should be performed within same day.

Introduction
Quantitative sensory testing has become a very useful tool in the clinical assessment of foot sensory data. Although early research has identified factors that influence foot sensitivity, e.g. age and vibration frequency, basic aspects of sensory data like the reliability of the thresholds are still controversially discussed (Hilz et al., 1998; Halonen, 1986). Therefore, this series of studies had the goal to evaluate the intra- and inter-day reliability of foot vibration thresholds measured in healthy young subjects.

Methods
A pool of 60 subjects (30 female, 30 male,age ranging from 18-35years) participated in two separate studies which investigated the intra-day as well the inter-day reliability of vibration threshold data. In all studies, thresholds were measured at 200Hz by using a modified vibration exciter at three anatomical locations of the plantar foot: heel, first metatarsal head and hallux. All measurements were performed under controlled temperature conditions. Reliability of the data was analysed using the Normalized Root Mean Square Error (RMSEnorm) (Maiwald, 2008) and according to the procedures described by Bland and Altman (1986).

Results
The results of the intra-day investigation show very good repeatability of thresholds measured at all anatomical locations. The inter-day study shows sufficient threshold repeatability only at the first metatarsal head, with poor results found at the remaining anatomical locations

Conclusion
The repeatability of the thresholds seems to be influenced by the perception capability of the subjects, especially regarding the inter-day thresholds. The results of both investigations suggest that treatment studies on foot sensitivity should be performed within the same day, due to the high inter-day variability shown by plantar foot vibration thresholds. Furthermore, subjects should be characterized regarding their sensory capability prior to treatment studies, in order to enhance the quality of the measured data.

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Symposium: Latest Developments in the Treatment with Sport Shoes
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3539-830]

Overload Induced Tendon Injuries of the Lower Extremity

Author
Lohrer, Heinz (Frankfurt am Main DE) | Dr. med.

Introduction
The lower extremity is functionally involved in posture and locomotion. Capacity of the tendons to tolerate repetitive load in training and competition is limited and overload injuries may develop.
This presentation aims to describe sport induced overload injuries of the tendons of the lower extremity, illuminating specific details in history, physical findings, treatment, and prevention.

Methods
We analysed the clinical records from a 3.5 years period (Institute for Sports Medicine, Frankfurt am Main, Germany). 5 258 patients presented themselve 25 033 times. 800 of them (15,2%) underwent surgery.

Results
13.0% of the patients suffer from Achilles tendon related overuse injuries (Achilles tendinopathy, Haglund's disease, Achilles tendon insertional tendinopathy/posterior heel spur). Probability to undergo operative treatment during the course of the overuse injury is markedly increased for peroneal and posterior tibial tendon disorders and for the Flexor hallucis longus/Os trigonum pathology (Table 1).

Conclusion
Our data indicate that tendons encompassing and stabilizing the ankle are prone to sport induced overload injuries. Correct diagnosis and knowledge of the differential diagnosis is crucial for the applied treatment strategy. Results for both conservative and operative treatment of overuse induced tendon injuries of the lower extremity are good. There is no need for immobilization for more than one week even following surgery. However, rehabilitation frequently covers a period of up to one year.

Image: Lohrer_None.jpg (see online)

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Symposium: Latest Developments in the Treatment with Sport Shoes
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3535-710]

Dynamic Foot Scanning. A new Approach for Measuring the Human Foot Shape during Walking

Author
Schmeltzpfenning, Timo (Tübingen DE) | Dipl. Ing. (FH)
Uniklinik Tübingen, Biomechanik - Medizinische Klinik, Abteilung Sportmedizin

Coauthors
Clemens Plank, Inga Krauss, Petra Aswendt, Stefan Grau

Abstract
Investigation of dynamic foot shape was performed using a synchronized multiple scanner ensemble (ViALUX, Germany) based on fringe projection technology. Significant and practical relevant changes during stance phase of gait were determined whereas differences between static and dynamic values were not significant.

Introduction
The human foot is a complex structure with highly dynamic functions, like supporting weight and accelerating. Anthropometric data of the foot are normally measured in static situations. However, it is well known that static foot changes shape under different weight bearing conditions (Tsung et al., 2003; Xiong et al., 2009). These static information may help shoe designers understand foot deformations, but for more precise and realistic data on foot changes during the roll over process (ROP) we need to analyze foot shape in a dynamic situation. Overall, there is only very limited knowledge on dynamic foot anthropometry during walking or running which is mainly caused by limited measurement technique. Therefore, the aim of this project was to develop a 3D-scanner system to capture human foot shape during ROP. This technique is then used to quantify foot shape changes within ROP, differences between static and dynamic foot structure as well as predictability of dynamic foot changes.

Methods
106 subjects (#47 #59) were measured 3 times during dynamic walking (4.5 km/h ±5%) and 2 times during bipedal, semi-weight-bearing standing. A 3D measurement set up consisting of 3 scanner units was used to capture the plantar foot shape during walking. All units were placed below the 4.6m walkway to measure the sole of the foot and maximum medial, lateral, anterior and posterior curvature. The proposed measurement system is based on a fringe projection technique, where a series of fringes is projected and recorded at ultra-high speed to provide 3D-shape information. Using light patterns instead of single stripe projection enables a single scanner unit to capture extensive areas of the foot at one time. The entire foot was captured at a 3D-frame rate of maximum 41 fps by running the camera (640x480 pixel) at its highest frequency (205Hz) in a 2x2 binning mode. Differences between static and dynamic and changes during ROP were quantified using an independent Student's t-test (#<0.05).

Results
Foot shape changes (maximum to minimum) during ROP of walking demonstrated significant foot deformations in length, width and arch values. Width measures increased up to 5.2mm (# > 8%) on average with the greatest changes in heel width. There was a decrease in arch height during ROP of 17% (# = -5.6mm) and in arch angle of over 23% (# > -8°) for the entire group. Medial ball length shifted by +2.4mm

whereas foot length increased during midstance phase (20% - 55% ROP) by about 1.4mm. Comparing static and dynamic foot shape showed high individual variations with only small, non significant differences over the random sample. However, especially changes in arch structure indicated dependency on different individual factors, like BMI and sex.
A regression analysis for each static foot shape variable as a predictor for changes in foot structure (response variable) during ROP of the given variable indicated that there is no relationship between each static foot measure and the corresponding range of foot shape changes during walking.

Conclusion

These results can help designers provide better fitting shoes and insoles, e.g. solving ambiguities in width and length allowance for last construction by considering dynamic foot geometry. This is important since changes during ROP can correspond to more than one shoe size in width. High individual differences of dynamic foot measures indicate the need for dynamic foot clusters to enable adjusted shoe and last construction. Although static and dynamic foot measures did not show a significant distinction, regression analysis showed that static foot values cannot indicate the range of dynamic foot changes during ROP; dynamic scans can provide essential supplementary details. In conclusion, the proposed measurement technique is a suitable technology for capturing the human foot shape during the ROP with high potential in different application areas. The presented measurement system is currently being upgraded to include 5 scanners to enable measurements of the entire dynamic foot shape.

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Symposium: Latest Developments in the Treatment with Sport Shoes
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3537-782]

Influencing Factors to Perform Dynamic Material Tests

Author
Heidenfelder, Jens (Chemnitz DE) | MA
Chemnitz University of Technology

Coauthors
Thorsten Sterzing, Thomas L. Milani

Abstract
The goal of the present work was to determine factors which are important to improve the quality of mechanical material testing. By using a holistic approach, with biomechanical and mechanical tests, it could be shown that it is possible to create a mechanical test design which is suitable to perform functional footwear tests.

Introduction
Viscoelastic materials have been used in shoes for many years. The field of application spreads from orthopaedic insets, through insoles to complete midsole materials. Due to functional demands, material properties can be shifted from highly viscous to mainly elastic behaviour. To characterize this behaviour in general, mechanical test procedures were used to obtain subject independent results.
Several authors performed mechanical tests with the demand to mimic natural running. But the mechanical input parameters used in these studies showed strong differences among each other (Walker, 1998; Aguinaldo & Mahar, 2003) and compared to biomechanical studies (Nigg et al., 1987). Comparing machine-simulated running and in vivo loaded shoes differences up to 25% were found (Cook et al., 1985). Therefore, it can be concluded that available dynamic material tests for shoe products are user specific and beyond that far away from simulating natural running.
The goal of the present work was to determine factors which a

Methods
In contrast to open-loop test devices which are suitable to perform simple drop tests, closed-loop test devices are appropriate to perform force-, path or speed-controlled tests. Besides single material characterization, these test devices offers the opportunity to investigate material durability and behaviour under different loading conditions.
To improve functional footwear testing mechanical and biomechanical studies were performed to (a) identify influencing factors, (b) evaluate mechanical input parameters for specific tests and (c) validate a mechanical cushion test.

Results
Magnitude, speed, frequency and area of the applied load as well as the number of cycles and temperature could be identified as influencing factors. Based on these findings a mechanical test design was created which is suitable to investigate functional cushion properties of running shoes, and which can be adjusted to perform functional product tests for further applications. The created test design was shown to be highly reliable. The capability to mimic natural running was proved by comparing mechanical and natural aged running shoes. For shock attenuation mean differences are less than 3% and for single results not higher than 10%.

Conclusion

With this test design, influencing factors such as geometry, material composition and environmental influences can be investigated under standardized conditions. Furthermore, the findings of these studies are helpful to improve existing test designs and to interpret results of similar studies.
Acknowledgement: Supported by Puma Inc., Germany.

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Symposium: Latest Developments in the Treatment with Sport Shoes
Friday 2010/05/14 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3538-795]

Mechanical Properties of Medical Compression Textiles

Author
Riesner, Isabel (Chemnitz DE) | MA
Chemnitz University of Technology

Coauthors
Stefan Schwanitz, M.A.

Abstract
For the development of a system to determine effects of medical compression stockings to the human body out of mechanical properties in first step the direct pressure measuring with Medical Stocking Tester was researched. For different stockings the reliability and absolute accuracy of the MST were tested. In common the function of the MST could be proved.

Introduction
All medical compression textiles have the aim to support the body because of chronic disease in common. Elastic compression stockings are essential for therapy of chronic venous insufficiency and lymph oedema in the lower limb. The effect of compression are determined by the resulting pressure on the limb and the stiffness of the medical compression textiles 2. The medical compression textiles have to comply with the RAL GZ 387/1 2 and build the demanded pressure in the area of the ankle. In addition the pressure have to reduce from distal to proximal.
This pressure can help to receive the effect of therapy by lymph oedema, e.g. lymphatic drainage, or improve the venous hemodynamics.
For the effects of compression not only the interface pressure also the extensibility of the material is important. So there are stocking in different compression classes comprising different material.
The aim is to find an easy and non destructive test to determine mechanical properties of medical compression textiles

Methods
On the first step it is necessary to research the common used methods of the market to measure the affected pressure of the medical compression textiles to prove its reliability.
The most prevailed system for quality assurance is the “Medical Stocking Tester” from Salzmann AG (MST MK III) which consists of a plastic tube with integrated pressure sensors. The MST is put on a specified part of the body, or a reconstruction of it, and under the medical compression textile. In the measurement the MST is slightly blown up and records the pressure affected by the medical compression textile.
In the study 7 different elastic round knitted compression stockings were chosen. 4 of these belong to the compression class 1, which means an interface pressure at the ankle of 18-21 mmHg, and 3 to the compression class 2, interface pressure at the ankle of 23-32 mmHg. All stockings are appropriated to the circumferences of a leg by the data of the manufacturer. The measured body part is an reconstruction of a leg deliver

Results
The first results are that the MST is strongly dependent on the time of relaxation of the material. Less time after putting on the stocking a considerable drop of the measured pressure could be recognized. A

constant value tunes in 3 minutes after slipping over. Because of that a relaxation time of 3 minutes were set for the following measurements.
The repeated measurements shows an increasing average range of pressure of 2 mmHg by putting off the stocking between against 0.75 mmHg without. On 3 of 4 measurement points the higher variance causes also a shift of the mean to lower pressures. This is shown in figure 1. The same test setup on different days shows a correlation coefficient r = 0.94.
In common the expected pressure gradient and the for the compression classes postulated values could be proved. Because of the less accuracy of MST it is not possible to recognize changes smaller then 1 mmHg.

Conclusion
The MST is reliable and exact enough for the quality assurance in production. For the aspired system the direct measuring of the pressure with MST is not sufficient. Because of that in next steps a research of the mechanical properties of the medical compression stockings is necessary. In connection with the gained results it should be possible to determine a correlation between the
extensibility and the affected pressure.

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Image: Figure1_795.gif (see online)

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3695-None]

Rehabilitation - Chronic Low Back Pain, Miscellaneous

Session Chair
Jarl, Gustav (SE) | Mr.
Habilitation, Örebro County Council - Dept. of Prosthetics and Orthotics & Centre for Rehabilitation Research

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg238683

Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [2873-73]

Long-term Effects of a Multimodal Treatment Concept for Chronic Low Back Pain. Can the Effects of the Orthopaedic-psychosomatic Concept be Replicated?

Author
Fröhlich, Stephanie M. (Bad Rothenfelde DE) | Dipl.-Psych.
Institut für Rehabilitationsforschung Norderney e.V. - Bad Rothenfelde

Coauthors
Dibbelt S, Greitemann B, Niemeyer R, Niemeyer C

Abstract
In the present study the effectivity of the integrated orthopaedic-psychosomatic Concept of the Munsterland Clinic for the treatment of chronic low back pain could be mostly replicated, after it was successfully implementated in three further rehabilitation clinics.

Introduction
The integrated orthopaedic-psychosomatic Concept (IopCo) of the Munsterland Clinic in Germany is an evidentially long lasting sustainable approach for the treatment of chronic back pain, which is counted among the biggest cost factors in the German health system. The aim of the current project was the implementation of the Iopko with the multimodal treatment program “Rückenfit (backfit)” especially for chronic low back pain patients with additional psychological or occupational problems in further rehabilitation clincs. The evaluation was a longitudinal study with a control group.

Methods
The implementation was made by intense, goal-oriented and supportive communication. The therapists were trained by job shadowing (sitting in on treatment of patients) and by DVDs with filmed therapy-examples. Of course there was also a manual for the therapists as well as a rehabilitation book for the patients.
The evaluation of the therapeutic concepts was a controlled long-term study with 4 measurement times up to 10 months after end of rehab. 651 patients (SG: 342) from 5 rehabilitation clinics (61% males,Mean age 48.4) took part in the study. The data analysis was conducted separately for each clinic and in parts gender specifically.
The evaluation of the implementation process was carried out after the first half of the project run time. We used a self constructed questionnaire for the involved members of staff to assess e.g. the satisfaction and problems with the implementation process.

Results
The implementation of the IopCo and the multidisciplinary treatment „Rückenfit“ was successfully implemented in three further orthopaedic rehabilitation clinics. 437 patients received the special treatment program, further 375 were part of the control group, who received a standard program for chronic back pain. Ten months after
discharge the results showed an increased health status for all patients. The study group was found to do better than the control group primarily in active health behaviour, pain perception and absence-from-work-times.

Conclusion

The implementation of the IopCo and the multidisciplinary treatment „Rückenfit“ comprised modifications of their previous routines for the clinics. For the success of such an implementation process the present situation in the clinics and the ability to change management plays an important role. Intense communication, support by the clinic management, motivated employees and an open minded staff are adjuvant.

Regarding the evaluation it could be declared that the positive and long-term results of the IopCo can be replicated in the majority of cases. Even clinics which implemented the new concept just because of the project produced remarkably better outputs for the study than the control group 10 months after discharge. The reasons for these effects are supposedly more homogenious treatment groups and the observance of psychological and occupational problems beside the chronic low back pain.

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Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3033-231]

Lets Map the Path to Well-Being

Author
Pihlar, Zdenka (SI)
Institute for Rehabilitation, Republic of Slovenia - Clinic for PRM

Coauthors
Križnar A, Mikuleti# M, Burger H

Abstract
The aim of our study was to find out which activities people after amputation want to perform and consider important. We assessed fifty patients after lower limb amputations using FIM and COPM. We found that independency in DA is not sufficient, the patients want to perform other activities as well.

Introduction
The basic aim of rehabilitation after lower limb amputation is to restore ones functioning before amputation and return him/her to the previous environment. This does not encompass only providing the prosthesis and independence in daily activities (DA), but also activity in the fields of work and productivity and free time (1).
The majority of specific tools for assessing people after lower limb amputation, such as the Locomotor Capability Index (LCI), emphasise walking – in different conditions, on different surfaces (2). Some scales, mainly general ones, include DA assessment.
The aim of our study was to find out which activities people after amputation want to perform and consider important, how they rate their own performance and satisfaction, and how well do the scale that we use cover these issues.

Methods
Fifty patients after lower limb amputation admitted to primary rehabilitation at the Institute for Rehabilitation in Ljubljana, Slovenia, in February and March, 2009, participated in the study. They were assessed using FIM within 72 hours after admission. During the first day of occupational therapy (OT), a semi-structured interview was performed in which the patient chose five most important activities in the areas of self-care, work/productivity and free time with with he/she experienced difficulty in performing. The assessment of performance and satisfaction with performance of the selected activities using COPM (3, 4) was performed on the second day of OT.

Results
There were 29 men and 21 women, aged between 43 and 87 years (average 70 years), of whom 27 (54%) had transtibial, 20 (40%) transfemoral and 3 (6%) bilateral amputation, almost in all cases (96%) because of peripheral vascular disease or diabetes. The total FIM scores ranged between 30 and 124 (average 93, SD 18).
The patients selected as important and either desired by them or required from them 25 activities from work and productivity, 18 from self-care, and 16 from free time. The top activity choice belonged to self-care 10 times, to work and productivity 9 times, and to free time 8 times.
The average rating of performance was 4.5 points out of 10, whereby the average satisfaction rating was 5.1 points. The lowest ratings were assigned to activities from work and productivity, as well as free time.

FIM covered 10 of the 59 activities selected as important by the patients, all from the area of self-care, while LCI covered none.

Conclusion

We found that patients after lower limb amputation are not satisfied by being independent in basic DA because they want to perform numerous other activities. As many as 80% of them chose among top priorities activities from the area of work and productivity. Those activities are often excluded from rehabilitation programmes (2).

We also found that FIM as the most commonly used general scale in rehabilitation, and LCI as a specific scale for assessing elderly patients after lower limb amputation, do not cover the majority of activities desired by the patients.

The task of the OT included in the rehabilitation programme for persons after lower limb amputation is to select activities that the patient considers important. The OT teaches the patient how to achieve effective performance using environment adaptations, aids and devices, and performance strategies. The final aim is return to the pre- amputation environment and performance (5).

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Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3244-425]

Parzivar: An Intervention Towards "Smart" Shared Goals in Rehabilitation for Patients with Chronic Low Back Pain

Author
Dibbelt, Susanne (Bad Rothenfelde DE) | Dr.
Institut für Rehaforschung - Bad Rothenfelde, Klinik Münsterland

Coauthors
Dudeck A, Glattacker M, Greitemann B, Jäckel, WH

Abstract
Summary. In the Parzivar-Project, physicians and therapists were trained in a step-by-step-intervention to negotiate individual, quantified treatment goals which tie in with important patient's concerns. The effectiveness of the intervention with respect to numerous treatment outcomes is currently a

Introduction
Setting individual goals with the patients and monitoring their achievement is a core practice within rehabilitation. Evidence from motivation and volition research underline the impact of well defined or "SMART" individual, function oriented goals, shared by patient and physician [1,2,3,4,5,7,8]. However, previous studies have suggested that in the negotiation of rehabilitation goals there seem to be serious communication barriers on the patient's and the physician's side in discussing and formulating shared goals adequately [6].

Methods
In the Parzivar-Project, a step-by-step-dialogue to negotiate rehabilitation goals with patients was developed. Physicians and therapists were trained in accomplishing a dialogue and setting individual goals, quantified and related to important concerns of the patient. Goals and goal attainment have to be assessed and adjusted during and at the end of stay. The effectiveness of the intervention with respect to numerous treatment outcomes is currently assessed in a sequential (pre-post) controll group design study in three cooperating clinics with 660 patients suffering from low back pain, coronary heart disease and diabetes mellitus II.

Results
In our contribution we describe the procedure of participative goal setting and give examples of prototypical goals and goal features developed with patients suffering from chronic low back pain. We expect that training and intervention will lead to more systematic definitions of patient goals, which provide better feedback to both patient and physician about changes in health status, are more realistic and thus more motivating than goals defined under current care conditions.
Furthermore, we expect that the intervention has (1) direct effects like stronger (more noticeable) participation of the patient in the treatment process, higher quality of physician-patient-interaction and stronger self efficacy expectation by the patient; (2) mediated effects on disease specific clinical outcomes like pain or medication as "generic" outcomes like functioning and quality of life.

Conclusion

First experiences (sample interviews with patients and physicians) suggest that participative goal setting (Parzivar) leads to a better exchange between patient and physician. Although the dialogue and its documentation is somewhat time demanding, it forces a veritable exchange between patient and physician regarding concerns, expectations and perspectives. Analogous to a shared decision making procedure, it provides a framework of necessary steps of goal processing, described in a manual including training material like case vignettes and phrasing aids.

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Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3350-525]

The Value of the Isernhagen Work Systems (IWS) for the Social and Medical Judgement in Inpatient Orthopaedic Rehabilitation

Author
Greitemann, Bernhard (Bad Rothenfelde DE) | Prof. Dr. med. Dipl. Oec.
Klinik Münsterland der Deutschen Rentenversicherung Westfalen

Coauthors
Greitemann B, Schaidhammer M

Abstract
Based on an overview over IWS-literature this study shows that IWS can give useful information to physicians and patients if its boundaries are taken into account. However, many patients, especially those with a bad psychophysical background experience a significant increase of pain.

Introduction
At the end of rehabilitation physicians judge the ability of their patients to return to work. Therefore they have to compare the demands of the patient`s job with his physical abilities. Unfortunately, standard orthopaedic measures as well as imaging procedures do not help very much in the judgement of one`s ability to do complex tasks. So functional capacity evaluations (FCEs) as the IWS are seen as the gold standard of instruments for this task. They let subjects withstand demands of daily work like lifting, carrying or sitting. In practice, FCEs are seen as objective, reliable and valid. The literature shows a more heterogeneous picture, presenting limited studies with very different results. Nonetheless even a method of questionable quality is to be used when it is the most useful you have. So we asked if the IWS
a. helps physician in judging patients` physical capacity;
b. helps patients to assess their physical abilities correctly;
c. involves the risk of increased pain.

Methods
The study contains data of 76 patients of the Klinik Muensterland (Bad Rothenfelde) and the Reha-Zentrum Bad Pyrmont who absolved IWS. Three stopped the assessment because of increasing pain, so the results are based on data of 73.
Methods:
a. Use for physicians: We compared the IWS-results with the physicians` blinded estimates of the patients` physical abilities. Instruments included the IWS-form with 5 categories and an analoguous self-made-questionnaire for the physicians. Differences and correlations were calculated.
b. Use for patients: Patients estimated their abilities and told us about their job prospects before and after IWS. Instruments included self-made questionnaires, the IWS-form and pre- and post-PACT. We compared patients` pre- and post details as well as both of them with IWS-results.
c. Increase of pain: Via analysis of variance we compared the four reports of pain patients gave during IWS at the beginning and the end of both days on a numeric scale 0 to 10.

Results
a. Physicians estimates and IWS-results differ widely. In comparison, physicians ascribe more general physical ability (0,21 IWS-categories; kendall’s tau .57; p=.000), but less single abilities to their patients

(between -0,09 and 1,54 IWS-categories; kendall's tau between .04; p=.700 and .40; p=.000) than IWS. The differences can be put down to special features of IWS outlined in literature and expert discussion. Above all, these are that the IWS does not take special burdens of the individual jobs into account, that it does not consider developments and prognoses, and that there are more variables than the physical abilities determining IWS-results. Questionnable is the extrapolation from a test situation with strong timely limitations to a real fulltime job. Indicators for the influence of these variables are shown in our data.
b. About 2/3 of the patients say that they had learned something about their physical activities. The number of patients whose PACT-value comes near the IWS-results increases from 21 to 44, but the job prospects stay stable.
c. The mean of reported pain increases significantly from 3,20 at the beginning of the first day to 4,75 at the end (p=.000) and then stays statistically stable with 4,58 and 5,00 at the second day. Three patients did not come to a regular end of the test because of an increase of pain. One of them had a discus prolaps, the others felt better again quite soon.

Conclusion

a. The IWS can give useful information to the physicians above all if the patient appears contradictory. But for a valid estimation of return to work ability it is absolutely necessary to get the IWS-results in tune with patients individual reality. The IWS can supplement but in no way replace the estimation of an experienced physician.
b. Many patients correct their own estimation of their physical abilities after IWS, but because of conditions like the labour market their job prospects remain stable.
c. The average patient experiences a significant increase of pain during IWS. Especially patients who fear to be sent back to a job they do not like seems to lead to a high risk. This should be taken seriously in the preparation for IWS as well as in the treatment of the increased pain in order to prevent further fear and and chronification.
So the IWS can be useful with motivated patients but the assessments boundaries must be named and taken into consideration by all persons involved.

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Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3198-385]

Fossil - Efficacy of a Shoulder-joint Functional Orthesis in Shoulder-joint Subluxation after Stroke to Avoid Post-hemiplegics Shoulder-hand Syndrome

Author
Hartwig, Maik (Bad Neustadt DE) | Msc Neurorehabilitation
Neurologische Klinik Bad Neustadt - Neurorehabilitation / Ergotherapie

Coauthors
Griewing B,Gelbrich G

Abstract
Aim of this study is the judgment of the effectiveness with the use of a shoulder-joint-functionorthesis in shoulder-joint-subluxation after ischemic brain stroke in regard of avoidance of a posthemiplegic shoulder-hand-syndrome.

Introduction
The shoulder-joint-subluxation is a frequently appearing complication, which is observed secondary by central arm paresis after a stroke. In the next sequence of this subluxation, with false positioning and pull at the capsule-band-apparatus of the joint, developing of a shoulder-hand-syndrome with the leading symptoms, pain in the shoulder-joint, pain and swelling in the hand and changes of skin temperature, -turgor and color may occur. The incident of a shoulder-hand-syndrome, also well known as Sudeck's dystrophy, or complex regional pain syndrome (Type 1) reaches 12-34%, it develops in about 1 of 4 hemiplegics. A large number of SHS-treatments are suggested, however there is no definitive therapy yet. In diverse clinical studies, were studied the use of different slings and support devices to reduce the shoulder-joint-subluxation. The use of a shoulder- joint-functionorthesis in relation with shoulder-hand-syndrome was however not yet proven through clinical studies.

Methods
In a cohort of 50 patients, which show the CT-secured diagnosis of a immediate, ischemic brain stroke (0-21 days after appearance) with following shoulder-joint-subluxation, will get treated through randomizing, 25 Patients with shoulder-joint-functionorthesis (Sporlastic) and conservative therapy, as well as the other 25 patients with conservative therapy exclusively. In each half of the cases of each application group, the user hand was effected by the stroke. The patients must be able to be mobilized and cannot show high levels of conscious interference as well as perception interference. Based on the clinical used finger measurement and the anthropometric analysis, is determined the status of the shoulder-joint-subluxation after 0,7,14,21 and 28 days, also with the use of a valid shoulder-hand-syndrome score , according to Braus, the prevalence of the shoulder-hand-syndrome.

Results
We demonstrated that the functional orthesis NEURO-LUX is efficacious in the reduction and prevention of pain, hand oedema, and limitations of movement of the upper extremity in patients with a caudal subluxation of the glenohumeral joint after ischemic brain stroke. The treatment by the orthesis was well tolerated by the patients. Only few symptoms of the shoulder-hand syndrome were observed after four weeks of treatment, compared to a considerable burden of symptoms observed in the control group.

The clinical efficacy of shoulder joint functional orthesis was able to be proven with significance, whereby the SHS score, the shoulder subluxation and the acceptance of the orthesis were assessed as criteria for success.

Conclusion

The orthesis examined in this trial is useful to prevent or reverse the onset of the SHS in patients with shoulder-joint subluxation after ischaemic brain stroke. A study involving more patients should investigate the daily and total duration of application of the orthesis necessary to achieve enduring clinical success.

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Session: Rehabilitation - Chronic Low Back Pain, Miscellaneous
Friday 2010/05/14 | 10:30 - 12:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Congress Lecture [3199-386]

Validity of the Swedish Version of Orthotics and Prosthetics Users' Survey (OPUS-Swe)

Author
Jarl, Gustav (SE) | Mr.
Habilitation, Örebro County Council - Dept. of Prosthetics and Orthotics & Centre for Rehabilitation Research

Coauthors
Jarl GM, Heinemann AW, Norling Hermansson LM

Abstract
The Orthotics and Prosthetics Users' Survey (OPUS) is an instrument evaluating different aspects of orthotic and prosthetic outcomes. OPUS-Swe was answered by 299 clients and validated by means of Rasch analysis. The results support the instrument's validity and provide suggestions for improvements.

Introduction
Self-report instruments are one of the tools available for assessing the outcome of O&P interventions. The OPUS was developed in the USA to assess the outcome of both prosthetic and orthotic users.1 It consists of five modules; Lower Extremity Functional Status (LEFS), Upper Extremity Functional Status (UEFS), Client Satisfaction with Device (CSD), Client Satisfaction with Services (CSS), and, Health Related Quality of Life (HRQoL). Each module has 10-23 items, answered on Likert scales with 4-5 response categories. In earlier studies a ceiling effect has been shown in the UEFS module,2 and a similar effect is expected in the LEFS module for clients with insoles,3 suggesting the addition of more difficult items to these modules. For this reason 6 items were added to the UEFS module and 7 items to the LEFS module. The OPUS has been translated to Swedish and tested for linguistic validity.3 The aim of this study was to assess construct validity of OPUS-Swe by means of Rasch analysis.

Methods
Clients at the Departments of Prosthetics and Orthotics, Hand Surgery, and Rheumatology, respectively, Örebro University Hospital, Sweden, were informed and asked to participate. Those who agreed received the modules appropriate in accordance to their physical condition. OPUS was also sent by mail to arm prosthesis users. Persons <18 years of age or who could not be expected to understand the modules correctly were excluded. In total, 299 persons answered OPUS (Table 1). WINSTEPS® software, using the rating scale model, was applied for the analysis.4 Rating scales were examined using Linacre's guidelines.5 Targeting was examined by comparing mean item difficulty and mean person ability. Unidimensionality was examined by fit statistics and principal component analysis (PCA) of residuals. Reliability was estimated for items and persons. Differential item functioning related to gender and device was examined. The study was approved by the Regional Ethics Committee.

Results
LEFS
The rating scale worked well. Items were slightly mistargeted. Three items were deleted to improve unidimensionality. Reliability was excellent. No items demonstrated DIF.
UEFS

The rating scale worked well but items were somewhat mistargeted. One item was deleted due to redundancy. Unidimensionality was satisfactory with one item misfitting. Reliability was excellent. Three items demonstrated gender-related DIF and three items demonstrated device-related DIF.
CSD
The rating scale demonstrated some problems due to mistargeting of the items. Two items were deleted as they measured another dimension. One item misfit. Reliability was excellent for items but fair for persons. One item demonstrated device-related DIF.
CSS
The rating scale exhibited some problems due to mistargeting of the items. Unidimensionality was satisfactory. Reliability was very good for items but fair for persons. No items demonstrated DIF.
HRQoL
The PCA suggested splitting the module into two subscales. The limitations subscale had minor problems with the rating scale due to mistargeting of the items. One item was deleted due to misfit. Reliability was excellent for items and good for persons. Five items demonstrated device-related DIF. The emotions subscale had minor problems with the rating scale due to mistargeting of the items. Unidimensionality was satisfactory with one item slightly misfitting. Reliability was excellent for items and good for persons. One item demonstrated gender-related DIF.

Conclusion
This study provides evidence in support of the construct validity of OPUS-Swe. Although OPUS-Swe is a promising instrument for clinical and scientific settings, further development and evaluation is needed. Specifically, further evaluation of the new items added to the LEFS and UEFS modules is needed. Furthermore, new items indicating a higher degree of satisfaction and quality of life are needed for the CSD and CSS modules and the HRQoL subscales, respectively. A study investigating the test-retest reliability of OPUS-Swe is underway.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Poster Session [3702-None]

Foot and Shoe

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg243071

Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3318-493]

Acceptance of Safety Footwear for Trainees in the Motor Vehicle Trade

Author
Betz, Manfred (Dillenburg DE) | Dr.
Institut für Gesundheitsförderung & -forschung - Betriebliches Gesundheitsmanagement

Coauthors
Berschin G, Hartmann M, Sommer HM

Abstract
The acceptance of safety footwear has been studied on 500 mechanic trainees in the car industry. 62% of the trainees complain about discomfort while wearing safety shoes, 5% rarely or never wear their safety shoes. Every fifth person adds insoles that are not approved.

Introduction
Safety footwear is used to protect the feet from injury. The acceptance of safety shoes mainly depends on their comfort. The comfort is, among other things, deter-mined by individual fit, weight and the ability to regulate heat production of the shoe (Mattil 2002). Badly fitting shoes increase the risk of foot deformity and other disor-ders (Marr & Quine, 1993). Our investigation focused on the individual fit and per-sonal acceptance of safety footwear with trainees in the motor vehicle trade.

Methods
500 male mechanic trainees (mean age: 19.2 ± 2.8 years) were interviewed using a standardized questionnaire regarding their satisfaction with their safety footwear, health problems caused by wearing safety shoes and ergonomic aspects. Moreover, it reviewed the correlation of physical discomfort with certain activities such as standing for prolonged periods, lifting goods or kneeling down. Further data was collected on the shoes' brand, their retail price, their security classification, the number and type of pairs used, the orthopaedic insoles and orthopaedic shoe modifications.

Results
44% of the trainees did not know the brand or model of their safety shoes and 85% were unaware of the level of security.
90% of respondents own one pair only; 80% wear mid-height shoes, 19% boots and 1% sandals. The average life span is 11.3 ± 8.0 months (23% of the pairs are older than one year).
7% of the pairs cost more than 100 €, 23% less than 50 € (average price: 66 ± 42 €).
21% of the trainees used orthopaedic insoles and 2% have an orthopaedic shoe modification.
62% of the wearers had problems with their safety footwear within the last 12 months, of which bruising (34%), pain (13%), reddening (6%) and blisters (6%) were the main concerns.
41% of the trainees were satisfied with their shoes, 39% were partially satisfied and 20% were dissatisfied.
52% were satisfied with the general fit, 38% complained about excessive sweating in the shoe, 32% found their shoes to be uncomfortable, 26% thought the shoes were too heavy and 46% complained about the lack of fashionable appearance.
5% of respondents never of seldom wear the required safety footwear because of the problems they cause.

Conclusion

Trainees know very little about the laws regulating the use of safety footwear at work. Thus, one in five adds their own, unapproved insoles. The shoes are usually purchased by the employer with the main selection criterion being the price. The trainees often have no influence on the selection resulting in ill fitting shoes. Consequences are usually orthopaedic complaints. The more complaints and the worse the fit, the lower the general acceptance. In the worst case, the trainees stop wearing safety shoes altogether.

To optimize foot protection in the workplace, trainees must be better informed in the field of “safety footwear” and employers should focus on purchasing ergonomically high-quality shoes taking the individual fit into greater consideration, even if that means offering different models to chose from and buying an additional pair for alternate wear.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [2996-194]

The Newly Devised Sole Insert with the Lateral Wedge and Medial Forefoot Lowering in Level added to the Metatarsal Pad Beneath Metatarsal Arch

Author
Nishimoto, Akira (Touonshi JP) | Mr
Nishimoto hospital - Orthopaedic Surgeon

Coauthors
Akiyama,S(Executive Director,Obara kogyo Co.,Ltd.)
Morinaka,S(P.O and Director,Shiyomigishi Co.,Ltd.)

Abstract
The sole insert has been applied to 520 knee joints of medial type of osteoarthritis. Biomechanical analyses were performed in 30 affected knee joints and clinical functional abilities were evaluated in 70 affected knee joints. From the result obtained, it has been proved to be much more effective.

Introduction
The newly devised total sole insert (called the DB by us) is with the extended lateral wedge and medial forefoot lowering in level added to the metatarsal pad beneath the metatarsal arch. It is clarified biomechanically that these affected knee joints reverse screw-movement. And, as the destructive changes in the medial component of the knee advance, the leg with the affected knee abducts and rotates externally, resulting limitation of internal rotation of the hip.
The DB was fabricated at due consideration to above mentioned biomechanical disturbances. It has been applied to 520 affected knee joints from 2004 to 2009 April for 6 years.
As to 30 cases with affected knee joints, gait analysis and transferring of gravity line were examined, and also, as clinical functional evaluations, VAS (Visual Analogue Scale) and JOA (Japanese Orthopedic Association) score were countered, as to 70 joints of 50 patients.

Methods
The DB is fabricated based on the following procedure. It has an extent long counter on the lateral wedge to prevent depression of the lateral longitudinal arch with providing the hard wall which does not allow movement of the knee into varus. The counter ends at the tip of the toes. At the medial side, the extent counter to the toe is fabricated to prevent depression of the medial longitudinal arch by providing a hard wall which restricts movement of the foot into valgus. The small metatarsal pad is laid beneath the metatarsal arch, The area of the heads of 1,2 metatarsi lowers to make a difference in level. These fabrications bring internal rotation of the hip and shift the gravitation line forward to the lowering area, resulting decrease of varus momentum of the foot.

Results
The DB has been applied to over 500 affected knee joints for 6 years from 2004 to 2009. 30 cases wearing the DB were selected at random, and gait analysis was performed 3 dimensionally by Vicon-Mx and the shift of gravity line was measured by Eclipse 4. Furthermore, the clinical functional disturbances were evaluated in 50 cases wearing the DB by VAS and JOA Index.

It was well recognized clearly that biomechanical disturbances were improved. Namely, the restriction of internal rotation of the hip decreased with decreasing of valgus momentum of the foot added to tendency of decrease of varus momentum of the knee. The gravity line shifted to the forefoot area (the heads of 1.2 metatarsi).
The evaluated cases continued to wear the DB over 3 weeks. The scores were compared before and after wearing the DB. In Vas the scores went down from 5.6 points to 2.7 points before and after. In JOA, as to the capability of gait with slight or almost without pain, the score showed improvement from 23.6 points to 26.9 points before and after. As to ROM, the score showed improvement from 28.7 points to 30.8 points before and after. 45 cases of 68 cases told us with satisfaction that pain particularly at the time of weight bearing reduced. They become to ambulate comfortably. Some of them had the lateral side of the heels of their shoes wore down before, but these changes could not be found after.
Based on the various investigations, the DB has been proved to be a useful, effective insert.

Conclusion

At present, we enter an era of an aging population, and aged persons have a tendency to be affected with osteoarthritis of the knee, particularly medial type of it. For this affected knee, as the non-operative treatments, braces or heel inserts are widely fabricated. And applied heel inserts are lateral heel-wedge inserts, including many modified types.
The newly devised total sole insert (The DB) is fabricated based on the biomechanical, clinical functional considerations. It has been applied to over 500 affected knee joints with medial type of osteoarthritis for past 6 years. Almost all patients (510 knee joints in 396 patients) become to be able to ambulate comfortably, keeping their stable balance, almost or totally without pain after few days.
It is summarized that the DB is much more useful, effective.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [2958-156]

Continuation of Use of Custom-made Orthopaedic Shoes

Author
van Netten, Jaap (None NL) | MSc.
Center for Rehabilitation, University Medical Center Groningen - Department for Rehabilitation Medicine

Coauthors
Jannink MJA, Hijmans JM, Geertzen JHB, Postema K

Abstract
More than 10% of the patients who used their custom-made orthopaedic shoes (OS) shortly after delivery, did not continue their use. Negative short-term outcomes of the usability of OS were associated with not continuing. To prevent this, patients should be closely monitored.

Introduction
In order to be effective, it is essential that custom-made orthopaedic shoes (OS) are being used. Non use is not a major issue shortly after delivery of OS [1,2]. However, short-term use does not necessarily lead to continuation of use. It has been suggested, for assistive technologies (AT) in general, that short-term outcomes with regard to the use and usability of the AT are determinants associated with continuation of use [3].
For OS, the relation between short-term use and continuation of use has never been studied, and there are no determinants known that are associated with continuation of use.
The purposes of this study were: to investigate the continuation of use, 1.5 years from delivery of a patient's first pair of OS, and to find determinants associated with continuation of use of OS.

Methods
A short version of the Monitor Orthopaedic Shoes (MOS) [4] was sent to 339 patients, 1.5 years after delivery of the patient's first pair of OS. These patients had completed the post part of the MOS three months after delivery [2]. MOS is a practical and reproducible questionnaire, of which the post part can measure relevant aspects of use and usability of OS from a patient's perspective.
283 patients responded (83%). Mean age was 64 ± 14 (SD) years; 38% were male; 67 patients had diabetes mellitus, 49 rheumatoid arthritis, 206 a foot disorder (not further specified), 21 a (neuro)muscular disorder, and 92 another disorder (non foot). Disorders were indicated by patients themselves. More than one disorder could be indicated.
Use was categorized into frequent use (4-7 days/week), occasional use (1-3 days/week) and non use. Differences between the groups were assessed with a Chi-square, Kruskal-Wallis or Mann-Whitney U test.

Results
Continuation of use of OS was 87%. Reasons for not continuing were: problem solved (18%), not able to use them anymore due to deterioration of their physical situation (23%), or not satisfactory outcomes of the usability of their OS (59%).
Of the patients who used their OS frequently after three months, 84% continued to use them frequently after 1.5 years; 6% of these patients used their OS occasionally after 1.5 years; 10% did not continue to use their OS.
Significant differences between these groups were found in the short-term outcomes: patients who continued to use their OS frequently, reported after three months a larger decrease in pain in both the skin

and the muscles (p = .012 and .028); a better fit of their OS (p = .001); ease of walking with their OS (p = .013); and a more positive opinion of the cosmetics of their OS (p = .036), compared to both other groups. Of the patients who used their OS occasionally after three months, 46% used them frequently after 1.5 years, 23% still used them occasionally, and 31% did not continue to use their OS.
A significant difference was found in the short-term outcomes. Patients who used their OS frequently after 1.5 years reported more ease of walking after three months (p = .008). A trend could be seen that showed that patients who did not continue to use their OS reported more negative short-term outcomes on almost all aspects of the usability of their OS.

Conclusion
Short-term use of OS does not automatically lead to continuation of use. Short-term outcomes were associated with continuation of use of OS. Patients who did not continue to use their OS frequently, already reported more negative short-term outcomes with regard to the change in pain, fit of OS, ease of walking with OS, and the cosmetics of their OS. One third of the patients who used OS occasionally after three months did not continue to use their OS. These patients also reported more negative short-term outcomes. The findings of this study demonstrate the importance of monitoring the usability of patients' OS in clinical practice in an early stage. When prescribing specialists will closely monitor patients, negative short-term outcomes can be observed, and OS can be adjusted. Otherwise it is likely that unsatisfied patients will not continue to use their OS.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3043-241]

A Modified Method for Desiging Forefoot Prosthesis

Author
Tiurparvaz, Ahmad (IR)
JMERC - biomedical department

Coauthors
Mahboobeh Mehdikhani, MSc

Abstract
in this poster the technical information of designing semi silicone froefoot prosthesis will be showed. aLL pictures were taken during making a forefoot prosthesis and technical information will explained in details

Introduction
patients with forefoot amputation needs an especial kind of prosthesis to help them to have a normal gait and to absorb shock.besides cosmetic appearance, function of forefoot prosthesis is important, too.

Methods
a patient with forefoot amputation was chosen and after casting a semi silicone prosthesis was made

Results
the forefoot prosthesis makes provide both apearance and function as the paitent can walk with and without footwear easily

Conclusion
the semi silicone forefoot prosthesis is cheap and durable. patients satisfy with both its apearance and function

References
atlas of amputation and limb deficiencies

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3594-674]

Computer Simulation of Walking Considering Foot Deformation

Author
Maruyama, Takayuki (Tokorozawa JP) | CPO
National Rehabilitation Center for Persons with Disabilities - College

Coauthors
Hisashi Naito, Takashi Nakamura, Motonori Hoshino, Takayuki Maruyama

Abstract
We constructed a bipedal walking computer simulation model, consisting of segments of lower extrimitie. The foot are modeled of viscoelastic objects using FEM and other segments are rigid-body links. The simulation show that the stability of gait is strongly affected by the flexibility of the foot.

Introduction
A human foot has the arches whose mechanism is unusual characteristic among any animal. The foot arches contribute to the stability of bipedal locomotion. It is reported that the foot arches deform in a gait cycle and have viscoelasticity [1]. It is also reported that a foot loses flexibility and deforms with age. The purpose of this study is to analyze the foot deformation using the FEM model, aiming at running simulations of deterioration with age by setting involutional changes of mechanical properties as parameters. In the future, by using this model which simulates foot deformities, it will be possible
to analize gait changes due to degeneration of arch support elements and the effect of foot orthoses to prevent the deformities.

Methods
The foot FE model consists of 4 bony components, connected to the viscoelastic elements.
The necessary elements and configurations are as below:
1) Surface data of bony components; Digitized by the noncontact measurement system(Vectron).
2) Positions of insersions of ligaments and muscles; Set on the surface of bones by the anatomical data[2[3].
3) Mechanical properties of tissue (e.c.Elastic coefficient, Poisson rasio); Refered to database[4].
As above stated conditions, the simplified foot FE model was constructed using ANSYS.
The parameters of the model were tuned based on the values obtained by measurement
of the biological foot with / without weight bearing in the standing position and its
deformation analysis .
With the foot model connecting to the rigid link model of human lower extrimities.
Here, to verify the model, the damping behaviour is simulated when it is dropped from
the height of 5 centimeters with the several foot model parameters; elastic moduli and viscous parameter

Results
As a result, it moves forward dynamically and shows convergent characteristics. The results of the simulation show that the flexibility and the viscosity of the foot model strongly affect the damping behavior of COG of the whole model. It is thought that to simulate aging is possible by using complicate models, and the
estimation of involutional changes of the mechanical properties value will be able to add
in the future.

Conclusion

1) The simple foot FE model is constructed.
2) The parameters of the viscoelastic elements are estimated based on experimental values.
3) The foot FE model is connected to the rigid link model of human lower extremities.
4) By using this model, the damping behaviour is simulated when it is dropped from the height of 5 centimeters above the floor.
5) The results of the simulation show that the flexibility and the viscosity of the foot model strongly affect the damping behavior of COG of the whole body.

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Image: Takashima_None.jpg (see online)

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3008-206]

Reaction of the Foot Arches on 24-hour Supermarathon

Author
Gritsenko, Petr (RU)
All-Russian research institute of physical culture and sport, Moscow - laboratory of the sport morphology and antropology

Coauthors
Nechaev VI, Abramova TF

Abstract
Foot is the basic "spring bearing" due to own the arch structures, which smooth mechanical concussions of a body at movement [1,2].

Introduction
It has been shown [3], that under the influence of long loading (many hours ski march) the height of the internal longitudinal arch is decreased: we have occurred flatness of the foot as "spring bearing". The purpose of the present work was the assessment of foot arches reaction on extreme loading (24-hour run).

Methods
Research of feet of 18 qualified sportsmen who was participants of the Championship of Russia on 24-hour run has been carried out. On the average for days sportsmen overcame distance about 170 km (114 - 213 km). Changes of geometry of foot it was estimated on podometric index (PI), and also on the areas of "print" of feet (forefoot, midfoot and rearfoot). All measurements were spent on the device of own design, allowing to scan feet of runners in position "standing" in horizontal and sagital projections. Measurements were made twice: before start and at the first oclock after finish.

Results
The received results have shown absence of reliable differences between PI values before start and after finish. With other side changes of the areas of prints of feet were significant. However, despite to expected result, feet were not spread, and opposite the tendency (P> 0.01) to increase feet arches of runners were observed. On the average the area of a "print" of forefoot has decreased for 9,6 %, midfoot - 12,7 %, rearfoot - 5,6 %. Total area of "print" of foot has decreased on 8,7 %.

Conclusion
Probably, those similar paradoxical results similar are related with sharp spastic reaction by extreme loading on skeleton-muscular system «foot - low extremity». The subsequent measurements made in later period - in 3-5 days after running could be confirm legitimacy of the similar assumption. The carried out researches also have shown, that for assessment of changes of feet`s geometry the method of measurement of the areas of foot`s departments is much more sensitive, than podometric index widely in use now.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [2978-176]

The Function of the Japanese Geta Clogs

Author
Otsuka, Akira (Mihara JP) | Ph.D.
Prefectural University of Hiroshima Faculty of Health and Welfare - Physical Therapy

Coauthors
Takahiro U, Masaki H, Kouji S, Syusaku K, Takeya O, Sadaki O, Takaaki C, Nobuyuki D.

Abstract
The purpose of this study was to investigate the function of the Japanese Geta clogs. We measured foot pressure and the distance between the Geta and the heel. The results suggest that the use of Geta clogs may contribute to preventing foot disorders and falls.

Introduction
Falling is a predominant cause of people becoming bedridden. In addition, Handa, et al, who studied static balance, and Kabe, et al, who studied dynamic balance, reported that the strengthening of the toes may improve walking ability and decrease the risk of falling. We also believe that toe strengthening is important for maintaining balance and preventing falls, and proper footwear may promote toe strengthening. The Geta are wooden clogs that one slips onto the foot and are fastened by a strap. Geta were general footwear for the Japanese 50 years ago, until sneakers and shoes came into fashion. When Geta were used, there were fewer foot disorders. Therefore, we aimed to improve the feet and toes through the use of Geta. We made Geta to use for promoting foot and toe health. Although it is known that Geta are good for foot health, little is known about their function. Therefore, the purpose of this study was to investigate the function of the Geta clogs.

Methods
An F-scan (Nitta, Inc) was used to assess foot pressure during walking and to determine how and how much the foot and Geta come in contact. A VICON 512 3-dimensional motion analysis system (Oxford Metrics, Ltd) and the VICON Clinical Manager (VCM) software were used to capture and analyze the distance between the Geta and the heel (G-H distance). Two experiments were separately carried out. The subjects walked at a self-selected speed along a 10-meter walkway, five times in bare feet and five times while wearing Geta. The wooden Geta clogs used in this study were made for a previous study. The Geta sole is similar to a shoe sole in that is covered with rubber for shock absorption. The surface of the Geta is flat and the sole curved, so foot-off can occur easily. The incline of the front of the Geta is 1.5mm. Similar to thongs, a material strap attached the Geta to the foot. The weight of each clog was 275g.

Results
1) From heel contact to heel-off during stance: After heel contact, the G-H distance decreases at once and then increases slowly to heel-off. Foot pressure starts at the heel, moves to the lateral border of the foot, and then moves to the forefoot. Therefore, we think that the decreasing G-H distance causes the soft tissue to become compacted by the weight of the body and to cause ankle eversion to shift to inversion.
2) From heel-off to toe-off during stance: After heel-off, the G-H distance increases suddenly and peaks before toe-off. The toe pressure peak was recorded at this time. In our understanding, these two results cause a common effect, where the increasing G-H distance produces toe hyperextension with an eccentric contraction of the toe flexors.

3) From toe-off to swing phase: After toe-off, the G-H distance decreases suddenly, and approximately the same data is noted as at heel contact. We confirmed that the heel-Geta contact is present at the beginning of swing phase. Therefore, active toe flexor muscle movement is most likely causing this action. We agree with his postulation that muscle movement occurred to approximate the foot sole and the Geta. In our study, we confirmed that the toe pressure increased during the swing phase of Geta gait. Toe flexor muscle activation must have occurred. Therefore, we believe that Geta gait is very useful for training toe movements.

Conclusion

We set out to investigate the function of Geta clogs in improving gait and helping to prevent falls. To sum up the major characteristics of Geta gait, we concluded that; 1) toe MP extension is activated from heel-off to toe-off during the stance phase; 2) active toe flexor and intrinsic muscle contractions were noted in the swing phase; 3) therefore, we think that Geta gait is effective in toe muscle strengthening, and we believe that it is possible to use Geta clogs to prevent falling, foot disorders, and deformities. If walking, balance, and strength are increased with the use of Geta clogs, falls and becoming bedridden may decrease. Before Geta clogs are used on a daily basis, we believe that they should be used for training only, as they might cause injury, especially to older people who are not used to them. Eventually, we hope to develop Geta clogs that are safer to walk in.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3476-651]

Dynamic Plantar Pressure Analysis of Flexible Flat Foot in Chinese Children

Author
Li, Nga Mei (HK)
The Hong Kong Polytechnic University - The Department of Health Technology and Informatics

Coauthors
MAN HS, ZHANG M, LEUNG Aaron KL

Abstract
A new assessment method was established to classify the foot condition.506 subjects from 6-11 years of age were recruited to examine dynamic plantar pressure using electronic pressure sensing walkway. A program was written for plantar pressure data analysis and is being updated for enhanced function

Introduction
Flexible flat foot is one of the most common lower extremity conditions in children. There are difficulties in differentiating the abnormal foot from the normal variance. Consequently there is controversy in the clinical management of the condition. This includes the various definitions, assessment methods and subsequently, the decision of offering treatment or not. A reliable method to better reflect the foot condition is required so that objective clinical decision will be possible. Static footprint parameters have been used to quantify arch height with conflicting results. The conflicting results could be caused by the inaccuracy of data collection and the variations of the weight-bearing conditions under which the footprints were collected. The objective of this study was to develop an automation approach for the analysis of dynamic footprints to classify flexible flat foot.

Methods
506 subjects from aged 6-11 were recruited from primary schools. An electronic pressure sensing walkway was placed in the middle of the 8-m walking path. Subjects were instructed to walk on the walkway barefootly with self-selected comfortable speed to record the dynamic footprints data. Multiple steps plantar pressure data in walking were captured. A software was developed to analyse the data(Fig. 1). The data frame at the instance that the hindfoot loading equals to the forefoot loading was selected for the calculation of the Modified Contact Force Ratio (MCFR). The MCFR was calculated by dividing the force at the midfoot to that of the entire foot with toes ignored. Subjects with MCFR larger than mean +1SD were classified as flexible flat foot group (Leung et al., 2005).The software is now being enhanced for analysing regional dynamic plantar pressure distribution.

Results
Since the oriental population has a higher degree of ligament laxity which is associated with the flat foot appearance, subjects with MCFR larger than mean plus one SD were classified as having abnormal low foot arch (Leung et al., 2005). The MCFR generally decreases from age 6 to 11. The incidence of abnormal low foot arch at each age group ranged from about 12 to 16%. The results showed that age has a significant effect ($P < 0.05$) on MCFR. There was no significant difference in MCFR between genders and sides ($P > 0.05$).

Conclusion
The mean MCFR in each age group was suggested as a reference to identify the abnormal low arched foot. Those feet with MCFR value bigger than the age mean plus one standard deviation were classified as abnormal. The cut-off values used to define abnormal low arch were suggested. The function of the software is being enhanced for further analysis of regional dynamic plantar pressure distribution for different foot conditions.

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Image: 1_None.jpg (see online)

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3310-485]

Shoes Usage and Foot Morphology in Children aged 5 to 6

Author
Chau, Diana Yuen Lam (CN)
The Hong Kong Polytechnic University - Dept. of Health Technology and Informatics

Coauthors
Dr. LEUNG Aaron K.L.

Abstract
The footprints of 228 children were collected. Footprint angle was measured to investigate the influence of shoe types and schooling time on foot morphology. Shoe types did not affect the foot morphology but the prevalence of flat foot was significantly higher in children of whole day class.

Introduction
Campos and associates (1990) found that there was significant change in footprint parameters which reflect foot arch configuration from 3 to 5 years of age. This indicated that the 3rd to 5th years of life are the key moment for significant foot arch development. Shoe types as well the appropriate time to wear shoes have also been considered as factors for foot arch development. In Hong Kong, children of the said age range attend kindergartens. Individual school has own policy in uniform requirement and school time. Shoe types and wearing time vary in children of different schools. The arrangement during the critical life period may affect foot arch development of the children. This study was aimed to find out whether there was any relationship among shoe types, school time and prevalence of flat feet in children at 5 to 6 years of age (after the critical period). Students from kindergartens were recruited to participate in the study.

Methods
Three hundred and seven children, aged 5 to 6 years, from 3 kindergartens were invited to participate in the study. Each subject should have attended the same kindergarten for the last 3 years and did not have foot pain, foot orthotic intervention and any medical disorder. Each subject was asked to perform single leg stance on a foot imprinter for the collection of static full body-weight footprint. Footprints of both feet were collected. All footprints were taken by one examiner. The footprint angles [Schwartz et al., 1928] which served as an indicator to reflect the degree of flexible flat feet were measured on the footprints. The higher foot arch morphology would yield a high footprint angle. Each subject's schooling time, namely whole day (WD) class, morning (AM) class and afternoon (PM) class as well as shoe type worn during school time were also recorded. Data were divided into groups according to school time and shoe types. Two-way ANOVA with Bonferroni post-test were conducte

Results
In this study, 228 out of 307 subjects from 3 local kindergartens/nurseries fulfilled all the selection criteria. More than half of the subjects attended AM class (120 subjects), while 50 subjects attended PM class, and 58 subjects attended WD class. Two schools required their students to wear leather shoes and sports shoes on alternate days, while the third school allowed the students to wear sports shoes only.
The result of ANOVA test showed that the effect of school time was significant for both right (P = 0.031) and left (P= 0.027) feet. The post-test results also showed that the footprint angles of the WD group [Right: Mean (S.D.) = 19.38 (11.994); Left: Mean (S.D.) = 18.67 (9.872)] were significantly lower (P#0.05) than the PM group [Right: Mean (S.D.) = 28.00(12.972); Left: Mean (S.D.) = 25.54 (12.036)]. There was also a

tendency of increasing footprint angle across the data of WD class, AM class [Right: Mean (S.D.) = 23.53 (11.653); Left: Mean (S.D.) = 21.25 (10.414)], and PM class. The effect of shoe types was not statistically proven.

Conclusion

Whole day class students aged 5-6 are subjected to higher prevalence of flat foot. This result suggested that poorer foot arch development happened in the WD group of which the children had longer shoe-wearing duration. This was in line with the findings of Rao & Joseph (1992) and Sachithanandam & Joseph (1995). For the increasing hierarchy of footprint angles among the three school time groups, further investigation should be done to give stronger support on the discrepancy between the AM group and PM group and investigate the possible causes.

The effect between wearing sports shoes daily and wearing sports shoes and leather shoes on alternate days was not significant.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3115-313]

Treatment of Persistant Toe Walking with Botulinum Toxin Together with Other Medical Aids

Author
Pomarino, David (Hamburg DE)
Physiotherapiezentrum - Physiotherapiezentrum, Forschung und wissenschaftliche Begleitung

Coauthors
Dr. Martin, Stock S, Klawonn M, Walther C

Introduction

Persistent toe walking can be found at 15% of all children within a three month time period. Children suffering from toe walking do not walk permanently on the forefoot. They alternate between plantigrade and forefoot gait pattern. If toe walking persists over a long time-period considerable complications could occur. Severe structural changes like misalignments or deformities of the foot could lead to damages of the spine. Irreversible contractures of the Achilles tendon are a frequent problem of strong toe walkers. Therefore persistent toe walking could require a Botulinum Toxin therapy.

Methods

Treatment with Botulinum Toxin® (Botulinum A) is an injection into the heads of m. gastrocnemius.

Results

Treatment with Botulinum Toxin is just applied in strong and resistant cases if toe walking persists over a long period. In the majority two applications are enough to achieve the required gait pattern. Through this surgeries to elongate the Achilles tendon could be avoided.

Conclusion

The therapy of toe walking starts with Pyramid Insoles by Pomarino®. If there are severe structural changes Pyramid Insoles are combined with physiotherapy. This method is at 90% successful. If the required gait is not reached individual adapted night splins are integrated in therapy. Botulinum Toxin® (Botulinum Toxin A) is only applied if there is still no therapy success.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [2923-121]

Rehab after Knee Surgery with a Rocker Sole Shoe (AuBioMo-Shoe)

Author
Franz, Wolfgang (Kaiserslautern DE) | Dr. med.
Lutrina Klinik - Knie-Chirurgie

Abstract
A key skill for early rehabilitation after orthopaedic surgery is coordination. Rocker sole shoes are supposed to improve coordination. We used these shoes in a randomized controlled study in patients after partial knee replacement and after ACL reconstruction. Both groups showed better results.

Introduction
After major surgery of the knee joint there is allways a decrease of muscle strength, range of motion and coordination in the affected leg. These changes are especially pronounced after partial knee replacement or reconstruction of the anterior cruciate ligament. The time of rehabilitation until the full regain of the pre-surgery abilities depends on how effective strength, range of motion and coordination can be build up. For this purpose physiotherapy and continous passive motion are routinely deployed. In an earlier study (Bastian, Franz) we could show that whole body vibration can significantly reduce muscle decrease after ACL reconstruction. Studies with AuBioMo shoes (Stefanyshyn, Yi) could show an increased muscle activity and an improved coordination.

Methods
For the first study with patients who underwent a partial knee replacement (UNI study) 16 patients of the Lutrina Klinik in Kaiserslautern, Germany were recruited and randomly grouped in a study and a control group. Both groups received standard postop treatment. The study group patients additionally used the AuBioMo shoes after 6 weeks. The subjective state and condition of the knee was asessed 6 and 12 weeks after surgery with the WOMAC score (Stucki et al.).
For the second study with patients who underwent ACL reconstruction (ACL study) 51 patients were recruited. The study group patients used the AuBioMo shoes 2 weeks after surgery. The asessment of coordination was done with a computerized flexible plate (Physiomat) after 6 and 12 weeks.

Results
The average WOMAC score for the study group in the UNI study was +0,1, for the control group -0.7.
The average WOMAC score for the study group in the UNI study was +0,1, for the control group -0.7. This means a clear tendency for better results in the study group, but no statistical significance.
The coordination value for the study group in the ACL study was 18, for the control group 8. The difference is statistically significant ($p < 0,01$). The patients with the rocker sole shoes achieved a clear higher level of coordinative abilities. This may contribute to a shorter rehabilitation period and an earlier comeback to work or sports.
Furtherrmore, in an application observation very high values of satisfaction were found.

Conclusion
The AuBioMo shoe is a valuable therapy option in the rehab protocol after knee surgery. There is a high patient satisfaction and compliance, no adverse effects and low costs.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3110-308]

Plantar Pressure Assessment in Healthy Adult's Feet during Standing and Walking

Author
Safaeepour, Zahra (Tehran IR)
University of Social Welfare and Rehabilitation Sciences - Orthotics and Prosthetics

Coauthors
1)Safaeepour Z,PhD candidate in biomechanics, Science and Research branch, Azad University, Tehran, Iran
2)Ebrahimi E,PhD, PT,IUMS
3)Saeedi H,PhD candidate in orthotics and prosthetics,IUMS
4)Kamali M,PhD, PT,IUMS

Abstract
knowledge of force acting under the foot is important in the assessment of various foot pathologies. Plantar pressure measurement is an important research tool in gait analysis. The general purpose of this study was to identify normal plantar pressure values during standing and walking in adults.

Introduction
to identify pathomechanical condition of the foot it is necessary to have some accurate data on the foot function and motion then to consider significant deviations as pathological condition. Study of large groups of asymptomatic feet is fundamental to the understanding of the weight bearing function of the healthy feet. Plantar pressure is commonly used to determine specific loading characteristics at the sole of the foot. However, there is a lack of consistency in both measurement technique and reporting of results. Then, this study was performed to determine plantar pressure in healthy adults with usage of foot pressure measurement device to establish normal plantar pressure values, and also to compare the plantar pressure values and foot dimensions between male and female.

Methods
In this study 80 subjects (46 females and 34 males, mean ages 25/67 years, range 19 to 40 years and mean BMI 22/45 kg/m2) with healthy feet (according to American Orthopaedic Foot and Ankle Society clinical rating system for the ankle and foot) were recruited. All subjects gave their informed consent. Plantar pressure was measured with usage of RS-Scan plantar pressure platform to measure plantar pressures in 9 anatomical regions of the foot during standing and walking with midgait method and average of 3 trials were recorded through a 9 meters walk path for both feet. Normal walking speed was accepted as standard. Peak pressure during walking (n/cm2), peak pressure during standing (percent), contact area (percent), foot length (inch), forefoot width (inch) were assessed.

Results
analysis of data was performed with SPSS software. The comparison between both sexes and both feet carried out via t-test. There were no significant differences between both feet in all variables. Mean static pressure was 64/26 percent in rarefoot and 35/87 percent in forefoot. The forefoot had largest contact area during walking and was followed by midfoot and heel. During walking, the highest pressure was located under the heel area (31/43 n/cm2), 2th (30/86 n/cm2) and 3th (28 n/cm2) metatarsal heads, followed by big

toe (23/51 n/cm2), and the lowest pressure was at 2-5 toes and midfoot. There was significant statistically differences between male and female in static pressure values for the right forefoot (p<0/001). Results showed significant differences in pressure under 4th metatarsal head of right foot (p=0/05), 4th metatarsal head of left foot (p=0/04), 5th metatarsal head of right foot (p=0/02) and under heel region of both feet (p<0/001).plantar pressure values are presented in figure 1.foot length and forefoot width were significantly larger in male (p<0/001).

Conclusion

in this study the means and standard deviations of maximum plantar pressure values in 80 subjects with healthy feet were measured. The heel is the first portion that receives body weight. The highest plantar pressure in our study was in the heel region that may be due to the structural and methodological factors such as data collecting method, ethnic related differences because there are differences in foot morphology in different part of the world. Asian feet have wider forefoot, lower longitudinal arch and more pronated feet. Since women have a more slender foot than men and their heel are narrower in proportion to the forefoot and it might result in significant high pressure values in rare foot in women. Determining the normal pressure value is important in assessment of disorders and making proper footwear modification according to the gender. These values also can be used in the other studies.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [2827-53]

Verification of Performance of Shoes with Negative Heel

Author
Gajewski, Robert (Kraków PL) | Ms.c
Instytut Przemys#u Skorzanego - Ergonomics

Coauthors
Bozena RC

Abstract
Footwear for expecting mothers and determination of effects of gestation on the foot has been a long surveyed problem. There were attempts to produce special footwear for pregnant women, such as shoes with negative heel. In this paper there will be presented results of evaluation of this footwear.

Introduction
For women, the extremely demanding moment of their life is period of pregnancy and puerperium. Changes caused by pregnancy affect more or less intensively every women who gave birth to a child. Selection of proper footwear for expecting mothers and determination of effects of gestation on the foot has been a long surveyed problem, but it occupies a marginal place in literature. Realized studies did not allow to draw conclusion but even to describe and confirm reliably a common subjective observation that the gait and posture is altered during pregnancy.
Despite of it, there were attempts to produce special footwear for pregnant women. For example, there was developed footwear with so-called “negative heel”, often promoted as designed for gravidas. This footwear has a bottom in which the lowest point in the heel area was slightly lower than the lowest point in the forepart.
This study was undertaken to investigate selected parameters of gait when walking in shoes with negative heel.

Methods
Tests were performed with a plantar pressure measurement system (EMED SF platform). Subjects walked through the platform wearing “flat” sole shoes (lowheeled). The soles were sticked with two millimetre thick layer of EVA copolymer. The measurements were performed in two stages:
Stage 1. Walking in “standard” shoes.
Stage 2. The forepart of the shoes was elevated by attaching light, low elastic foam which had a smooth curve to allow the subjects to walk. Obtained patterns of plantar pressures were analysed both for the entire foot and by dividing the foot into forefoot and rearfoot areas.
The measurements were made both under dynamic as well as static conditions. The following variables for each region were generated and analysed:
- Contact Area [cm2].
- Contact Time [ms].
- Maximum Force [N].
- Peak Pressure [N/cm2].
- Begin of Contact in Masks in percent of Total Contact Time [%].

Results

For the entire foot, under dynamic conditions Maximum Force was slightly reduced by shoes with negative heel compared to standard “flat” shoes. In contrary, Peak Pressure increased and Contact Time was similar in both kinds of shoes.

Under the forefoot, Maximum Force was on comparable level, whereas, Peak Pressure was markedly lower in the shoes with negative heel. Contact Time slightly increased.

Under the rearfoot, Maximum Force and Contact Time decreased, whereas Peak Pressure increased.

When measured under static conditions, the value of Maximum Force, obtained for entire foot, both in „flat” shoes as well as in negative heels shoes did not differ significantly. Instead, Peak Pressure is much higher in shoes with negative heel. In the forefoot Maximum Force was comparable in both kinds of shoes, the same in case of Peak Pressure. In the rearfoot Maximum Force was much higher in shoes with negative heel, the same refers to Peak Pressure.

Conclusion

Footwear with negative heel influences patterns of plantar pressure distribution. The most notable change is increase in Peak Pressure under the rearfoot and decrease under the forefoot. Very important differences were observed in relation to Contact Time. Subjects loaded their heels for a shorter period of time, whereas Contact Time in their forefoot was prolonged. Interesting interesting conclusions may be drawn from analysis of the begin of contact in the forefoot area in percent of total Contact Time. In the „regular” footwear it began in 16.26% of the total rollover process compared to 8.74% observed in shoes with “negative heel”. This shortening of the heel strike phase was probably the main reason for decrease in Maximum Force under the heel. On the other hand, the heel strike seems to be more violent than in the “regular” footwear, which is confirmed by increase in Peak Pressure.

A high value of Peak Pressure is disadvantageous from the point of view of back pain prevention.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3068-266]

Effects of Rocker Shoe Radii on Ankle Kinematics and Ankle-foot Roll-over Shapes

Author
Fatone, Stefania (Chicago US) | Dr.
Northwestern University - Physical Medicine and Rehabilitation

Coauthors
Wang CC

Abstract
This study examined ankle kinematics and ankle-foot roll-over shapes of eleven able-bodied persons when walking with four different rocker shoe radii. Able-bodied persons dramatically change their ankle kinematic pattern when using rocker shoes to maintain the same ankle-foot roll-over shape radius.

Introduction
Previous work has suggested that able-bodied persons react to several conditions of level walking to maintain an invariant roll-over shape (the effective rocker shape created by the lower limb system during the first half of the gait cycle [1]). In particular, the roll-over shape does not change appreciably when walking at different speeds [1], when carrying different amounts of added weight [2], and when walking with shoes of different heel heights [3]. However, the ankle kinematic patterns during the first half of the gait cycle may also be similar in these studies, suggesting kinematic invariance. The purpose of this study was to distinguish between these ideas using an experimental setup that made it impossible to yield both ankle kinematic invariance and roll-over shape invariance during walking. Understanding the apparent goals of the human lower limb system in walking could lead to improved designs of prostheses, orthoses, rocker shoes, walking boots, and total contact casts.

Methods
For each subject in the study, four pairs of high-top canvas shoes were altered by gluing a 7.5 cm thick crepe material to their soles. One of the pairs was left with this flat lift, while the others were cut to have radii approximately equal to 55% of leg length (LL), 40% LL, and 25% LL (conditions named FLAT, R55, R40, and R25 respectively – see figure). Subjects walked with each pair of shoes at a controlled speed that was self-selected for the same shoe before alterations. Motion analysis data and force platform data were collected during walking trials with each of the four rocker shoes. Ankle kinematic patterns were determined using commercially available software for gait analysis. Ankle-foot roll-over shapes were determined by transforming the center of pressure of the ground reaction force from a laboratory-based coordinate system to a shank-based coordinate system (using the three-dimensional approach described in [4]). Repeated measures ANOVA tests were used for comparisons.

Results
Range of motion of the ankle during single limb support was significantly decreased with increasing rocker shoe radius ($p<0.001$). Mean ankle range of motion values during single limb support (± standard deviations) were as follows: R25: 5.0±3.4 degrees, R40: 9.4±3.4 degrees, R55: 12.9±3.8 degrees, FLAT: 23.2±4.3 degrees. Ankle-foot roll-over shape radii were not changed significantly with the different rocker

shoe radii (p=0.11). Mean ankle-foot roll-over shape radius values (± standard deviations) were as follows: R25: 28.6±7.6 %LL, R40: 31.9±7.3 %LL, R55: 31.7±3.8 %LL, FLAT; 33.6±4.5 %LL.
Discussion: The results of this study and previous work [1-3] suggest that able-bodied persons adapt to various conditions of level ground walking to maintain an invariant ankle-foot roll-over shape. This study also suggests that the effects of clinically used rocker shoes on ankle motion should be predictable in certain users and that rocker shoes could be designed specifically to obtain a particular kinematic pattern of the ankle using invariant roll-over shape as a guiding principle. As an example, a rocker shoe that matches the invariant roll-over shape could provide “natural immobilization” of the ankle during single limb support, using the body’s natural tendencies. Perhaps such a shoe could lead to reductions in pain in cases in which pain is a function of combined joint compression and movement. Such designs would also need to consider other functional tasks such as standing.

Conclusion

Able-bodied persons make significant changes to their ankle kinematics when walking with different rocker shoe radii. They appear to make these changes in an effort to keep the ankle-foot roll-over shape the same. The idea of roll-over shape invariance has already been used for design [4], alignment [5], and evaluation of prosthetic [6] and orthotic [7] components. The invariance of roll-over shape could also be a guiding principle in the design of rocker shoes and may be useful in determining the appropriate rocker shapes for walking boots and total contact casts.

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Poster Session: Foot and Shoe
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Poster [3533-654]

Technical Aspects of Therapeutic Insole Construction: a Survey in Belgium

Author
De Ceulaer, Frederik (Geel BE)
K.H.Kempen University College - MOBILAB

Coauthors
Vertommen, H. (MsC, PT)
Guldemond, N.A. (PhD)
Lissens, M. (MD)
Prof. Peeraer, L. (PhD)

Abstract
Therapeutic insoles are widely used in treatment and prevention of foot disorders. This survey focuses on technical aspects of insole construction: used materials, production techniques and measurements. The optimal beneficial effect of insoles merely depends on
these different aspects.

Introduction
Therapeutic insoles are widely used in treatment and/or prevention of (acute and chronic) foot disorders and other pathologies in sport applications and activities of daily life. In 2006, the Belgian national institute for health and disability insurance (RiZiV) refunded 242.586 pairs of insoles, representing an 7,5% increase compared to 2005. The beneficial effects elicited by foot orthoses, can be very diverse: pain relief, improved kinematics during gait, altered muscle activation patterns etc. However, in some cases there is little or no beneficial effect. According to Razeghi (2000), adverse effects are attributed to poorly fitted and/or badly fabricated orthoses, or poor diagnosis. To achieve a maximal therapeutic effect, the(mechanical) properties of materials, including abilities of force-distribution, shock absorption and durability, should also be considered thoroughly. Thus, the therapeutic effects of insoles depend on the design, the appropriate manufacturing techniques an

Methods
Belgian orthopedic companies and individual manufacturers were contacted. 19 employees
of all different companies were selected based on the yearly production amount of
therapeutic insoles, representing the most important part of the Belgian orthopedic industry.
Interviews with these 19 orthopedic technicians and orthopedic shoe technologists were
performed, using a standardized questionnaire. The reserved topics concerned 2 major parts: characteristics of the population treated with insoles (age, pathology) and technical aspects of the production (measurement, manufacturing techniques, materials). All subjects participated voluntarily in this survey and informed consent was provided.

Results
The majority (74%) of the interviewed companies indicate therapeutic insoles as quantitatively most important orthosis manufactured. 52% of the responding companies have a yearly production of over 2000 pairs of insoles.

Population characteristics
Most patients treated with insoles are between 40 and 60 years of age, according to 74%. Pedes plani are reported as most treated pathology (32%). Furthermore pedes planovalgi(21%) and metatarsalgia (16%) are indicated.
Technical aspects of insole manufacturing
The most common foot measurement technique for construction of therapeutic insoles is the
foam box, used by 74%. 94,7% of the interviewed companies practice several techniques. Frequency and causes of using these different techniques were not investigated. Therapeutic insoles fabricated in Belgium by orthopedic technicians and shoe technologists
are always considered to be custom made. Several production methods were indicated.
Semi-custom made insoles represent the most important construct method (47%), i.e. individual adaptation of prefab parts or prefab insoles to patient's specific needs. Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) is minimally utilized in Belgium. Companies applying CAD/CAM exclusively use this type of production process. A extremely large variety of materials was reported, including brands and chemical composition. We classified materials into 6 groups based on chemical composition. The most important material groups include cork (63%)

Conclusion
Pedes plani are clearly indicated as most treated with insole therapy. More traditional measurement techniques are mostly used in Belgium, although more modern techniques e.g. plantar pressure measurements can be considered as more reliable. In personal communication, therapists report that these modern techniques still have different shortcomings. Evidently, a foam box is easy to use in daily practice. Semi-custom made insoles represent the major part in production, due to reduced production time. Only a minority uses CAD/CAM. This technique implicates a more limited assortment of
materials and little possibilities of combining different materials within one insole. Hence, it
might occur that the optimal material combination cannot be achieved, implicating a decreased therapeutic effect. Furthermore, the reported material selection criteria are likely to dictate the choice of production technique.
We reported a large variety of materials for insole construction. Other authors indicat

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Congress: 13th ISPO World Congress
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Poster Session [3704-None]

Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg245277

Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3190-377]

The Correlation Analysis between Leg-length Inequality and Knee Adduction Moment in Trans-Femoral Amputee Gait

Author
Chang , Yunhee (KR)
Korea Orthopedics & Rehabilitation Engineering Center - Biomechanics Lab.

Coauthors
Kim JK, Bae TS, Kim SK, Mun MS

Abstract
This study examined how the difference of leg length among transfemoral amputees influences the intact knee adduction moment during walking. The research included 9 transfemoral amputees. The knee adduction moment in the intact side increased as the difference in leg length increased (r=0.723).

Introduction
Previous studies argue that an increase in the prevalence of osteoarthritis of the knee among transfemoral amputees is likely related to the increase of intact knee adduction moments in biomechanical studies [1, 2]. The difference in leg length due to inappropriate prosthesis alignment introduces the lateral tilt and anterior torsion of the pelvis, both causes of lower back pain and major musculoskeletal diseases. The change in lower-extremity alignment of the coronal plane caused by the lateral movement of the pelvis has a great impact on the intact knee joint during walking [3]. Moreover, clarifying the original cause is most important to the prevention and treatment of the disease. Therefore, this study examined the impact of the difference in leg length that resulted from the inappropriate fitting of prosthesis on the intact knee adduction moment during walking.

Methods
This study conducted experiments on 9 unilateral transfemoral amputees (table 1). The inclusion criteria were as follows: 1) those who were amputated at least 2 years ago 2) amputees due to trauma 3) prostheses are appropriately aligned 4) those who can walk without walking aids 5) no musculoskeletal problems [4]. The subjects signed an informed consent. The 3D motion analysis system (Motion analysis Ltd, USA) consisted of 8 infrared cameras (Eagle 4), 4 force plates (900mm×600mm, Kistler Ltd, USA) and a data acquisition system. Using Helen Hayes marker sets, 19 pieces of 10mm reflective markers were attached to the anatomical landmarks. The subjects walked around 5 times at self-selected walking speeds and the average values were used for the analysis. Pearson correlation analysis was used to know a degree of relation between leg-length discrepancy and the knee adduction moment using the SPSS (ver12.0) statistics package. The statistical significance level of ## 0.05 was used.

Results
Table 2 presents the correlation analysis results between the intact knee adduction moment and the leg length discrepancy. The correlation coefficient between the leg length discrepancy and the knee adduction moment is 0.723, showing a positive correlation (p=0.028). The study results indicated that leg length of the prosthetic side is 2.4 mm shorter than that of the intact side, on average. Moreover, the knee adduction moment (0.42Nm/kg) increased as the length difference of the prosthesis increased. The previous studies, on average, 5-10 mm shorter than the intact side, the results from this study indicate less of a difference [3].

Meanwhile, the imbalance of leg length causes a lateral tilting of the pelvis on the coronal plane, and a pelvic torsion on the sagittal plane, which often results in scoliosis. These scenarios are also known to be highly related to the occurrence of lower back pain and other musculoskeletal diseases, especially hip joint and knee osteoarthritis [5]. This causes formation of an abnormal joint angle of the coronal plane of the lower extremities, consequently resulting in abnormal distribution of the forces on the affected joint [6]. Despite the relatively small difference in leg length—on average less than 2.4 mm than that in previous studies—this study provided positively correlating results regarding the increase in knee adduction moments following the increase in the difference in leg length.

Conclusion

This study clarifies the cause of the increase in intact knee joint moment during transfemoral amputee gait that indicated a high prevalence of knee osteoarthritis on the intact side. Specifically, this study focused on the correlation between intact knee adduction moments and leg length discrepancy that causes changes in lower-extremity alignment through lateral displacement of the pelvis on the coronal plane. The study results, there was a positive correlation between the leg length discrepancy and the intact knee adduction moment (r=0.723). Following the increase in leg length difference, the intact knee adduction moment also tended to increase. Equality in leg length is most important; this is a necessary condition for preventing secondary disease such as Knee OA. In addition to proper prosthesis fitting, it is important to balance the loading between the prosthetic and the intact side through various methods of training, including balance, muscle strengthening and gait training.

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Image: table_377.png (see online)

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3120-318]

Relationship between SIGAM/WAP Mobility Grades and Pedometer Step Counts in Transtibial Amputees

Author
Berduszek, Redmar J. (Groningen NL) | BSc
University Medical Center Groningen - Center for Rehabilitation

Coauthors
Rommers GM (MD, PhD)

Abstract
The number of steps taken by unilateral transtibial amuptees is higher with increasing SIGAM/WAP mobility grades, resulting in a moderate positive relationship. Step counting using a pedometer is an easy, affordable and reliable way to assess actual walking activity.

Introduction
Walking is an important aspect of prosthetic use after lower limb amputation. The SIGAM/WAP mobility scale is used increasingly in the Netherlands to measure mobility of lower limb amputees. This scale consists of six grades (A-F) and reflects prosthetic-related mobility. Grades are assigned by algorithm after completion of a questionnaire. Grade A or B is assigned for non-ambulators, grade C is assigned when walking indoors, grade D when walking outdoors using walking aids, grade E when walking aids are used occasionally and F when walking without walking aids over more than 50 meters.
Existing mobility scales have certain disadvantages: ordinal scaling makes comparison difficult and they rely considerably on the self-reported estimation of walking efforts by the amputee. Objective and continuous measurements of walking activity may enhance the understanding of functional prosthetic use after lower limb amputation.

Methods
Participants were selected from patients who received rehabilitation treatment after lower leg amputation, between Dec 2006-Jan 2009. Unilateral amputees who completed rehabilitation treatment were eligible for inclusion. Participants had to use their prosthesis for walking (SIGAM/WAP grade C or higher).
All participants wore a Yamax SW-200 pedometer during two periods of seven consecutive days, with four weeks between both periods. This pedometer has been found to be as accurate as a specifically designed accelerometer among unilateral lower limb amputees. The pedometer is more affordable and easier to use. SIGAM/WAP mobility grades were assigned at the start of each measurement period. Daily step counts were calculated by dividing the total number of recorded steps by the number of days the amputee actually walked (diary reported).
The relationship between SIGAM/WAP grades and step counts was determined by use of Spearman’s rank correlation coefficient.

Results
A total of 20 unilateral transtibial amputees (16 male, 4 female) completed all measurements. Mean age was 63.4 years (range 40-85). Vascular pathology was the reason for amputation in 17 (85%) of the participants. SIGAM/WAP grades ranged from Db-F, meaning that all amputees walked outdoors to a

certain extent. SIGAM/WAP grades changed between measurement periods in three participants. Step counts ranged from 81-9559 steps per day.
Most participants were graded SIGAM/WAP Db (6/20) or F (9/20). Other assigned SIGAM/WAP grades were Dc (3/20) and E (2/20).
Eighteen participants walked all 7 days, two walked on 5 or 6 days in the measurement weeks. The number of steps taken daily was higher in participants with higher SIGAM/WAP grades, as reflected by a correlation coefficient of 0.657 (p=0.002) and 0.671 (p=0.001) for the first and second period respectively. Within specific grades, step count ranges were large and considerable overlap in step counts between grades existed. Step counts were slightly higher during the second measurement period (442 more steps; 95% CI: 68-816, p=0.023). Test-retest reliability of step counting was very high with an intraclass correlation (ICC) of 0.933 (95% CI: 0.840-0.973, p<0.001).

Conclusion

A moderate positive relationship between SIGAM/WAP grade and daily step count was found. Considerable overlap in step count ranges between SIGAM/WAP grades was observed.
Step counting using a pedometer is an easy, affordable and reliable way to assess actual walking activity in community-dwelling unilateral transtibial amputees.

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Image: boxplots_steps_sigamwap_None.gif (see online)

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3029-227]

Relationship between Berg Balance Scale (BBS) Score and the Distance of Six-minute Walk Test (6MWT) in Transfemoral Amputees

Author
Azuma, Yuji (JP)
Hyogo Rehabilitation Center - Physical Therapy

Coauthors
Chin T, Maeda N, Oyabu H, Takase I, Machida K, Kato M, Tezuka Y, Nakatuka A, Urabe T, Kanazawa Y, Kono H, Sawamura S

Abstract
We evaluated BBS and 6MWT in transfemoral amputees. There was a significant correlation between BBS score and the distance of 6MWT in participants. This finding suggested that BBS could be considered as a useful indicator in predicting successful prosthetic ambulation in transfemoral amputees.

Introduction
Originally 6MWT has been shown to have a significant correlation with exercise capacity in individuals with cardiorespiratory disease1. BBS was designed to evaluate functional standing balance2. Later, both 6MWT and BBS have been widely incorporated into clinical fields. It is well known that a good ability to stand on non-amputated leg and physical fitness are the valuable clinical factors contributing successful prosthetic ambulation in lower limb amputees3,4 . Some modes of exercise testing such as one-leg cycling, arm ergometry are required to evaluate physical fitness. But the equipment is expensive. Such kinds of testing are time consuming and are not easily applied. Thus, 6MWT may serve as a useful evaluating method for physical fitness. We hypothesized that transfemoral amputees who had better standing balance would walk a longer distance in 6MWT. The aim of this research is to identify the relationship between BBS score and the distance of 6MWT in transfemoral amputees.

Methods
Thirteen transfemoral amputees ,who were capable of prosthetic walking at least for six minutes at a constant pace when discharged ,were included in this study. All were hospitalized at this center for prosthetic fitting and training, and had never been fitted with prostheses before. The mean age of the subjects was 54 years. Three were female, ten was male. BBS was used to evaluate for standing balance, and 6MWT was used to evaluate for exercise capacity. Subjects were permitted to use any necessary ambulatory aids (cane, crutch, or walker) and asked to walk as far as possible for 6minutes on a level surface when conducting 6MWT. After completion of rehabilitation program, both BBS and 6MWT were performed. The correlation between BBS and 6MWT was calculated by the Pearson Product-Moment correlation technique.

Results
The BBS score for the subjects was 46.5 ± 6.0 . In a total BBS score out of 56 points, more than 41 points is representing a better balance. Of these subjects, two subjects who needed to be watched during resting scored less than 41 points. All other subjects scored more than 41 points. All the subjects have successfully completed the 6MWT. The distance of 6MWT was for the subjects was 423± 147m. Among

these subjects, the correlation coefficient for the relationship between BBS score and 6MWT distance was 0.85($P<0.001$), indicating a significant correlation between the two(figure 1).

Conclusion

In this research, a significant relationship between BBS score and 6 MWT distance in transfemoral amputees was demonstrated. BBS has been shown to represent the ability of standing balance among subjects, and 6MWT has been considered as a measure of exercise capacity . Although physical fitness is regarded as an important factor for predicting successful prosthetic rehabilitation, exercise testing is not easily conducted. Since BBS can measure easily in a clinical field, it makes it potentially useful as an indicator for evaluating the physical fitness instead of different kinds of exercise testing. Thus, BBS score can be considered as a critical predictor for successful prosthetic rehabilitation. This research also suggested that incorporating balance training into daily physical therapy for amputees would improve the balance and enhance the possibility to regain prosthetic ambulation successfully.

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Image: Relationship between the score of BBS and the distance of Six-MWT_None.png (see online)

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3394-569]

Unilateral Transfemoral Amputee with Delayed Bone Union in the Contralateral Lower Limb Fracture – Case Report

Author
Yoo, Jeehyun (Seoul KR) | Dr.
Yonsei University College of Medicine - Department of Rehabilitation Medicine

Coauthors
Yoo JH, Lee YS, Goo HR, Kim DH, Park CI

Abstract
We report a case of unilateral transfemoral amputation, in which a delayed union of a distal femur fracture complicated the prosthetic management.

Introduction
Early ambulation in patients with a unilateral amputation accelerates the process of prosthetic rehabilitation, and reduces the duration of hospital stay. However, in case of fractures in the contralateral lower limb, the common choice of a physiatrist is to postpone ambulation until the fractures show complete union. The delay in weight bearing leads not only to a prolonged process of prosthetic rehabilitation, but also to a delay in bone union. We report a case of unilateral transfemoral amputation, in which a delayed union of a distal femur fracture complicated the prosthetic management.

Methods
A 29-year-old male patient was involved in a traffic accident while riding a motor cycle on August 21, 2007. After being admitted at a university hospital he was diagnosed with right radius fracture, left carpal bone fracture, lateral malleolus fracture of the left fibula, and a complex fracture of the right femur. Transfemoral amputation of the right lower extremity was performed on September 4, 2007. Weight bearing of the left lower extremity was started late November, 2007.
On December 4, 2007, he was admitted to the department of rehabilitation medicine at our hospital for prosthetic management and gait training. After admission, electrodiagnostic studies showed injury of the left tibial and peroneal nerves at our around knee level. A transfemoral prosthesis with a quadrilateral socket, a pelvic belt suspension, a weight activated stance control knee joint, an endoskeletal shank, and a dynamic SACH foot was fitted.

Results
However, after parallel bar standing was started, the patient complained of pain in the left knee, and MR imaging revealed an old fracture of the lateral condyle of the left femur and a partial tear of the lateral collateral ligament of the left knee. The department of orthopedic medicine was consulted and osteosynthesis, of the lateral condyle was performed on January 9, 2008, and a long leg cast was applied to the left lower extremity. As the patient was not yet trained for prosthetic gait, but needed weight bearing for bone union, the right transfemoral prosthesis was lengthened by 1 cm to limit weight bearing to the left lower extremity, and a manual lock was added to the knee joint. Bone union of the lateral condyle was complete two months later.
The knee joint of the transfemoral prosthesis was substituted with a polycentric knee joint with pneumatic control, a solid ankle-foot-orthosis was applied to the left ankle. As push off was limited by the solid ankle-

foot-orthosis, a 5mm rocker bottom was applied to the left shoe. At discharge, the patient was able to walk with a unilateral crutch, and later improved to walking with a unilateral monocane.

Conclusion
Early weight bearing of this unilateral amputee with a delayed union of the contralateral lower limb fracture most likely promoted bone union, which again reduced the duration of prosthetic rehabilitation.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3072-270]

Amputees and Sports: A Systematic Review

Author
Mihai, Bragaru (Groningen NL) | Msc
Graduate School for Health Research SHARE - UMCG Rehabilitation

Coauthors
Rienk Dekker MD, PhD
Jan H.B. Geertzen MD, PhD
Pieter U. Dijkstra PT, MT, PhD

Abstract
A systematic review on amputees and sports was performed searching 4 databases. Three assessments were performed by 2 independent reviewers. Sport and physical activity positively influenced the outcome of amputees. However, level of evidence is low due to the presence of a limited number of sports.

Introduction
Amputation of a limb causes permanent disability and leads to a decrease in mobility, physical capacity and overall physical fitness. Active sport participation is beneficial in maintaining a good health. A minimal period of 30 minutes/day of physical activity is highly recommended by health organizations world wide. Since for the amputee population, the effects of sport participation are not known, a systematic search of the literature for papers concerning amputees and sports in order to identify the present level of evidence in this field was performed.

Methods
Four databases (Pubmed, Embase, Cinahl and SportDiscus) were screened for papers in October 2008. A MeSH terms and free text search was performed with no limits for publication time or language. References of included papers were also screened for relevant papers. Papers concerning amputations distal to the wrist or ankle, letter to the editors, reviews and case reports were excluded. The review process consisted of three assessments (title, abstract and full text), each performed by two independent assessors following a list of major and minor criteria. Major criteria were: presence of at least 10 amputees and presence of sport or physical activity with a minimal duration of 30 minutes. Minor criteria used in full text assessments concerned patient and amputation characteristics. The assessments results of the reviewers were compared and in case of major criteria disagreement a consensus meeting was held. If disagreement persisted an independent arbiter gave a binding verdict.

Results
The search retrieved a number of 3243 papers. At the end of the review process, 40 papers were included in the systematic review. Due to their different outcome variables, the included papers were organized by their main outcome in six categories, as follows:
1.Biomechanics (9 papers): sports studied consist of running and long jump. Athletes with a more distal amputation experience fewer problems compared to athletes who were amputated more proximately.
2.Cardio-pulmonary function (13 papers): amputee’s physical fitness can be improved by a training program. Exercise rate should be set according to patient’s heart rate at anaerobic threshold. No specific training program was found.

3.Psychology and Quality of Life (4 papers): sport and physical activity improve the self esteem, body-image and quality of life of amputees.
4.Rehabilitation and functional outcome (10 papers): amputees take part in a large number of recreational activities. Age and etiology appear to influence functional outcome. Being physically active improved balance, fear of falling, prosthetic use, walking speed and distance, and the physiological cost of walking.
5.Sport injuries (4 papers): Injury rate of physically active amputees does not appear to be higher than in able bodied athletes. There is no data available on other sports than soccer and skiing.
6.Prosthetic devices used in sports (0 papers): no papers found.

Conclusion

Overall, a consistent number of papers were found. The level of evidence in each outcome category was rather low due to the fact that only a limited number of sports were approached. Sports and physical activity improves the overall outcome of amputees and the inclusion of a physical training program in the rehabilitation of amputees should be taken into consideration.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3382-557]

Biomechanical Analyses of Stair Ascent in Transfemoral Amputees

Author
Hobara, Hiroaki (Tokorozawa JP) | Biomechanical analyses of stair ascent in transfemoral amputees Research Institute, National Rehabilitation Center for Persons with Disabilities - Department of Rehabilitation for the Movement Functions

Coauthors
Kobayashi Y, Naito K, Nakamura T, Yamazaki N, Nakazawa K

Abstract
The present study suggests that alternate stair ascent in transfemoral amputees requires 1) a fully-extended prosthetic knee joint in the early stance phase, and 2) both strong counter-movements and greater joint extension in the contralateral limb during the late stance phase.

Introduction
In daily living, stair ascent is a very demanding task for transfemoral amputees. Indeed, some studies (Bae et al., 2007; Bae et al., 2009; Schmaltz et al., 2007) reported that the transfemoral amputees in their study could not climb the stairs in step-over-step manner. Thus, transfemoral amputees experience limitation in function in stair walking due to the loss of muscles, joints and nerves in the amputated limb. However, on very rare occasion, there are transfemoral amputees who can climb stairs using a step-over-step gait pattern without an intelligent prosthetic knee joint or handrail use. Analyzing such a transfemoral amputee would enable us to better evaluate ambulatory abilities and could aid in the development of more effective locomotor training methods in rehabilitation settings. Thus, the aim of the present study was to investigate the biomechanical characteristics of a transfemoral amputee who can climb the stairs in a step-over-step manner.

Methods
One traumatic transfemoral amputee (male, age = 50 years; height = 1.75 m; mass = 67.8 kg, amputation time = 43 years, residual limb length= 30.5 cm) was asked to climb a custom-built staircase (80 cm wide, 16 cm high, and 30 cm deep) in a step-over-step manner at his preferred speed. Ten trials beginning from right or left were randomly performed with a sufficient rest period in between. Kinematic and kinetic data were sampled synchronously at 60 Hz using an eight-camera motion analysis system and force platforms embedded in all the steps of the staircase. Two-dimensional positional data of the reflective markers were low-pass filtered by a fourth-order zero-lag Butterworth filter with a cut-off frequency of 8 Hz, from which joint angular displacements were determined.

Results
Swing phase and gait cycle duration were similar between prosthetic limb and sound limb. From the moment of touchdown, the prosthetic knee joint was rapidly extended, and remained at around 180 degrees until toe-off. The prosthetic ankle joint was steady at around 135 degrees during the gait cycle. For sound limb, both the knee and ankle joints demonstrated continuous extensions during the stance phase. However, the joint motion was interrupted by a temporary joint flexion at the later half of the stance phase. At the end of the stance phase, the ankle joint of the sound limb showed greater plantar flexion than those

of prosthetic limb. Although the vertical component of the ground reaction force in prosthetic limb peaked at the middle of the stance phase, the peak force in sound limb occurred at the late stance phase. Moreover, the peak vertical ground reaction force in sound limb was markedly higher than those of prosthetic limb.

Conclusion

The most striking feature in the transfemoral amputee is that from the instance of touchdown, the prosthetic knee joint was rapidly extended, and remained at around 180 degrees until toe-off. Extending the prosthetic knee joint during the stance phase may be prerequisite strategy for transfemoral amputees to prevent the knee flexion generated by the body's weight. At the later half of the stance phase, both knee and ankle joints of the sound limb simultaneously demonstrated rapid joint flexion during the continuous extension. Further, at the end of the stance phase, the ankle joint of the sound limb showed greater plantar flexion than those of prosthetic limb. Therefore, the transfemoral amputee in the present study would lift the whole body in an upward direction using strong counter-movements and greater joint extension during the stance phase.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3020-218]

Measurement of Proprioception of the Knee in Hemiplegic Patients Using an Isokinetic Dynamometer

Author
Kim, Hyun-Dong (Busan KR) | Measurement of Proprioception of the Knee in Hemiplegic Patients
Busan paik hospital - rehabilitation medicine

Coauthors
Yang-Ju Song, Ji-Sun Hwang, Yun-Jeong Cho

Abstract
The quantitative test using an isokinetic dynamometer is a reliable method to measure knee proprioception, and it is possible to detect proprioceptive deficit in hemiplegic patients.

Introduction
To determine criteria of normality and reliability of the quantitative method to measure knee joint proprioception using an isokinetic dynamometer, to measure knee joint proprioception in hemiplegic patients after stoke and to compare it with the result from conventional clinical method.

Methods
Thirty healthy subjects and 24 hemiplegic patients participated in this study. Joint position sense was evaluated by passive angle reproduction of 30°(PAR 30°), and 60°(PAR 60°) of knee flexion and kinesthesia was evaluated by the threshold for detection of passive movement(TDPM) from 45°of knee flexion. We used toe-"up or down"-test for conventional clinical method.

Results
Intraclass correlation coefficient(ICC) for PAR 30°, PAR 60°and TDPM was 0.80, 0.79 and 0.61 respectively. Significant proprioceptive deficit was observed not only in paretic knees of both right and left hemiplegic patients($p<0.05$) but also in nonparetic knee in right hemiplegic patients($p<0.05$). A significant difference was found between proprioception deficit defined with current clinical test and quantitative test in the nonparetic knee($p<0.05$), but not in the paretic knee($p>0.05$).

Conclusion
The quantitative test using an isokinetic dynamometer is a reliable method to measure knee proprioception, and it is possible to detect proprioceptive deficit in hemiplegic patients. Conventional clinical assessments are poor for predicting the results of the quantitative measure in the nonparetic knee. This quantitative method may be useful in diagnosis and follow-up of knee proprioception of hemiplegic patients after stoke.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [2920-118]

Mobility Following Lower Extremity Amputation in the Elderly: a Systematic Review

Author
Fortington, Lauren (NL)
Department of Rehabilitation Medicine - University Medical Centre Groningen

Coauthors
Rommers GM, Geertzen, JHB, Postema K, Dijkstra PU

Abstract
A systematic review to investigate factors which influence mobility in elderly amputees and the level of evidence in support of these factors.

Introduction
It is recognised that older age alone does not preclude a successful rehabilitation outcome following amputation of a lower limb. However, the rehabilitation capacity of elderly amputees will, in general, differ from that of their younger counterparts. A fundamental component in the rehabilitation of amputees is mobility, as it opens the opportunity for greater independence. This systematic review was undertaken to investigate factors which influence mobility in elderly amputees and the level of evidence in support of these factors.

Methods
A literature search was undertaken in Medline, Embase and Cinahl, using keywords and synonyms for lower limb amputation, elderly, rehabilitation and mobility. References of publications were reviewed for further inclusions. Two authors assessed the publications by title, abstract and full text, to identify those which reported: [a] a mobility outcome; [b] measured at a minimum 6 months post-amputation or 3 months after discharge from a rehabilitation program; [c] in an elderly population, defined as greater than 60 years of age.

Results
From over 800 publications, 22 met the criteria for inclusion in the review. In 9 publications a mobility outcome in a population consisting exclusively of patients who were aged over 60 years was reported. The mean or median age of these patients was between 70-79.7 years, with a range from 60 to 92 years. The remaining publications had amputees of all ages included but presented a mobility outcome separately for a group who were all aged over 60 years. Preliminary results indicate a low level of evidence for factors which influence mobility outcomes in elderly amputees.

Conclusion
Elderly amputees have unique requirements with their rehabilitation. Only a handful of publications investigate mobility in elderly amputees independent from a younger population. Overall, the level of evidence was low in relation to factors influencing mobility in the elderly amputee population.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3054-252]

Comparison of Plantar Pressure between Weightlifters with Flatfeet and Normal Feet

Author
Feng, Beibei (CN) | Comparison of plantar pressure between weightlifters with flatfe
The Hong Kong Polytechnic University - Department of Rehabilitation Sciences

Coauthors
Huang Dongfeng, head of Department of Rehabilitation Science, Zhongshan Medical Colleage, Sun Yat-sen University, Guangzhou, China

Abstract
The study aimed to explore the effect of foot type on the distribution of the plantar pressure via testing the differences in plantar pressure between subjects with flatfeet (n=14) and normal feet (n=24). Results showed that flatfeet could influence the normal plantar pressure distribution.

Introduction
The prevalence of flatfeet has been increasing in the past few years. Flatfeet subjects are likely to be subjected in symptoms like fatigue and foot pain, and secondary injuries even deformity. The prevalence of flatfeet is said to be correlated with several factors including age, gender, weight and BMI. Given the specific characteristics of the weight-lifting sport requiring high-intensity, and maximum strength training, they have to sustain long-term immense loading, which may result in adaptational changes in body morphology, muscoskeletal structure and physical quality. Thus far, few researchers have studied the foot morphology and flatfeet epidemiology among weightlifters. This study aimed to investigate the foot conditions of weightlifters and explore the role of flatfeet played on normal plantar loading. Hopefully, it could appeal more attention for the foot health status of weightlifters, and provide statistical evidence of plantar pressure for better flatfeet intervention.

Methods
Thirty-eight weightlifters were recruited in this study and they were divided into two groups-the flatfeet group (14 subjects) and the normal feet group (24 subjects) using the three-line foot print method. These subjects were then asked to stand in a neutral position on the pressure platform of the HR Mat system. Parameters including force percentage, contact area, contact area percentage, contact pressure, peak contact pressure were measured.

Results
The force percentage in midfoot and the first metatarsal for the flatfeet group were greater than that for the control group, while the force proportion in the heel area for the flatfeet group was smaller($P<0.05$). The midfoot contact area and its proportion for the flatfeet group were significantly greater compared to the control group, while the contact area percentage at medial heel and the third metatarsal for the flatfeet group were smaller ($P<0.05$). As for the pressure parameters, subjects with flatfeet generated higher pressure at the first metatarsal area but lower pressure at the lateral side of the heel in contrast with the control group($P<0.05$).

Conclusion

Flatfeet could influence the normal plantar pressure distribution. The loading patterns of flatfeet subjects during stance and weight-bearing shifted medially to the midfoot and medial forefoot. In flatfeet group, the contact area of midfoot and the pressure at the first metatarsal significantly increased.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3252-433]

Effect of Mattress for Prevention of Pressure Ulcer and Position on Interface Pressure

Author
Bae, Tae Soo (Incheon KR) | Ph.D
Korea Orthopedics and Rehabilitation Engineering Center - Biomechanics & Gait Analysis Team

Coauthors
Hwang IH, Ahn YH, Kim SK, Mun MS

Abstract
By measuring contact pressures in relation to changes in the kinds of mattresses,bed positions,and BMI of subjects, the effects of each conditions for prevention of pressure ulcer could be quantified. Air mattresses showed generally even effects to prevent pressure ulcer across all the bed position.

Introduction
Decubitus is known to be a very important problem in intensive care units and it results in huge treatment costs as well as even threatening patients' lives in severe cases. Since it is generally unavoidable to use various bed positions in order to treat patients, patients with poor blood circulation carry the risk of decubitus caused by the pressure higher than the reference value continuously imposed on protruded areas for short time. Several mattresses have been introduced in order to prevent decubitus caused as such. However, since there are diverse kinds of them and many different methods to use them, patients' families and nurses experience many difficulties in selecting and using mattresses for prevention of decubitus. Therefore, in this study, the effects of diverse mattresses for prevention of decubitus and bed positions on contact pressures in the areas such as the scapula, the hip and the feet-heels will be quantitatively measured, analyzed and compared with each other.

Methods
Experiments were conducted on one each of a normal person with under-weight, normal, and over-weight body. A general mattress and four types of mattresses for prevention of decubitus (latex, bubble, alternative, and air mattress) were largely used as experimental environments and five different bed positions (ground, head 30 degress, head 60 degree, head 30 degree and foot 30 degree, and side) were defined as experimental conditions using three-step electromotive beds. A order-made pressure measuring system (Pliance FTX, v12.1.36, Novel Gmbh) was used in order to measure contact pressures between the subjects and the mattresses. The same processes were repeated for five different bed positions in the experiment. Contact pressures on largely three areas including the area of the scapula, the area of the hip and the area of feet-heels were separately measured using the predefined mask function by measuring the maximum peak pressure (MPP) in each area.

Results
In the case of flat positions, the result indicated that only bubble mattress was acceptable to the subject with normal body weight, latex or air mattress to the over-weighted subject and only air mattress to the low-weighted subject. In the case of the subject with normal body weight for 30o position in the head area, MPP lower than 32mmHg in all the mattresses except for latex and bubble mattress and in the case of the over-weighted subject, all mattresses were usable except for general mattresses, alternatives, and bubble

mattress but in the case of the under-weighted subject, all the mattresses showed higher MPP value. In the case of 60 o position in the head area, only the latex mattress was acceptable to the subject with normal body weight while all the mattresses showed higher MPP value in other subjects. In the case of 30°positions in the head area and in the foot respectively, it was indicated that only general mattress and alternative mattress were acceptable to the subject with normal body weight while only general mattress, latex, and air mattress were acceptable to the over-weighted subject. In the case of the low-weighted subject, latex, alternative, and air mattress showed lower MPP value. Lastly for side position, all the mattresses showed results exceeding the reference value in the case of the subject with normal body weight and the over-weighted subject while it was indicated that alternative and air mattresses were acceptable to the over-weighted subject.

Conclusion

By measuring contact pressures between the subjects and mattress for three separate areas in relation to changes in the kinds of mattresses and bed positions by means of measuring maximum contact pressures, the effects of conditions of the subjects, the kinds of mattresses, and the supine positions could be quantitatively summarized as follows. Air mattresses showed generally even effects to prevent decubitus across all the bed positions followed by latex mattresses. However, it was indicated that decisions to use bubble or alternative mattresses for prevention of decubitus should be made more carefully. It is considered that in studying and developing decubitus mattresses, practical studies should accompany that would consider not only the material and structural characteristics of mattresses but also the living environments of actual patients.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3217-399]

Skin Problems of the Stump in Lower Limb Amputees: a Clinical Study

Author
Meulenbelt, Henk (Groningen NL) | MD
University Medical Center Groningen, University of Groningen - Department of Rehabilitation Medicine

Coauthors
Geertzen JHB, Jonkman MF, Dijkstra PU

Abstract
Skin problems of the stump were assessed clinically and compared to opinion of the amputee. 139 amputees participated; in 34% of them were skin problems observed, while 36% reported one or more skin problems. Significantly more skin problems were reported (.96, SD=1.7) (p=.009).

Introduction
Skin problems of the stump in lower limb amputees (LLA) are frequently observed in clinical practice.[1;2] However, basic epidemiological data is limited.[3]
In a previous study, we assessed skin problems in LLA by a questionnaire.[4] Higher age, male gender, and peripheral arterial disease and/or diabetes as reason for amputation were protective factors. Smoking, use of anti-bacterial soap, and a high frequency of washing the stump were risk factors. The estimated prevalence of skin problems was 63% (95% CI, 60%-67%).[4] In a study (a retrospective chart review) prevalence was 41% (95% CI:37%-44%) and amputation level, being employed, type of walking aid, and absence of peripheral vascular disease (as co-morbidity) were identified as risk factors.[5]
However, skin problems were not clinically assessed.[4;5] Main goal of the present study is: estimate prevalence of skin problems in LLA by means of clinical assessment, and evaluate influence of these problems.

Methods
LLA who visited an orthopaedic workshop for prosthesis related reasons were invited to participate. Inclusion criteria were: LLA/congenital lower limb deficiency at transtibial level or more proximal, at least 3 months experience with a prosthesis, and be at least 18 years. Exclusion criteria were: amputees with inadequate knowledge of the Dutch language, or with cognitive problems which interfered with answering a questionnaire. Participants were asked to fill in a questionnaire, which was designed to assess skin problems of the stump, and determinants of these skin problems. The questionnaire has been used previously.[4] The stump was visually assessed by a physician for skin problems. When a LLA didn't want to participate, gender and date of birth were registered.

Results
In total 124 questionnaires were available for the statistical analysis (response rate of 85%). Participants were significantly older (60y; SD 16y) than non-participants (52y; SD 16y) (p<.05). Sex distribution did not differ significantly between participants (71% men) and non-participants (73% men).
Most common level of amputation was transtibial (54%), most common reason for amputation was peripheral arterial disease and/or diabetes (37%). Most of the participants had a maximal walking distance

less than 500 metres (63%), and walked less than 500 metres/day (63%). A majority used a liner in their prosthesis (61%).
In 42 amputees (34%; 95% CI 28% to 40%) one or more skin problems were observed whereas 44 amputees, 36% (95% CI: 30% to 43%) reported one or more skin problems. This difference was not significant (p=.845). The number of observed skin problems (mean 0.69, SD=1.0) was significantly lower than the number of reported skin problems (mean 0.96, SD=1.7) (p=.009), mean difference 0.28, 95% CI: 0.07 to 0.49). When the last comparison was made, excluding presence of a cold skin and or excessive perspiration as a skin problems the differences between observed and reported skin problems were no longer significant (p=.250). Walking distance without a break decreased significantly as a result of skin problems of the stump (p=.012).
Three participants changed the product for cleaning the stump (7%).

Conclusion

The prevalence of skin problems of the stump in lower limb amputees is 36%. Our reported prevalence is in agreement with two other clinical studies [1;6], which assessed skin problems of the stump in lower limb amputees, and with the results of a retrospective chart review.[5] The prevalence of this study is in contrast with the prevalence found in our previous study by means of a questionnaire (63% (95% CI: 60%-67%)).[4] This difference may be explained by study method and differences in study population. Skin problems result in a reduction of walking distance. There was a reasonable agreement between skin problems observed by the physician and reported by the participant on number of skin complaints. Cold skin and excessive perspiration were significantly more frequently reported than observed.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [2886-84]

Assessment of the Plantar Foot Pressure in Diabetic Patients

Author
Bahramian, Hooman (Tehran IR) | M.Sc.
Ortopede Fanee Andamkar Shargh - Orthotics and Prosthetics

Coauthors
Forogh B

Abstract
the aim of this study was in one way, the assessment of the plantar foot pressure in diabetic patients and the comparison of their values with normal subjects and on the other way, the determination of the susceptible points of ulceration on plantar surface of the diabetic feet.

Introduction
Diabetic patients have insensate feet which are susceptible for plantar ulceration. Current CT and MRI techniques are not appropriate for detection of at risk plantar foot points. Foot pressure measurement is a reliable technique for screening patients with high plantar foot pressures who are at risk of plantar ulceration.

Methods
In this cross sectional study, the plantar foot pressure of 20 subjects who were selected based on judgmental sampling method and assigned in diabetic and normal groups was assessed during walking using foot scan system in 10 different zones under the feet. Independent T statistics used to compare the means of two groups.

Results
While the lowest plantar foot pressure located under the Toes 2-5, the highest plantar foot pressure was under the third and then the fourth Metatarsal heads. Although diabetic patients had higher plantar foot pressure than the normal subjects in eight foot zones, but their mean differences were not significant ($p>0.05$)

Conclusion
It is proposed that may be because of our patient selection that was zero degree of the Meggit-Wagner grading, the mildest degree of ulceration, there was not significant difference between diabetic and normal participants. In diabetic patients with higher disease severity, complications of joint range of motion and feet muscle imbalance may cause higher plantar foot pressures during walking.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3440-615]

An Objective Evaluation of Gait Adaptability in Persons with Transtibial or Transfemoral Prostheses

Author
Houdijk, Han (Amsterdam NL) | Dr.
Vrije Universiteit - Faculty of Human Movement Sciences

Coauthors
Kerste M, Kraal J, Wiggerts H, Polomski W, Janssen T, Roerdink M

Abstract
We investigated whether gait adaptability can be measured objectively in people with lower limb prostheses. Obstacle avoidance and pattern walking differentiated between groups and was mildly correlated with clinimetry. We conclude that this method can be a valuable tool to evaluate walking ability.

Introduction
Regaining walking ability is an eminent goal of rehabilitation after lower limb amputation. Walking ability is a broad concept but generally quantified in terms of walking speed, energy efficiency or stability. While the assessment of the first two is relatively straightforward, assessing walking stability is more equivocal. In a clinical sense walking stability refers to the risk of falling. Although falling is not uncommon in amputees a clear indicator of fall risk is not available[1,2]. A concept strongly related to stability and fall risk is adaptability. In order to safely cope with perturbation in daily life people need to be able to adapt their gait pattern in anticipation or reaction to obstacles. In this study we investigated whether gait adaptability can be measured objectively using an instrumented treadmill with virtual obstacles (the C-mill [3]). We tested how gait adaptability differs between groups and how it is correlated with clinical measures of walking ability.

Methods
Twelve transfemoral amputees (TF), 12 transtibial amputees (TT) and 12 healthy controls (CO) participated. Amputee subjects scored C-F on the SIGAM scale and were able to walk 4 minutes on a treadmill independently. All subjects walked at comfortable walking speed on a treadmill that was equipped with a force plate to record foot position and connected to a projector to project images on the surface. Subjects walked in 3 conditions: 1) avoiding visual obstacles presented two strides in advance (anticipatory obstacle avoidance), 2) avoiding visual obstacles presented one step in advance (reactive obstacle avoidance), 3) following an imposed step pattern with different levels of predictability. The success rate of obstacle avoidance tasks and the error of the foot placement during pattern walking were assessed. In addition, clinical outcome measures related to walking ability were assessed in all amputee subjects: 10m walk test, TUG test, SIGAM, LCI and fall incidence in previous year.

Results
All subjects succeeded in performing the three conditions, although 7 transfemoral amputees needed handrail support during the obstacle avoidance tasks. The success rate of anticipatory obstacle avoidance was significantly lower in the TT (88±23%) and TF (84±13%) group compared to CO (98±3%) (Fig1a).The success rate of TT was higher compared to TF but this difference was not significant. In the reactive obstacle avoidance task TF (40±26%) had a significantly lower success rate compared to CO (79±21%).

A trend was found for a lower success rate of TT (55±35%) compared to CO. The difference between TT and TF was not significant (Fig1b).
The error in foot placement in the pattern walking task was highest for the TF group followed by the TT group and CO (Fig1c). This difference was only significant between both amputee groups and CO. Errors depended strongly on walking speed. After correcting for walking speed all group differences became significant. In addition, the interaction between group and predictability of the step pattern became significant.
Pearson's correlation, with treadmill speed as a covariate, revealed a positive correlation between success rate of reactive obstacle avoidance and walking speed on 10m walk test (r=0.57, p=0.003), a negative correlation between error on the pattern walk test and 10m walking speed (r=-0,44, p=0.02) and SIGAM score (r=-0.464, p=0.015), and a positive correlation between error on the pattern walk test and TUG (r=0.450, p=0.018).

Conclusion

Gait adaptability in people with lower limb prostheses can be quantified objectively from obstacle avoidance and pattern walking using an instrumented treadmill with virtual obstacles. All subjects successfully completed the tests, although TF amputees required handrail support. This handrail support is possibly the reason for the lack of significance between TT and TF in the obstacle avoidance task. Walking speed was identified as another modifier of the results which should be taken into account. The correlations found between gait adaptability and clinimetrics indicate that, in general, people with reduced walking ability demonstrate reduced gait adaptability. However, the limited strength of the correlations indicate that testing gait adaptability can add extra information when assessing the level of walking ability as well as its underlying deficits. This method can be valuable when evaluating walking ability during rehabilitation or testing the efficacy of different prostheses.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3215-397]

3D Gait Kinematic of Transtibial Amputees Walking in Every-day-life Environments: Reliability Study of a Protocol based on Inertial & Magnetic Sensors

Author
Cutti, Andrea (Vigorso di Budrio IT) | Dr.
INAIL Centro Protesi - Motion Analysis Laboratory

Coauthors
Raggi M, Garofalo P, Bottoni G, Ammaccapane A, Amoresano A, Davalli A

Abstract
A protocol named Outwalk has been recently proposed for the 3D gait analysis in real-life environments of transtibial amputees. This study addresses Outwalk's inter-rater reliability by involving 10 amputees and 2 rater. Results support the applicability of Outwalk in the clinical routine.

Introduction
The instrumental 3D gait analysis of amputees is currently limited to few prosthetic centres in which expensive movement analysis laboratories are available. Moreover, in the lab the gait of a patient can be conditioned by the stress imposed by the operators and by the artificial surrounding environment. Inertial and Magnetic Measurement Systems (IMMSs) might allow to overcome these limitations, being low-cost and portable. In addition, since the 3D orientation of their Sensing Units (SU) is known in a global earth-based coordinate system, which is ubiquitous, long measurements can be possible "out-of-the-lab", in real-life environment, e.g. where the gait-training is carried out. For this purpose, we proposed a protocol named 'Outwalk' to measure the 3D kinematics of gait based on the IMMS by Xsens Technologies (NL) [1]. The aim of the present work was to test the inter-rater reliability of the protocol on Transtibial Amputees (TA).

Methods
To measure the pelvis-trunk, hips, knees, and ankles 3D kinematics, Outwalk requires to 1) position 8 SUs on trunk and lower-limb segments; 2) flex-extend each knee to estimate its mean flexion-extension rotation axis; 3) measure the SUs' orientation with the subject in the upright anatomical posture [1].
Ten TA (45±10 year-old, K2-K3 level) participated in the experiment after signing an informed consent, together with 2 operators (O1, O2). O1 and O2 independently applied Outwalk on each subject and acquired the amputee's gait kinematics while walking at self-selected speed in the park of our Centre along a 30m straight path. Acquisitions by O1 and O2 were 10 min apart. Gait cycles were segmented using the algorithm described in [2]. To quantify the inter-operator reliability we computed, among others, the Standard Error of Measurement (SEM) of the 36 parameters described in [3], based on an ANOVA with repeated measures, as recommended in [4,5].

Results
For the interest of brevity, Table 1 reports SEM values for the 14 most significant parameters of the 36 examined, both for the sound and prosthetic side. The SEMs reported both consider random and systematic effects. The names used for the parameters are those reported in [3], to which the reader is referred for a detailed description. Here suffices to say that: 1)H, K, A refer to hip, knee and ankle; 2) parameters ending with 6 and 7 refer to the sagittal and frontal plane range of motion (ROM); 3) ending

with 2 refer to the maximum flexion/plantaflexion at loading response; ending with 3 refer to the maximum extension/dorsiflexion in stance phase; ending with 5 refer to the maximum flexion/dorsiflexion in swing.

Conclusion

Results appear consistent with reports on other populations [5,6]. In particular, the sagittal ROMs (H-K-A6) have a SEM<1.9°. Regarding the hip, H7 (useful for the analysis of hip circumduction deviations) appear particularly reliable with a worst-case SEM of 1.3°. Regarding the knee, K2 and K3 (SEM< 2°) appear reliable to draw conclusions on a flexed-knee gait, and K5 about the lack of foot clearance related to insufficient knee flexion in swing. Regarding the ankle, results for A2 and A3 (SEM< 1.8°) suggest the possibility of precise conclusions over vaulting problems, and A5 for push-off problems. SEMs for the prosthetic ankle (<1°) suggest the possibility of a detailed analysis of performance between different types of foot.

Even thou partial, results suggest the applicability of Outwalk for the “out-of-the-lab” gait analysis of TA amputees, with important implications for the diffusion of this powerful instrument to every-day-life clinical routine even in small prosthetic centres.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3297-472]

Exercise Prescription Protocol based upon the Amputee Mobility Predictor: A Case Report

Author
Gaunaurd, Ignacio (Miami US)
Bruce W. Carter Department of Veterans Affairs Medical Center - Research

Coauthors
Gailey RS, Raya MS, Roach KR

Abstract
This case report describes the progression of the AMP exercise prescription protocol for a unilateral transtibial amputee due to dysvascular disease who participated in the Evidence Based Amputee Rehabilitation (EBAR) Program in the Miami VAHS

Introduction
The Amputee Mobility Predictor (AMP) was designed to measure components of mobility, both with (AMPpro) and without a prosthesis (AMPnoPro), in lower limb amputees. The findings of Gailey et al (2002) suggest that the AMP is not only a valid measure of function as it pertains to an amputee's ability to ambulate but it could help the clinician to differentiate among the 5-level Medicare functional classification level system (MFCL) , which defines the various levels of mobility for the lower limb amputee and recommends corresponding prosthetic prescription [1]. Each of the 20 items of the AMP, have the potential to direct exercise prescription based upon an individual's performance of each item. The purpose of this case report is to describe the progression of the AMP exercise prescription protocol for an individual with a unilateral transtibial amputation due to dysvascular disease.

Methods
The patient chosen for this case study was a 60 y/o black male veteran of the Vietnam War, diagnosed with Type II DM in 1989. The subject became a right lower limb transtibial amputee due to dysvascular disease. The intervention consisted of three 60-minute treatment sessions per week for a total of 8 weeks. Based upon the score for each item, the subject was prescribed specific exercises. For example, when performing item 7 of the AMP (Single-limb standing balance), the subject was able to balance, without assistance, over his prosthesis for only 1.5 seconds before requiring a standing walker to complete the test. This indicated that the subject was unable to balance over his prosthesis and was prescribed the following 2 exercises: 1) Weight shifting to re-educate the center of mass over the base of support and 2) Stool stepping with the intact limb to promote hip strategies, weight-bearing into the socket, and prosthetic foot sensation.

Results
The following outcome measures were performed: AMPPro, AMPnoPro, 6MWT, Functional Strength Measures of the Lower Limbs, and Prosthetic Observational Gait Assessment (POGA). Baseline AMPpro and AMPnoPro scores were 35/47 and 27/41, which classifies him at a MFCL level 2 or "limited community ambulatory". Distance ambulated during the 6MWT was 391.50 meters. The intact and amputated side hip extensor strength was 37/40 and 10/40. The amputated hip abductors strength was 14/40 to 16/40. The intact side plantarflexor strength was 15/40. The POGA was administered with the 6MWT and the subject presented with the following gait deviations at baseline: external rotation of the prosthesis and sound limb,

abducted prosthetic limb, adducted sound limb, knee hyperextension, valgus moment at the knee, lateral trunk bending toward the prosthetic side, and uneven arm swing. At discharge, AMPpro and AMPnoPro scores were 43/47 and 31/41, which indicated improvements in functional mobility with prosthesis and functional capacity without prosthesis. Distance ambulated during the 6MWT was 432.82 meters. The intact and amputated side hip extensor strength improved to 40/40 and 16/40. The amputated hip abductors demonstrated improvement to 16/40. The intact side plantarflexors demonstrated the greatest increase in strength to 28/40. External rotation of the prosthesis was the only gait deviation present at discharge.

Conclusion

An exercise prescription protocol based upon the AMP produced a significant change in functional mobility, strength, and endurance in an individual who had been a prosthetic ambulator for the past 5 years. Furthermore, the subject experienced positive anthropometric changes such as a total weight loss 37 pounds, which allowed him to control his type II DM with diet alone. Nine-month post intervention testing demonstrated AMPpro score of 42/47 which indicates that the subject was able to maintain his improved function.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [2999-197]

Realization of the "Assist-As-Needed" Behaviour in Motion Therapy Devices Using Soft Fluidic Actuators

Author
Wilkening, André (Bremen DE)
Friedrich-Wilhelm-Bessel-Institute - University of Bremen / Institute of Automation

Coauthors
Wilkening A, Baiden D, Ivlev O

Abstract
Conceptual designs of motion therapy devices with new soft pneumatic actuators of direct rotary type are presented. These inherent compliant drives allow a gentle physical interaction with humans and permit a simple realization of assistive control strategies considering patient's self-activity.

Introduction
Therapeutic advantages of patient-cooperative (assistive) rehabilitation robots/devices are assumed to be much larger compared to continuous passive motion (CPM) machines. Several recent studies have shown that this approach will cause higher therapy effectiveness [1]. By supporting patients to perform the motion by themselves, the muscle reconstitution is maximized so that treatment periods and costs can be reduced. The realization of this advanced robot aided motion therapy with conventional electrical drives demands high control complexity and expensive force/torque sensors [2]. The inherent compliant actuators like pneumatic muscles [3] are more suitable to achieve the desired assistive behaviour, require however complex transmissions for realizing revolute joints.
The problem can be solved by using direct-drive rotary soft fluidic actuators, well suitable for modular design of motion therapy devices and by implementing assistive control strategies without torque sensors.

Methods
To meet the requirements of compact design, necessary for actuators working in immediate proximity with human, new disc actuators with rotary elastic chambers (REC-actuators) have been developed [4]. The working chambers of these patent pending actuators are made from a standard industrial or fire flat hose. The coiled (cREC) or buckled (bREC) pieces of flat hose with hermetically sealed ends and integrated inlet/outlet pipe are clamped to the ends of two moving parts, connected by a revolute joint. If pressurized, the hose tends to stretch, generating torque with tens of Nm. The main advantages by using a fire hose material in comparison to the previously used pleated chambers (pREC), formed by welding of polyurethane film [4,5], are the reduced chamber's cost as well as the enhanced safety because of high hose burst pressure. Using these new "slim-line" REC-actuators, two modular motion therapy devices for lower extremities – "full-leg" and "free-knee" concepts – have been designed.

Results
Recently, a test-bed of "free leg"-concept with pREC actuators has been realized and tested. To achieve an assistive behaviour we adapted and implemented the "Assist-as-Needed" (AaN) force controller suggested in [6]. The actuator torques are estimated based on pressure measurements; controller only generates force to assist the patient in case of insufficient movement. The patient effort against the desired target firstly causes a smooth increasing of force to guide the patient into the right direction. When increasing the

patient counteraction, the robot force decreases to avoid injury in case of involuntary muscular spasm for instance. Thus, the device behaves very gentle and save robot assisted therapy is ensured.
To maximize the success of medical treatment the patient should be motivated to be as much active as possible. For this purpose, the audio-visual feedback is implemented. The current muscular effort of a patient is detected with the recently developed air pad-sensor. The adequately interpreted signal can be displayed on the monitor and/or used for A/V- feedback.
User interface offers self descriptive settings, whereby a comfortable handling of the device, even for elderly people, is assured. Maximum robot force, velocity as well as the desired angular range can be specified via sliders and buttons on the touch-screen.

Conclusion
Initial trails using the “free-knee” test-bed have demonstrated a really convenient “Assist-As-Needed” behaviour without expensive sensors and confirm the effectiveness of the soft fluidic actuator used in robot aided rehabilitation. Low-cost, light-weight and portable motion therapy devices can be used in hospitals and at home. Currently, a prototype of the “full-leg” device is being assembled. Prospective tests and analyses with patients in the clinic will show the grade of patient’s acceptance.
The concepts of new motion therapy devices with REC-actuators were in detail discussed with the cooperation partner Dr. Paul Koch GmbH and Clinical Centre Stuttgart within the cooperative research project KoBSAR “Compact assistive/restorative motion therapy devices based on fluidic soft actuators with rotary elastic chambers”, supported by the German Federal Ministry of Education and Research (BMBF). Product design renderings are produced by :i/i/d Institute of Integrated Design, Bremen.

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Image: Fig 1_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg245277/cg35138

Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3561-658]

Evaluation of Demographic Data, Rehabilitation Milestones and Outcomes for Lower Limb Prosthetic Users

Author
Burgess, Laura (London UK) | MCSP Grad Dip Phys
Holderness Rehabilitation Centre Department - Charing Cross Hospital Country

Abstract
The aim was to review initial results of demographic data, rehab/prosthetic milestones, location, type&frequency of rehab provided&the outcomes achieved of 49 new lower limb prosth. users. LCI scores&TUG times were better for prosth. users who had undergone in-patient rehab in early prosthetic phase

Introduction
From clinical experience there is an awareness that a large variation exists in the rehabilitation of lower limb prosthetic users. The British Association of Chartered Physiotherapists in Amputee Rehabilitation guidelines dictate that during prosthetic rehabilitation patients should receive physiotherapy as often as their needs and circumstances dictate & that a physiotherapist specialised in amputee rehabilitation should be responsible for the management of physiotherapy care (Broomhead et al. 2003). Munin et al. (2001) report a longer length of stay during rehabilitation showed a significant relationship to successful prosthetic rehab. Stineman et al. (2008) found that acute post-op inpatient rehabilitation was associated with improved outcomes. The aim of this study was to review the initial results of demographic data, rehabilitation & prosthetic milestones, location, type/frequency of rehabilitation & discharge destination and outcomes achieved of new lower limb prosthetic users.

Methods
Senior specialist physiotherapists from 4 disablement services centres in London and the south east of the UK developed a data collection tool. The key rehabilitation milestones and the validated outcome measures were agreed among the specialist physiotherapists. Standards were agreed for first physiotherapy treatment post-amputation 1 day, fitting compression sock 5-14 days, use of early walking aid 5-14 days and primary appointment at the disablement services centre 14-28 days. The tool was used by physiotherapists to record demographic data & information regarding hospital admission & discharge, rehabilitation/prosthetic milestones, location & type of rehabilitation and results of outcome measures. Reasons for delay in achieving milestones were recorded. Data was collected on 49 subjects who had undergone lower limb amputation, had been fitted with a prosthesis and were undergoing rehabilitation. The data collected was anonymous and analysed using Microsoft excel software.

Results
The final study sample was 49 prosthetic users. There were 28(57%) males and 16 (33%) females (with no data for5(10%)); 28(57%) transtibial, 18 (37%) transfemoral, 2(4%) knee disarticulation and 1(2%)hip disarticulation. The mean age was 63 years. The cause of amputation was 33(68%) dysvascular, 9(18%) trauma, 5(10%) infection, 1(2%) neoplasia and 1(2%) other. There were 3 bilateral prosthetic users.
The mean total length of hospital stay was 88 days and 16(33%) of patients were discharged prior to prosthetic fitting. Examining the data for first use of compression sock, the mean time was 32.4 days, 15 (31%) of subjects had met the standard of 5-14 days. For use of early walking aid, the mean time was 28

days and 16(33%) of subjects had met the standard of 7-14 days. When reviewing the data against the standard for primary appointment 25 patients(51%) achieved the standard of 14-28 days post-amputation and the mean was 40 days post-amputation. The mean time for prosthetic fitting post-amputation was 68.5 days. In terms of discharge destination 38(77%) patients went home, 9(17%) were rehoused, 1(2%) went to
sheltered housing and there was no data for 2(4%).
Due to the number of patients who were discharged prior to prosthetic fitting, it was not possible to compare outcome measures at the discharge from hospital stage. The outcome measures for early prosthetic rehabilitation were compared between in and out-patient groups and are represented in graph 1.0 below.

Conclusion

This study supports the view that there is currently a wide variation in the rehabilitation offered to lower limb amputees. Approximately one third of the sample group achieved the standards set related to use of compression socks and early walking aids. On an initial review of the results the group of patients who had undergone in-patient rehabilitation had better outcomes for the locomotor capabilities index and timed up and go test than those having out-patient early prosthetic rehabilitation. The author appreciated that this is a relatively small sample size but the group appears to be representative of this patient population. The plan is for this piece of work to be expanded to a larger sample group and for outcomes to be extended to 10-14 months post prosthetic delivery. Also there will be a more detailed analysis of the results and relationships between level of amputation, location, type and frequency of rehabilitation and prosthetic users' outcomes.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3017-215]

Importance of Vertical Displacement of Center of Mass (COM) in Stroke Hemiplegic Gait

Author
Kobayashi, Toshiki (HK)
The Hong Kong Polytechnic University - Health Technology and Informatics

Coauthors
Boone DA, Leung AKL

Abstract
The correlations among vertical displacement of COM, lower limb joint kinematics and temporal-spatial parameters in stroke hemiplegic gait were investigated. The results suggested that an increase in vertical displacement of COM might be associated with improvement of gait in stroke hemiplegics.

Introduction
The movement of COM in gait represents the overall result of joint and segment kinematics on the forward progression, and it has been considered important to describe pathologic gait (Broström et al., 2007). Minimizing the vertical and lateral excursion of COM has been thought as one of the goals in human gait to reduce energy consumption (Orendurff et al., 2004). A simulation study revealed that much of the mechanical work was done in early stance phase to raise COM (Neptune et al., 2004). However, it was also reported in healthy adults that increases in velocity would result in increases in vertical displacement of COM and reductions in lateral one (Orendurff et al., 2004), and reduction of a vertical displacement of COM would increase mechanical energy cost due to enhanced mechanical work at lower limb joints (Gordon et al., 2009). The purpose of this study was therefore to investigate the effect of vertical displacement of COM on parameters of gait in stroke hemiplegics.

Methods
Ten hemiplegic subjects (10 males; aged 54.3 (8.4)-year-old) who suffered from a stroke for more than three years (duration of 3.7- to 16.5-year) participated in this study. Each subject wore an experimental ankle-foot orthosis (EAFO) whose flexibility was adjustable. A gait analysis was conducted under 9 flexibility conditions (6 trials each) using a 3D motion analysis system. Therefore, a total of 540 gait cycles data were collected (10 subjects × 9 flexibility conditions × 6 trials) and subsequently analyzed. Vertical displacement of COM was studied by sub-dividing its movement (L1 to L6) throughout a gait cycle as described in Figure 1. Sagittal plane kinematics of the lower limb joints, velocity of COM (COMv) toward the line of progress, and stride length were also computed. Finally, correlations among these parameters were investigated by calculating the Pearson's coefficient. The study was approved by the ethics committee of The Hong Kong Polytechnic University.

Results
L2 ($r=0.681$, $p<0.01$) and L3 ($r=0.622$, $p<0.01$) showed significant correlations with COMv. The summation of L2 and L3 also revealed correlations ($r=0.713$, $p<0.01$) with COMv. Therefore, it was suggested that vertical excursions of COM would relate with gait velocity not only in healthy subjects (Orendurff et al., 2004), but also in stroke hemiplegics. The range of motion (ROM) of the affected side hip joint showed significant correlations with COMv ($r=0.723$, $p<0.01$), L2 ($r=0.846$, $p<0.01$), L3. ($r=0.51$, $p<0.01$) and

stride length (r=0.72, p<0.01). Finally, L2 (r=0.699, p<0.01) and L3 (r=0.832, p<0.01) showed significant correlations with stride length. Thus, the significant associations among vertical displacement of COM (L2 and L3) and other parameters of gait in stroke hemiplegics were revealed.

Conclusion

The results of the correlational study among gait parameters investigated in this study demonstrated that hip joint kinematics of the affected side, gait velocity (COMv), stride length and vertical excursion of COM were closely associated to each other in stroke hemiplegics. Among the COM parameters, L2 and L3 parameters, which would represent how far a stroke hemiplegics can bring the height of COM down on the affected side and up on the sound side respectively, were shown to be significant parameters that were closely related to other gait parameters. Summation of L2 and L3 also showed good correlations with COMv. These results suggested that an increase in vertical displacement of the COM at this phase of a gait cycle might be associated with improvement of gait in stroke hemiplegics. Development of a robotic hip joint assistive device that enhances vertical COM displacement might be useful both for orthotic and therapeutic purposes.

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Poster Session: Rehabilitation
Friday 2010/05/14 | 12:00 - 14:00 | Topic: Related Rehabilitation | Subtopic/Track: Rehabilitation

Poster [3225-407]

Do Unilateral Transtibial Amputees Distribute Weight Symmetrically during Sit-to-stand and Stand-to-sit Activities?

Author
Agrawal, Vibhor (Miami US)
University of Miami - Biomedical Engineering

Coauthors
OToole CO, Gaunaurd IA, Gailey III R, Carriere DL

Abstract
This study characterized the loading pattern of the intact and amputated limbs of unilateral transtibial amputees (TTAs) during sit-to-stand and stand-to-sit movements. The weight distribution symmetry in TTAs was found to be significantly different than healthy subjects for both activities.

Introduction
While walking, negotiating obstacles such as ramps and stairs are common activities, the tasks related to sitting may be one of the most frequent and demanding activities performed on a daily basis by people with limb loss. Sit-to-stand and stand-to-sit maneuvers are performed 43-61 times a day[1, 2] by unilateral transtibial amputees (TTAs). The high incidence of degenerative joint diseases found in TTAs has been attributed to increased loading of the intact limb during everyday movements[3]. Biomechanical investigations of sit-stand and stand-sit activities in TTAs have not been reported in the scientific literature. The purpose of this research was to characterize weight distribution symmetry between the intact the prosthetic limb of TTAs during sit-stand and stand-sit activities. It was hypothesized that TTAs will exhibit asymmetrical weight distribution while able-bodied subjects will symmetrically distribute body weight between the lower limbs during the two activities.

Methods
Twelve TTAs (mean age 49±10.5 years) and 12 able-bodied control subjects (mean age 52.4±8 years) performed 3 to 5 rising and sitting trials using chair arm-rest assistance. Vertical ground reaction forces (GRF) from the chair and the feet were collected using a Tekscan Matscan system. The two activities were divided into 5 events[4, 5]; Sit-Stand (1) Initiation: Start of forward momentum generation. (2) Start-of-Ascent: Onset of vertical center of mass (CoM) acceleration (3) Seat-Off: Zero load on the seat. (4) Deceleration: Start of vertical CoM deceleration. (5) Standing: Attainment of a stable standing posture. Stand-sit[4]: (1) Start-of-Descent: Initiation of vertical CoM descent (2) Deceleration: Onset of CoM deceleration. (3) Seat-contact: Start of weight transfer from legs to the seat. (4) Stabilization: Beginning of trunk and balance adjustment. (5) Sitting: Onset of quiet sitting. Symmetry of weight distribution was calculated at each event using GRFs from the chair and feet.

Results
TTAs exhibited an inconsistent weight distribution symmetry pattern during the sit-stand and stand-sit movements. For both activities, they had high symmetry indices at the start and end of each activity and a tendency to shift weight to the intact limb during the course of the maneuvers. Controls subjects also did not have equal weight distribution between the two limbs and were found to load the dominant side more than the non-dominant side. The symmetry index in controls was never less than 90% and the symmetry

pattern was quiet consistent at all the 5 events of both activities. Table 1 shows the symmetry indices for TTAs and controls at the 5 events of sit-stand and stand-sit activities. The difference in symmetry indices between the two groups of subjects was found to be statistically significant for both the sit-stand and stand-sit activities. In TTAs, the high asymmetry seen at the Seat-off event (71.4%) and the Seat-contact event (68.6%) resulted from an approximately 25% increase in the weight borne by the intact limb. The mean (SD) rise time for TTAs and controls was 2.84 (0.3) seconds and 2.6 (0.4) seconds respectively. The mean (SD) sit time for TTAs and controls was 3.05 (0.3) seconds and 2.98 (0.5) seconds respectively. The rise and sit times between the two groups were not significantly different.

Conclusion

The time period around the Seat-off event in rising and just before the Seat-contact event during sitting can be considered as the most challenging phase of the respective activities. The noticeable asymmetry at these events indicates the tendency of TTAs to rely on the intact limb for successfully executing the stand-sit and sit-stand movements. High biomechanical demands placed on a compromised musculoskeletal system of the amputated side possibly trigger a weight shift to the intact limb in TTAs. Overloading the intact limb and foot during the course of the activities may prove detrimental, particularly when the activities are repeated multiple times a day over several years. Some possible ways to address this asymmetry include task specific training for the sit-stand and stand-sit activities, awareness training to promote a conscious effort of equal weight distribution between the limbs and choosing the appropriate prosthetic foot.

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Image: Image for Table 1_None.JPG (see online)

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3790-900]

Diabetic Foot Disease: Current Concepts and Clinical Practice Guidelines

Keynote Author
Idusuyi, Osaretin (Springfield, IL US) | Prof. Dr.
Southern Illinois University School of Medicine - Central Illinois Diabetic Research & Foot Clinic

Introduction
Although numerous clinical guidelines have been published to disseminate evidence-based practice, the lag between what is known and what is really done to the feet of diabetic patients persists.

Results
The pathophysiology of diabetic foot disease is directly related to the development of peripheral neuropathy. Persistent hyperglycemia cause nerve edema and subsequent neuropathy that has a sensory - motor - and autonomic component . This loss of protective sensation, along with foot deformities put the individual with diabetes at risk of unnoticed injury, resulting in an increased likelihood of ulceration. The identification of sensory changes in the diabetic lower limb is easily accomplished by the use of a 10 gram Semmes-Weinstein monofilament or a 128Hz tuning fork .
Diabetes accelerates arteriosclerosis. Peripheral vascular disease is the most important factor related to outcome of a diabetic foot ulcer. Minor trauma to the lower limb in diabetics with peripheral vascular disease can often initiate a cascade of ulceration and amputation; the most common cause of initial injury is inappropriate footwear.
Foot infections and Charcot neuropathic osteoarthropathy are the other two serious foot complications of Diabetes mellitus that too frequently lead to gangrene and lower extremity amputation.

Conclusion
The management of foot ulcers requires a multifactorial approach. It involves a thorough history and foot examination, control of glycemia, treatment of vascular disease, control of infection, control of edema, proper wound management, and effective off loading strategies.
Risk classification system based on the presence or absence of sensory neuropathy, peripheral vascular disease, foot deformities, and prior ulceration provides a useful tool to direct management strategies, such as frequency of review, and to prevent foot problems. The International Consensus on the Diabetic Foot (1999)
Management of the healed ulcer and prevention of recurrence is of paramount importance. Effective strategies include a multidisciplinary team approach, regular inspection and examination for risk factors, identification of "at risk foot", education of patient, family and health providers, appropriate footwear and a prophylactic nail/skin care. When these strategies are fully applied the diabetic foot complicati

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3845-None]

Open Forum 7

Session Chair
Yazicioglu, Kamil (TR) | Professor, MD
Gülhane Military Medical Academy - Department of Physical Medicine and Rehabilitation, Turkish Armed forces Rehabilitation Center

Session Chair
Franke, Jens (Dortmund DE)
Bundesinnungsverband für Orthopädie-Technik

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg622134

Session: Open Forum 7
Friday 2010/05/14 | 15:00 - 16:30

Congress Lecture [3846-868]

Prosthetics and Orthotics in Turkiye: Past, Present and Future

Author
Alsancak, Serap (Kecioren TR) | Professor
Ankara University

Introduction
The first development in Turkey in the field of prosthetics and orthotics took place during the reign of the Ottoman Sultan Abdulhamid II. In the 1890's workshop studies on P&O and the
first technical workshop on P&O 'Tersane-i Aleti Nazikiye' was built under the leadership of
the navy mechanical engineers in the 1910's. The loss of the limbs of soldiers in World War I, played an important role in the improvements made in this field in Turkey. Some military and civil technicians were sent to Vienna and Bonn in the early 1920's. The Turkish technicians educated in Germany caused an acceleration in P&O manufacturing. The first state university workshop was founded in the 1940's at the Medical Faculty of Orthopaedics Surgery Department in Ankara University. In the 1950's the first Turkish resource in P&O was published by Professor Cevat Alpsoy, who was a surgeon and worked together with Professor Sudeck in Hamburg.

Methods
According to Turkish Statistics Institute Reports, there are approximately 8.6 million (12.3% of population) disabled people in Turkey. 1.25 % of population is physically disabled. P&O services are provided through state hospital departments and private centres. There are 25 prosthetics and/or orthotics departments in Turkish state hospitals and universities. The number of private workshops providing P&O services in good quality standard have reached
80. On the other hand, there are 300 private Orthotic Centres selling prefabricated orthoses and/ or wheelchairs. These services are mostly provided by PO technicers/technicians, physiotherapists, orthopedic surgeons and physical therapy physicians. In addition to this few
POs and engineers have been working. There are approximately 1.000 people employed in
P&O today. There are 23 manufacturers in Turkey. Most of the P&O components are manufactured by domestic manufacturers. However, Turkey imports many P&O components that are commonly used in this field.

Results
TSAPO has organized 7 national P&O congresses with international participants since 1994. 3 of them has been organized by TSAPO and ISPO Turkey. Also the last 2 of the congresses brought together scientists from Middle East working in this fields. Work has been done on improving P&O standards in Turkey such as P&O manufacture and fitting rules, CE marking of domestic P&O components and regulations draft to supervise the licensing of the centres working. In addition to these, the regulations have just been updated concerning the terminology of prostheses and orthoses and their costs. Thus the future of our sector will be more prosperous in the days to come.

Conclusion
Our future aims are:
• Develop new methods and products
• Improve domestic technologies

• Transfer new technologies
• Improve partnerships between universities' P&O programmes and government, companies/manufacturers
• Increase resources
• Bringing together responsibility and authority
• Develop and spread standardization
• Encourage life-long learning
• Increase the duration of professional P&O training at universities
• Increase academic research

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Session: Open Forum 7
Friday 2010/05/14 | 15:00 - 16:30

Congress Lecture [3847-None]

Managements, Patient Care, Publications from Past till Today in P&O

Author
Goktepe, Salim (TR) | Dr.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg622134/cg622761

Session: Open Forum 7
Friday 2010/05/14 | 15:00 - 16:30

Congress Lecture [3851-855]

My Prosthetic/Orthotic-Related Experiences in Cambodia

Author
Bowerman, Kim (Edmonton CA) | Bachelor of Science (BSc) Degree and P/O Diploma
Glenrose Rehabilitation Hospital - Prosthetics, Orthotics and Seating

Abstract
My first visit to Cambodia in 2005 truly opened my eyes and ignited my interest in the field of prosthetics and orthotics. Three years later, I took the opportunity return to the country prosthetic/orthotic student volunteer. These experiences have helped me to grow as an individual and student, and will contribute to the Prosthetics/Orthotics professional I become.

Introduction
The time I spent as a traveller and volunteer in the developing world has had a huge impact on me as a person and a Prosthetic/Orthotic professional. I would like to share the Prosthetic and Orthotic-related experiences I had as a traveller and volunteer in Cambodia.

Results
My first visit to Cambodia really sparked my interest in the field of Prosthetics and Orthotics and was the reason that I decided to return to school and study in the Prosthetic/Orthotic field. The further experience I obtained upon my return to Cambodia as a student volunteer was incredible. Furthermore, I am motivated to return to work in the developing world once I become established in my field of work.

Conclusion
Practising Prosthetics/Orthotics in a developing nation is a great way to gain exposure to our field in a completely different setting. In addition, it allows us to become familiar with the different resources, limitations and variables impacting that setting. This exposure helps to shape us into more well-rounded and aware Prosthetic and Orthotic professionals.

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Session: Open Forum 7
Friday 2010/05/14 | 15:00 - 16:30

Congress Lecture [3852-891]

Prosthetic Experiences in Thailand

Author
Lung, Stephanie (Halifax CA) | Bachelor of Arts Degree (BA) and P & O Diploma
Nova Scotia Rehabilitation Centre - Prosthetics and Orthotics

Introduction
I have always been interested in working in different parts of the world enabling one to experience different cultures, languages, and work schedules. My first exposure abroad was working in Hong Kong at the Kowloon Hospital in 2006, completing a one-month work term while I was a student in the George Brown College (GBC), Prosthetic-Orthotic Technician program. During my studies in both technical and clinical programs at GBC, we learned a lot about the current components used and what the future has to offer. I always wondered what it would be like in countries that have much less in terms of overall resources than we see in Canada and how it would be without all the fancy technology we are exposed to in our setting. This intrigued and inspired me to want to experience first hand how prosthetic services are provided in such settings. Fortunately such an opportunity arose after graduation and I was given the privilege to volunteer abroad in Nonthaburi, Thailand at Sirindhorn National Medical Rehabilitation

Results
During my time in Thailand, I was exposed to a variety of patients. I was also fortunate enough to be part of a mobile service which provides prosthetic and orthotic services to more remote areas of the country. During my stay there, I was in total awe at how quickly devices were fabricated and the continual dedication displayed by the staff I worked with. After spending a month in Thailand, it has made me realize how lucky people in developed countries are, and I was able to see first hand how happy, versatile and amazing people in developing countries are.

Conclusion
My time in Thailand has made me believe that incorporating an exchange program in our field would be beneficial, as such experiences facilitate the expansion of our current knowledge bases, but more importantly allow one to observe how things are done in different parts of the world. This particular experience has increased my skill set by helping me gain a better understanding of what we learned in the classroom and apply that to a different environment. The culture, friendships, and memories will never be forgotten.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3547-None]

Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees

Session Chair
Thiede, Klaus Frederik (duderstadt DE)
Otto Bock HealthCare GmbH

Session Chair
Brückner, Lutz (Bad Klosterlausnitz DE) | Priv.-Doz. Dr. med. habil.
Moritz-Klinik Gmbh & Co. KG - Orthopädie / Unfallchirurgie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57890

Symposium: Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3549-727]

Liner - The Aspect of Adhesion and Friction

Author
Drerup, Burkhard (Münster DE) | Prof. Dr.
Klinik für Technische Orthopädie und Rehabilitation - Klinische Prüfstelle für orthopädische Hilfsmittel

Abstract
Liners exhibit in general a high adhesion and friction in contact with the skin. Therefore, to transfer tangential forces between stump and socket normal pressures may be lower when using liners than without. This is illustrated by pressure measurements under different conditions.

Introduction
The connection between stump and socket is an essential biomechanical prerequisite to allow the prosthesis to take on the axial load of body weight and the horizontal forces in controlling the movements of the prosthesis and finally to prevent the prosthesis from loosening during the swing phase. In order to certify a good suspension liners come increasingly into use.
In order to generate the connection between liner and socket forces of adhesion and friction may be used. The stability of this connection depends on the magnitude of normal pressure and the coefficient of friction between the contacting surfaces: Given a normal force FN between two contacting surfaces and a tangential force FT acting in parallel to the contact surface. Then a sliding movement between the surfaces is prevented as long as the normal force is large enough, i.e. as long as the ratio of FT /FN does not exceed the friction number #. The friction number between silicon and skin is higher than between typical socket materials and ski

Methods
A biomechanical experiment has been conducted to elucidate these considerations and to find out the effect of higher friction to reduce normal pressure on the skin in two different sockets for a transfemoral amputee. The socket design was in both cases quadrilateral of ischial containment type. One socket was made to be used with a liner insert, the other without. Pressure sensors were applied in 5 positions:at the distal end of the stump, and in the entrance plane of the socket at a lateral and medial, ventral and dorsal position. Pressure measurements in these positions were made in the two-leg standing condition and were repeated several times to allow mean-value calculation. As the number of available sensors was not sufficient for all 5 positions, two subsequent series of trials were made, one with the sensors in the distal, lateral and medial position, the other with the sensors in the distal, ventral and dorsal position.

Results
In both sockets – with and without liner – the pressure measurement in standing condition resulted in 0,9 N/cm² demonstrating that the two sockets may be compared for their pressure distribution in the entrance plane of the socket. The results for the lateral and medial, ventral and dorsal position reveal a significantly lowered pressure in most positions for the liner-socket. Only at the medial position a slightly increased pressure was observed for the liner condition. In order to not impede blood supply of the stump it is most important, that in the ventral position a pressure reduction was obtained when using a liner.

Conclusion
The high friction of liners provides for a good connection between socket and stump and it simultaneously reduces the normal pressure on the skin.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57890/cg58029

Symposium: Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3550-716]

Limitations in the Application of Linersystems

Author
Brückner, Lutz (Bad Klosterlausnitz DE) | Priv.-Doz. Dr. med. habil.
Moritz-Klinik Gmbh & Co. KG - Orthopädie / Unfallchirurgie

Introduction
Liners, now more frequently used for upper and lower extremity prostheses have-if indicated-indeed their place.This statement however can be misleading.There are
problems with liner fittings often not recognized or not fully realized.One can therefore state that the routine or incorrect use of liners can lead to a negative outcome for the amputee.

Results
The use of liners can cause:
-skin problems (suspension problems)such as irritations, listers, pimples, boils, ulcers, excessive patella pressure
-the thought of providing a soft tissue substitute or compensation is only marginally possible
-stump scars often permit unfavourable air intake
-not all socket-liner sytems are suitable, particularly in the presence of excessive soft stump tissues (Contra-indication:fitting an excessive soft tissue stump with a shuttle system)
-the distal shape of the liner, particularly in transtibial amputations, does not match the shape of the stump. This results in reduced proprioception.
-Noteworthy here is the fitting of a liner with a pin (Iceross prcedure).The sockets are insufficiently fitted and thus cause instabilities.
-during prologed sittig periods liners press into the hollow of the knee and thus compromise the blood/ lymph circulation resulting in stump size changes
-a thick liner (6mm) causes the feeling of"swimming"

Conclusion
Contraindications:
-poor hygiene
-non-endbearing stumps (too sensitive)
-possible functional upper extremity restrictions which could cause problems when dressing
-Cortisone treatment affecting stump circumference and skin alterations
-stump too long, therefore insufficient space for a shuttle system
"The fitting of a liner is a possibilty but not a solution for every situation" (B. Sippel, 2007)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57890/cg58066

Symposium: Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3552-878]

Special Liner Fittings for Transtibially Amputated Patients

Author
Gawron, Olaf (Heidelberg DE)
Pohlig Orthopädie-Technik, Niederlassung Heidelberg - Prothetik untere Extremität

Introduction
For the management of transtibially amputated patients there are various ready-made liners of different materials. From the economical point of view of a prosthetic management we should
first consider if a successful management can be achieved by using industrially manufactured
types of liners. Only if during this reflection no satisfying solutions can be found individual adaptations of the liners should be made or individual silicone liners be manufactured. Special techniques of fitting can also be applied in combination with liner systems. For example a partly flexible design of a prosthetic socket may significantly improve the socket comfort of a transtibial prosthesis. From the point of view of the authors there are four different procedures to achieve special possibilities of fitting.

Methods
1. Ready-made copolymer liners can be individually molded in the heating furnace at around 80°C. That way, flat grained reliefs can be effected or the liner can be lengthened or upset in order to adapt it to special shapes of the stump.
2. Quite often stumps, due to scar indentation or an insufficient soft tissue covering, have unregularly shaped tips. The other parts of the stump are shaped regularly and could be fitted with a ready-made silicone liner. In this case, a soft silicone crosslinked at room-temperature can be molded for compensation and fixed to the existing liner.
3. In case of deeper scar indentations with more complex shapes or a very low soft tissue
covering in the area of the stump tip an alternative is the fitting with a partial siliconegel protective element for the soft embedding and/or the compensation of defects in case of distinctive scar reliefs.
4. Fittings with individual silicone liners.

Results
Experience shows that in the management of transtibially amputated patients we normally first try to apply a ready-made liner, if necessary in a modified version. Individual silicone liners should only be applied if standardized and modified liners do not correspond to the shape and the demands of the stump. Indications for this procedure are the existence of scar indentations and scar channels on a large part of the stump surface or extreme stump shapes. A significant advantage of the individual liner technology is the fact that the flexion area in this variant can be designed freely, which, in comparison with traditional liner variants, makes an increased flexion possible. The manufacturing of an individual silicone liner may also correspond to the desire of the user for an aesthetically nice outward appearance of the prosthesis which should be as slim as possible.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57890/cg58104

Symposium: Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3548-696]

Overview and Range of Application for Common Linersystems

Author
Thiede, Klaus Frederik (duderstadt DE)
Otto Bock HealthCare GmbH

Coauthors
Bernd Sibbel (OTM) Bundesfachschule für OT

Abstract
Many different liner systems are available on the market. The lecture will give an overview of the various liner and connection systems, and a recommendation for the patient specific selection.

Introduction
Due to the diversity in the liner range the prthethetists are increasingly placed on the problem to choose the appropriate liner and connection system for their patient.

Methods
Based on long time experience with transtibial amputees we developed a system to classify the current liners systems according to their materials and connectivity.

Results
The mean selection criteria are soft tissue properties and individual demands on safety and handling.

Conclusion
Careful examination of the stump and a thorough survey of the patients need make it easier to come to a decision about the best liner system for a transtibial amputee.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg57890/cg57992

Symposium: Possibilities and Limitations in the Application of Linersystems for Transtibial Amputees
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3629-737]

Advantages and Disadvantages of Liner Use in Trans-Tibial Prostheses on the Base of a Literature Review and Practical Experience

Author
Baars, Erwin C.T. (Zwolle NL)
Vogellanden Center for Rehabilitation - Vogellanden Center for Rehabilitation

Abstract
Topics reviewed are among others: patient comfort, skin reaction to the liner, functional benefits and donning and doffing of the liner prosthesis. I have studied the last topic in relation to hand function of the amputee.

Introduction
Since the 1980's the silicon liner socket has been increasingly used in the transtibial prosthesis. In practice these liners give a more secure fit of the stump in the socket and also the producers of the liners propagate advantages in their use for example better suspension of the prosthesis, protection of the stump skin and improved cosmetic appearance of the prosthesis. However clinical experience also shows that liners can cause skin irritation for example blistering, folliculitis and yeast infection. This is partly caused by problems with donning and doffing of the liner. Adequate donning and doffing requires a sufficient hand function while insufficient hand function can cause air entrapment between the liner and skin resulting in blister formation (1). We performed a review to find objective documentation in the literature in support of the advantages in prosthetic fitting and use of silicon liners (3). We also performed a retrospective study in relation to hand function and skin problems in

Methods
A Medline search was performed with the key words: "silicon liner socket, Icelandic Roll On Silicon Socket (ICEROSS), trans-tibial prosthesis, lower leg prosthesis and stump sockets". In relation to the hand function and liner use we studied the medical charts of 60 patients with a knee disarticulation (n=10) and trans-tibial (n=50) amputations.

Results
In the literature search, after application of our selection criteria, six studies remained for further investigation. In only two studies clinical examination was done while in the rest questionnaires were used to collect data. The indication for amputation varied from vascular insufficiency, diabetes mellitus, infection and trauma. Most studies mentioned improved prosthetic suspension compared to the conventional supracondylar fitting. Also the walking performance improved with less use of walking aids. There were reports of positive and negative effects on the stump skin for example excessive perspiration and itching. Patients had a general preference in prosthetic appearance in favor of the prosthesis with a silicon liner. Regarding hand function we found that patients with an impaired hand function had more stump skin problems in the liner prosthesis.

Conclusion
Liner use in the trans-tibial prosthesis gives better suspension of the prosthesis but can also result in stump skin problems, especially when the patient has impaired hand function.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3875-None]

Amputation of the Upper Extremity and Healing of the Residual Limb

Session Chair
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg756018

Symposium: Amputation of the Upper Extremity and Healing of the Residual Limb
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3877-899]

Conventional and Current Amputation Techniques

Author
Baumgartner, René (Zumikon CH) | Prof. Dr. med.

Introduction
Scars are to be placed at the dorsal side of the stump in order to offer full sensation to the important tip of the stump.
Due to the limited overall number of upper extremity amputations, statistically evident numbers of long term results are lacking.
In the upper extremity, there are no “useless” areas or those making prosthetics impossible. Only in severe arterial occlusive diseases such as Buerger-Winiwarter, disarticulations better be avoided.
This philosophy means that the prosthetist will have to deal with stumps he may not be prepared for. Disarticulations create long bulbous stumps which are difficult to fit with the usual components. On the other hand their bulbous shape permits an excellent total contact socket, leaving the elbow or the shoulder joints completely free.
Ultra short carpal or ulnar stumps present another challenge to the prosthetist. These levels save important joints, but their lever is extremely short. This makes fitting with a rather heavy myoelectric prosthesis diff

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Symposium: Amputation of the Upper Extremity and Healing of the Residual Limb
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3878-None]

Amputations in Cases of Tumor

Author
Streitbürger, Arne (Münster DE) | Dr. med.
Klinik und Poliklinik für Allgemeine Orthopädie

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Symposium: Amputation of the Upper Extremity and Healing of the Residual Limb
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3879-None]

Measures to Improve Healing of the Residuum

Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3677-None]

Foot & Shoe - Biomechanics, Age and Woman

Session Chair
Soares, Denise (Porto PT) | Ms
University of Oporto - Laborathoty of Biomechanics - Sports School

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Session: Foot & Shoe - Biomechanics, Age and Woman
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3191-378]

An Experimental Study of Influence of Wedged Insoles on Forefoot Plantar Pressures

Author
Ban, Masuhara (Kyoto JP)
Sakamoto co., ltd. - Research and Development

Coauthors
Sakamoto A

Abstract
The objective of this study was to investigate the influence of various wedged insoles on forefoot plantar pressure values. Forefoot plantar pressure values were measured under using 3 different types wedged insoles during static standing / dynamic walking compared with a barefoot value as control.

Introduction
The wedged insoles are often used for the conservative treatment of the medial compartment osteoarthritic knee. Yasuda and Sasaki[1] reported the latelal-wedged insoles decreased the tensile force in the lateral collateral ligament and iliotibial tract and the resultant compression force that affected the medial joint surface of the tibia was reduced. Ohata and others [2] reported that lateral wedged-insole caused the COP(center of pressure) to move laterally and to generate a change in activity of the peroneous longus from electromyographic data. However studies regarding the influence of the wedged-insoles on forefoot plantar pressure are still a few.
This report describes experimental results of change in shifts of forefoot plantar pressure and reaction force among 3 types of wedged-insoles during a static standing / a dynamic walking compared with a barefoot as control. The results were analyzed using in an ANOVA.

Methods
8 healthy men [mean age 28(SD 4.7) years; mean mass 66.2 (SD 12.9) kg; mean leg-heel-alignment valgus 2.3/2.6 (SD 0.9/1.3) deg (L/R)] were explained of the aim of this study and informed consents were obtained from each subject.
[Exp. 1: Static tests]
The subjects were in a static standing posture on the EMED platform (Novel GmbH) set on the half of a walkway (width x length=0.9 x 8.0m) under testing conditions: (1)control: barefoot[BF], (2) 7mm lateral wedge [LW], (3) 7mm lateral wedge with arch support[LW+A], (4) 7mm heel lift wedge [HW]. The pressure and force value were normalized by the BF mean as 100 and compared.
[Exp. 2: Dynamic tests]
The subjects were walking along the walkway with the same insoles in the Exp. 1. An index IF is acquired by Force-Time-Integral (FTI) in 1 walking cycle which is normalized by the BF mean as 100.
In Exp. 1 and 2, the subject repeated measurements 3 times with each insole. The forefoot of left foot was divided into three distinct areas.

Results

The SPSS was used for statistical analysis. For analysis of mean values such as pressure, reaction force and IF, Dunnett's t-test as multiple comparisons ANOVA was used to find significant differences between control (barefoot) and test values(with test insoles) and the criterion for significance was $P < 0.05$.

In the results of Exp.1, there was significant difference ($P<0.05$) in the LW and HW compared with BF in M01 area, where the force increased (fig. 1). Therefore, the force increased according to the direction of wedge inclination.

There was significant difference ($P<0.05$) in LW+A compared BF in M02 area, where the pressure reduced. The reason was thought to be that increased total contact area by the arch support reduced the forefoot pressure.

In the results of Exp. 2, the IF increased in LW compared with BF in M02 area, while IF decreased in the M03 area (Fig. 2).

In this case, compensatory movement or inertia of the lower extremity during walking may have shifted the main loading area from M01 to M02.

There was significant difference ($P<0.05$) in LW+A compared BF in M01 and M03 area, where the IF reduced as the same reason of the Exp. 1 was thought.

There was no significant difference in HW compared BF in all area, although the IF of HW was lower than LW in M02 but higher in M03. Therefore the effect of directions of wedge inclination was thought to have influenced the distribution of the IF again as in the Exp. 1.

Conclusion

The forefoot plantar pressure under using 3types of wedged insoles standardized by the barefoot value were, measured during a static standing / a dynamic walking.

In the static condition, estimated reaction force calculated by pressures was increased in the direction of wedge-inclination, while the pressure values decreased when lateral wedged with an arch support was used.

In the dynamic condition, the loading variation with an index IF in 1 walking cycle calculated by FTI was evaluated. When using lateral wedge insole, IF value increased in the medium area of forefoot. On the other hand, IF value decreased in the lateral area of forefoot when using lateral wedged insole with /without arch support. IF values of a heel lift wedged insoles showed different distribution pattern from a lateral wedged insole.

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Session: Foot & Shoe - Biomechanics, Age and Woman
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3333-508]

Reproducibility of Measurement Results from the Plantar Pressure Distribution

Author
Bayyurt, Jan (DE) | Kand. ing. & Kand. ing.
university of applied sciences münster - orthopedy

Author
Körber, Martin (Münster DE)

Coauthors
Bayyurt JC, Körber M

Abstract
The reproducibility of measurement results from the plantar pressure distribution was analysed for 2 test subjects. The results showed a high variability for the individual sensors of a measuring sole. Reproducibility is improved when major surface areas with a larger number of sensors are analysed.

Introduction
The idea for this study arose whilst performing plantar pressure measurements with the T&T Medilogic Foot Pressure Measurement System. The question of reproducibility arose as a result of unexpected results coming from individual sensors. Rather than providing similar values over a range of experiments, variability was observed even within individual experiments.
This question therefore brought about the objective of the study. Experimental results were analysed to determine if, and to what extent, the results of individual sensors are reproducible and how the behaviour of the reproducibility changes if larger regions of the foot are considered.

Methods
Two male subjects participated in the study, which consisted of 3 series of 5 separate measurements. To analyze reproducibility, the subjects' shoes were removed between each measurement and the measuring soles were repositioned. The subjects worn the same shoes in all test series and the lacing of the shoes was not changed between the measurements.
The foot pressure measurement was done on a straight, 10 meter long measuring track, which was supplemented by a start-up and run-off area. A metronome and webbing band between the subjects' ankles were used to eliminate irregularities in the subjects' pace and stride. Rosenbaum et al. (1994) and Drerup et al. (2001) showed that variations in walking speed tend to change the plantar pressure.
Two different methods were used for the data analysis. The measurements were compared using variation coefficients and a variance analysis of the maximum pressure observed in each individual footstep.

Results
It was found that the measurement of average pressure in both the hallux area and in the area of the minor toes has a large variability on both sides. A large variability in the results of single sensors was also observed in the area of the medial metatarsus and the heel area on both sides. Furthermore, it was observed that the values of the mean pressure vary greatly at the edges of the measurement sole.

The coefficients of variation of the maximum pressure values show a large variability in the hallux area, in the area of the minor toes, and in the area of the metatarsus. An extremely large variability was observed in the boundary zones of the imprints.
The coefficients of variation were calculated for individual regions of the foot and it was determined that the variability between the individual measurements was reduced. This increase in reproducibility was attributed to the use of an average that was taken over a range of sensors.
The results of the analysis of variance showed that the distribution of the sensors is quite inhomogeneous, which made the identification of regions with a high degree of variance difficult. It is hypothesised that the arrangement and density of sensors in the measurement soles contributed to the variance observed in the results.

Conclusion

It was shown that measurement results based on one single sensor are not meaningful for analysis and evaluation. This was particularly evident at the edges of the measuring sole and in areas where variability arises due to movement of the measuring sole, slipping of the foot, and alternating strain during each footstep. The analysis of results using foot regions compensates for the local measurement differences of single sensors.
The variance analysis showed that the maximum pressure values also differed substantially in single measurements.

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Zhu, Hongsheng et al.: Walking Cadence Effect on Plantar Pressures.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg229786/cg43906

Session: Foot & Shoe - Biomechanics, Age and Woman
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3099-297]

Womens Experiences of Wearing Therapeutic Footwear - a Qualitative Investigation

Author
Williams, Anita E. (Salford GB)
University of Salford - Centre for Rehabilitation and Human Performance Directorate of Podiatry

Coauthors
Nester CJ, Ravey MI

Abstract
Specialist therapeutic footwear is provided for people with rheumatoid arthritis. Despite the known clinical benefits there remains a problem of low usage. This study used a qualitative approach to gain deeper insight into this problem than previous work.

Introduction
Specialist ‘therapeutic’ footwear is recommended for patients with diseases such as rheumatoid arthritis (RA) as a beneficial intervention for reducing foot pain, improving foot health, and increasing general mobility (Williams, Rome and Nester 2007, Fransen and Edmonds 1997). For this footwear to achieve good clinical outcomes, it has to be worn frequently enough. However, many patients choose not to wear this footwear despite attempts to involve patients in the design of this footwear, (Williams and Nester 2006) ending up as shoes in the cupboard (Williams and Meacher 2002)
If patients reject this footwear once it is provided then there is potentially a huge waste of resources both in the cost of the footwear itself and the practitioner’s time in providing it. This is of particular concern as increasingly, guidelines recommend its provision (NICE 2009)

Methods
The aim of this study was to explore RA patients’ (womens) feelings and attitudes in respect of their experience of therapeutic footwear, service delivery and of the clinical interaction/consultation with the practitioner. Further to this, to explore how these factors may influence the patient’s degree of engagement in the use of specialist therapeutic footwear. The study took place at three sites in the UK, Netherlands and Spain in order to explore potential differences in patients experience dependent on country.Following ethical approval, thirty females with a definite diagnosis of RA (Arnett et al 1998) were recruited as participants (10 from each site). Conversational style interviews were carried out with these. An interpretive phenomenological analysis of the transcripts was carried out to identify themes.

Results
The analysis revealed main themes that were common to all three groups. These were the participants’ feelings about their feet in relation to their changing appearance, feelings about their footwear, behaviour associated with the footwear, their experiences of the practitioner/s involved in providing the footwear. and their feelings about what would have improved their experience. Both positive and negative aspects in respect of their experience were revealed in relation to these themes. However, negative feelings such as sadness, anger, disappointment and loss were reported by the majority of cases, even by those who were wearing their footwear. A small number were satisfied overall, however the majority reported ‘gratefulness’

for something being tried rather than absolute satisfaction with the footwear and the process of it being provided.

Conclusion

Unlike any other intervention specialist therapeutic footwear replaces something that is normally worn and is part of an individual's perception of themselves and public perception of self. It has much more of a negative impact on the female patients' emotions and activities than previously acknowledged and this influences their behaviour with it. Further to this, the patients' consultations with the referring and dispensing practitioners are crucial in the patients whole experience of being provided with this footwear and appears to influence whether the patients chose to wear the footwear or not. Information, discussion and choice along all the pathway to provision of this footwear influences the patients feeling of being important and hence the importance that they assign this footwear.

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Session: Foot & Shoe - Biomechanics, Age and Woman
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [2909-107]

The Association between Patients Expectations and the Use of Custom-Made Orthopaedic Shoes

Author
van Netten, Jaap (None NL) | MSc.
Center for Rehabilitation, University Medical Center Groningen - Department for Rehabilitation Medicine

Coauthors
Jannink MJA, Hijmans JM, Geertzen JHB, Postema K.

Abstract
Expectations that were not met by the outcomes were associated with non use of custom-made orthopaedic shoes (OS), whereas expectations per se were not associated. This indicates that it is essential to keep patients expectations realistic, in order for OS to be used.

Introduction
The association between patients' expectations and the use of custom-made orthopaedic shoes (OS) is not clear [1,2]. It is known for other assistive technologies that realistic expectations promote use, and that non use is higher when expectations have not been met [3,4].
In accordance with this, discussion about the expectations, and adjustment of expectations to realistic ones, is regarded as a key part of the prescription process. The importance of discussion of patients' beliefs and expectations is also stressed in the literature [2,5].
The purpose of this study was: 1) to investigate the association between expectations and the use of OS, and 2) to gain insight in the frequency of discussion of patients' expectations during the prescription process, and the adjustments of patients' expectations afterwards.

Methods
A prospective cohort study with internal comparison was conducted in 12 orthopaedic shoe companies in the Netherlands.
To investigate patients' expectations and the discussion thereof, the Monitor Orthopaedic Shoes was used. This is a specially developed questionnaire that consists of a pre and a post part. The pre part was handed over during the visit were foot measurements were taken, the post part was sent to patients three months after delivery of their OS.
339 patients who completed both the pre and the post part were included (response rate: 67%). Mean age was 63 ± 15 (SD) years; 38% were male. 85 had diabetes mellitus, 60 rheumatoid arthritis, 237 a (not further specified) foot disorder, 23 a (neuro)muscular disease, and 104 another disorder. Disorders were indicated by patients themselves, and it was possible to indicate more than one disorder.
Differences between the groups were assessed with a Chi-square and a Kruskal-Wallis test.

Results
Three months after delivery of OS, 81% (n = 275) of the patients used OS frequently (4-7 days/week), 13% (n = 43) used OS occasionally (1-3 days/week), and 6% (n = 21) did not use OS.
There was no association between patients' expectations of the effectiveness or cosmetics of OS and the use of OS (p-values range from .134 to .607).

A large negative discrepancy (experiences were lower than expectations) was found in patients who did not use their OS, whereas almost no discrepancy (i.e., expectations and experiences were the same) was found in patients who did use their OS frequently or occasionally (p-values range from <.001 to .012).
During the prescription process, 73% of the patients discussed their expectations with the orthopaedic shoe technician. Of these patients, 57% had higher expectations afterwards, 3% lower, 27% did not change their expectations, and 13% had no expectations before. There were no differences between frequent, occasional, and non users.

Conclusion

The results of this study indicate that expectations that are not met by the outcomes are associated with non use, and that realistic expectations are associated with use of OS. Expectations per se were not related to the freuqnecy of use of OS. This indicates that it is important for prescribing specialists to make sure that patients' expectations are realistic.
When expectations have to be kept realistic, discussing them is essential. However, the results of this study also show that expectations were discussed with only 73% of the patients. Further, when discussion did take place, it led to higher expectations in more than half of the patients. This is a potential risk of because of the negative effect of unmet high expectations.
Discussion with patients which lead to realistic expectations may be an important area for improvement in the prescription process of OS.

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Session: Foot & Shoe - Biomechanics, Age and Woman
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Foot and Shoe | Subtopic/Track: Foot and Shoe

Congress Lecture [3442-617]

The Influence of Different Wedges in Elderly Gait Kinetic Parameters

Author
Soares, Denise (Porto PT) | Ms
University of Oporto - Laborathoty of Biomechanics - Sports School

Coauthors
Mendes EA, Castro MP, Sebastião RA, Machado LJR, LaFortune MA

Abstract
The purpose of this study was to investigate the influence of different wedges in elderly gait kinetics. Six kinds of wedges were used, in a sample of 17 subjects. Each subject walked over the force plate wearing each one of the wedges. The results showed that the influence is individual.

Introduction
The use of insoles as an auxiliar in small gait deviations is a common practice. From the analysis of the influence of the different parameters that constitute an insole, it is possible to apply these results to build insoles adequate to individuals with different diseases (Kerrigan et al, 2002). In the literature, there is no consensus about the influence of different wedges in the pattern of normal gait (Van Gheluwe et al, 2002). Considering that 11% of the elderly population has problems with mobility (Guccione et al, 1990), and that the use of insoles in the individuals shoe can influence decisively the quality of his gait (Kerrigan et al, 2002), the gait analysis of the elderly health population is fundamental to constitute a control group to the analysis of the influence of different factors that constitute the building of an adequate insole for different necessities.
So, the purpose of this study is to analyze the influence of different wedges in physically active elderly gait.

Methods
19 subjects (mean age 67 years old ± 8, 56) and physically active (SF36 physical function 82, 33 ± 18, 01) were asked to walk on a 8 m walkway, passing over a Kistler® force plate wearing their own shoes at a self selected speed. After a short adaptation, each subject walked three times wearing the shoes only and, after that, with each wedge inside the shoe, randomly selected.
The wedges were made of poliuretan cushion in six different shapes: two lateral, placed under the 5º metatarsal head (1L: 1cm) and (2L: 2cm), two medial placed under the foot arch (1M: 1,1 cm) and (2M: 2,2cm), and two posterior (1P: 0,9cm) and (2P: 1,8cm), placed under the calcaneous.
The kinetic data were recorded using the Simi Motion System, in a frequency of 1000hz. The values of Fx, Fy and Fz peaks, duration of stance phase and resultant force impulse were collected using MATLAB routines specifically developed.
The data were analyzed using SPSS software version 17.0.

Results
Differently from other studies, the results showed that there are no significant differences in the kinetic parameters anayzed. This can be due to the fact that there is a great variability in some data, and that the subjects are well trained and can adapt their gait to the new situation. Analyzing the data individually, it

is clear that each subject has a different adaptation to the wedges, in cases increasing the values,and in other cases decreasing, showing that the adaptation is an individual process.
Kinematic and padoborometric parameters should be analyzed to show a better overview on the influence of the wedges in gait parameters.
Other possible reason is that they used their own shoes to perform the trials, then the wedge inside the shoe is not variable enough to show differences.

Conclusion
According to the results, it is possible to conclude that adapatation to different wedges is an individual process, and depends not only on the height and position of the wedge, but also to the individual capability to adaptation.

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Image: force data_None.jpg (see online)

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3666-None]

Lower Limb Prosthetics - Functional Knee Components 2

Session Chair
Andrysek, Jan (Toronto CA) | Dr.
Bloorview Kids Rehab - Research Institute

Session Chair
Mukul, Pooja (DE) | Dr.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223303

Session: Lower Limb Prosthetics - Functional Knee Components 2
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2985-183]

Progressive Brake Activation and Release in a Weight Activated Mechanical Knee Prosthesis

Author
Ochoa, Juan (Basingstoke UK) | MSc
Chas A. Blatchford & Sons Ltd. - New Products Development

Coauthors
Zahedi Z

Abstract
Conventional weight activated knee prostheses rely on a self-locking mechanism to create the required stability during stance. A new joint has been developed, in which the brake moment depends only on the load magnitude and position, thus producing a natural and symmetric gait.

Introduction
Weight activated mechanical knee joints depend on friction to provide the required flexion resistance during the stance phase of the gait cycle. In most of the commercially available models, the compressive load on the joint is amplified by a self-locking mechanism, in which once a minimal amount of friction is established in the brake, the flexion moment applied to the joint helps increasing the braking moment. This produces a self-sustained brake moment, which remains present even when the load has been withdrawn. In order to release the brake to initiate flexion, the knee moment has to be eliminated, and then the load reduced below the threshold level. The consequence is generally an unnatural gait pattern.
A knee joint was developed in which the brake is activated by the load magnitude and position relative to the knee axis, and the brake moment does not rely on a self-locking mechanism. This allows the patient to initiate flexion naturally as the load progresses anteriorly.

Methods
A number of options for a weight activated brake were analysed under the criteria of reliability, manufacturability, cost of production, among others, and the design with the highest score was put forward for a proof of principle model. The winning design consists of a disc of tapered cross section that engages a brake member with corresponding contact surfaces, so as the activation force in the disc is magnified several times by the wedge effect of the acute angle.
Preliminary models were constructed in order to test the brake moment produced by different wedge angles and materials. Once the optimum combination was found, a series of prototypes were constructed and refined up to a clinically acceptable level to carry out patient trials. A total of 9 patients have been fitted with the unit, at different stages of development. Additionally, a test platform was constructed to assess quantitatively the performance of the brake and compare the new joint with other models in the market.

Results
The preliminary study of different geometries and materials showed that the best combination is a stainless steel disc with 24 degrees of tapered cross section and an aluminium-bronze brake member. This provides a good balance between brake force and clean release.
Patient trials and studies in the gait lab have revealed a number of benefits of this design when compared with other models of weight activated knees:

•The unit maintains its performance within a broad range of alignments.
• The activation of the brake at heel strike is natural and does not require any compensatory movements, even when walking down a slope.
•The degree of stability can be adjusted in the field to suit the patient's personal preferences and needs.
•The brake release occurs naturally as the load line progresses anteriorly, and requires no compensatory movements to initiate flexion.
•The overall gait is natural, symmetric and energy efficient.
The results obtained with the test platform show that the maximum brake moment in the new design is proportional to the applied load, in both activation and release. The commercially available units tested showed, on the other hand, that once the brake is activated, the self-locking mechanism provides an unlimited amount of resistance, within the limits of the structural strength of the unit. This on/off behaviour is desirable for a safety knee, but certainly is an inconvenient for an amputee with moderate to high level of activity.

Conclusion
Results from both patient trials and quantitative comparisons show the benefits of the progressive activation and release of the brake in a mechanical knee.
In this specific unit, the simple and robust design ensures ease of manufacture, assembly, fitting and maintenance, without sacrificing other aspects equally important as modularity, weight, size and aesthetic appearance.
The principle of progressive activation and release by means of a mechanism without a self-locking behaviour has been disclosed in the UK Patent Application No. 0813132.8.

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Session: Lower Limb Prosthetics - Functional Knee Components 2
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3205-391]

Functional Comparison of the Legs M1 Knee to Commonly Available Developing World Alternatives

Author
Rispin, Karen (Longview US)
LeTourneau University - School of Arts and Sciences

Coauthors
Husk C, Lew S, Schufeldt T, Ayers SR, Gonzalez, RV.

Abstract
Gait and functional characteristics were collected to compare the LEGS M1 knee a locked knee condition and a first-world polycentric knee. The LEGS M1 knee showed few gait penalties from a lower stability and amputees self reported a more satisfactory gait.

Introduction
In many developing world nations the primary prosthetic knees available to lower income transfemoral amputees are often used as semiautomatic knees kept locked in gait (Jensen and Raab 2004 and 2006). LeTourneau Empowering Global Solutions (LEGS) Prosthetic Project has developed a stable polycentric knee that can be manufactured on site in developing nations using simple tools and available materials. The purpose of this study was to quantify functional characteristics of active transfemoral amputees using the LEGS knee compared to the most commonly available alternative, a prosthetic leg with a knee kept locked in gait. Scant literature indicates that a locked knee may be more energetically efficient (Isackov et al 1986). Running legs without knees are now more commonly being proscribed in the developed world making the comparison of locked to articulating knee conditions of global interest (Menetrez and King 2007).

Methods
Subjects were nineteen transfemoral amputees from Kenya and Bangladesh (27±5.3 years 16 M, 2 F) who had worn the LEGS knee for a year or more (LEGS) ; all but four had previously worn locked knee (Locked). Each subject was tested with the LEGS knee, the LEGS knee locked with a locking jig, and eleven were tested with the OrthoEurope 4bar (OE) knee utilizing the same socket and foot. Temporal and spatial gait data were collected with GAITRite computerized gait mat. Energy cost data were collected with timed walk test (TWT) and Physiological Cost Index (PCI). Amputee input on functional parameters was collected with thirteen questions modified from the Prosthetic Evaluation Questionnaire and seven trial questions. Amputees estimated average daily time wearing the knee and distance walked. Gait spatial data was standardized to biological leg length. Gait temporal data was standardized to percent of gait cycle. Questionnaire data was normalized by standard deviation from amputee median.

Results
Paired T-tests revealed the following significant differences. LEGS was perceived to have a higher ease of swing through, more normal looking gait, less energy cost, less effort, more ease sitting down and standing up, more noise, and less standing balance than Locked. Spatial gait parameters showed a narrower heel-to-heel base of support, and greater prosthetic step length for LEGS than Locked. There were no significant differences in temporal parameters. Neither PCI nor the TWT showed significant differences between

LEGS and Locked; however, correlation analysis showed that amputee perception of lower energy cost correlated with lower PCI results.
For OE, there was no significant difference in PCI from the other knee conditions. However, TWT and prosthetic single support time were lower and double support time higher for OE than LEGS or Locked. Heel-to-heel base of support was wider for OE than LEGS, but not significantly different than Locked. For OE, like LEGS, amputees reported a higher ease of swing through, more ease sitting down, and more satisfaction with gait than for Locked. However, there was no significant difference in perceived effort or normalcy of gait between OE and Locked as there had been between LEGS and Locked, and amputees reported less walking balance for OE than either Locked or LEGS.

Conclusion

In the developing world, the appearance of disability is an extreme social and economic liability (Mitra and Sambamoothi 2008). The narrower and self perceived more normal gait enabled by the LEGS knee is of significant social value. Amputees' self reported increase in ease in swing through and ease in sitting were expected for a comparison of polycentric knees to a locked knee. A locked knee which can neither bend nor buckle was as expected quieter and more stable in stance. Currently available developing world prosthetic knees which are often worn locked can also be used unlocked by amputees able to deal with their instability. Short biological stance time and extended double stance time are known to reflect a lack of stability (Lusardi et al 2007). For these measurements, LEGS behaves more like the stable locked knee. With an approximate cost of $20 a knee, the LEGS M1 knee provides an affordable and stable articulating knee option to prosthetic clinics in low income nations.

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Session: Lower Limb Prosthetics - Functional Knee Components 2
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2980-178]

Stanford-Jaipur Knee Joint for Trans Femoral Amputees

Author
Mukul, Pooja (DE) | Dr.

Coauthors
Dr. Mukul Pooja
Joel Sadler
Eric Thorsell

Abstract
The development of Stanford - Jaipur polycentric knee have demonstrated the extreme affordability of the most advanced polycentric concept in the world. This is a major break through that would revolutionize prosthetic fitting of trans-femoral amputees.

Introduction
The most important distinction in lower limb amputees is whether the knee joint has been preserved or not, owing to the immense challenge posed by prosthetic knee replacement. Most trans-femoral amputees in India are fitted with a simple single axis knee joint, only because this is the only affordable option. The single axis knee joint presents gross limitations to gait performance, stability, energy consumption, initiating of swing, adopting the squatting posture and negotiating inclines.
Bio-design Division, Stanford University–USA in collaboration with Bhagwan Mahaveer Viklang Sahayata Samiti Jaipur has developed a Bio-mechanically advanced and affordable Polycentric Knee Joint

Methods
Following extensive fatigue, wear and failure testing and Finite Element Analysis using the resource of the Bio-mechanical Engineering Division, Stanford University – USA over 300 Stanford-Jaipur Knee Joints have been fitted to trans-femoral amputees since January 2009 at BMVSS, Jaipur.
This new design was the results of extensive computerize studies and the trial on patients in Jaipur.
After studying different materials for making these joints in bio design lab, the Stanford team suggested that these joints should be made with Nylon-66. They further recommended Nylon-66 with element of Oil was even more preferable. Accordingly Matelon, a variant of Nylon with self lubrication is the material being used for making these joints

Results
Field trials over six months have demonstrated bio mimetic i.e. gait of the patients while walking is like that of a normal person.
An enhanced stability during stance, ease of initiation of swing, full extension at heel strike and a range of motion of 160 degrees which permitted squatting were observed in 300 patients. Failure was encountered in only 3 patients. It may be mentioned here that many of the amputees, who were earlier using single axis joints, now fitted with polycentric joint indicated far more comfortable and natural gait with this knee joint.

Conclusion
The development of Stanford - Jaipur polycentric knee have demonstrated the extreme affordability of the most advanced polycentric concept in the world. This is a major break through that would revolutionize

prosthetic fitting of trans-femoral amputees. With the further changes, some of which may find acceptance, the joint may turn out to be even better.

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Session: Lower Limb Prosthetics - Functional Knee Components 2
Friday 2010/05/14 | 15:00 - 16:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3133-331]

A New Stance-phase Controlled Prosthetic Knee Joint for Low-income Countries

Author
Andrysek, Jan (Toronto CA) | Dr.
Bloorview Kids Rehab - Research Institute

Coauthors
Andrysek J, Abarca G, Heim W, Torres-Moreno R, Castaneda M, Mena E, Zelaya C, Trebbin H

Abstract
The development of a novel stance-phase controlled polymer injection moldable prosthetic knee joint for low-income countries is being presented. Prototypes of the knee joint were clinically tested indicating reliable stance-phase control and improved gait performance for the users.

Introduction
In low-income countries the need exists for prostheses that are functional, adaptable to local environments and climates, maintainable locally and affordable to the end user [1,2]. For a prosthetic knee joint, overall function is largely dependent on the effectiveness of the control mechanisms. When these mechanisms involve simple and robust designs, coupled with the use of conventional materials and manufacturing processes, durable and cost effective prosthetic devices can be achieved. The work presented relates to the development of a novel stance-phase controlled polymer injection moldable knee joint. During gait, as the knee joint extends it automatically locks, providing stability during weight bearing. In late stance the knee unlocks due to a forefoot loading and a hip flexion moment allowing for initiation of swing-phase flexion. Prototypes of the knee joint were manufactured and structurally tested to the ISO10328 A100 standard and an initial clinical evaluation was performed.

Methods
Five participants with unilateral above-knee amputations were recruited from a clinic in El Salvador. They were between 16 and 38 years old and used their prostheses on a daily basis. All had modular prostheses and SACH feet. Four used weight activated knee joints (3R15, Otto Bock) and one a 4-bar knee joint (3R36) (here forth conventional knees). Testing was initially performed on the conventional knees and then the prototype knees which were fitted to the subjects' existing prostheses. Walking trials and a custom questionnaire were used to evaluate gait and overall performance. The walking tests included the 2-minute walk test during which heart rate was measured. The physiological cost index (PCI) was calculated. Self-selected and fast walking trials were also performed over a 20 m course to evaluate speed. The questionnaire included items relating to performance, technical issues and overall satisfaction. The non-parametric Wilcoxon signed ranks test was applied for the analysis.

Results
In terms of the functional outcome measures, for the 20-meter walk tests all subjects walked faster with the prototype knee joints. Across subjects, the mean self selected walking speed for the conventional knees was 0.92 m/s compared to 1.07 m/s for the prototype knees, a 14 % increase ($p<0.05$). The mean fast walking speed also increased with the prototype knees by 7.6 % from 1.18 m/s to 1.28 m/s. For the 2-minute walk test, mean walking speeds were again higher for the prototype knees, on average by about

6.2 % or 1.22 m/s compared to 1.30 m/s. However, this was accompanied by an increase in the PCI of 6.1 %. From the questionnaire the subjects indicated their satisfaction with the prototype knee because it provided added safety. The participants also felt that it improved their gait. Long-term testing is currently underway. To date, the participants have been using the new knees for between one and four months and reported technical issues have all been minor thus far. They include the wearing down of an extension bumper (n=1) and foam getting caught in the lock causing it to temporality not work properly (n=1).

Conclusion

A new stance-phase controlled prosthetic knee joint has been developed. The knee joint is intended to facilitate safe and natural gait, and overall good function for active individuals with amputations. The knee joint is based on a simple design and is injection moldable to provide a durable, reliable and low cost component. Initial clinical testing is currently under way. Preliminary results suggest improved gait function with the prototype knee in terms of faster walking speeds when compared to other “low-cost” knees. Initial results also suggest that the prototype knee may provide more reliable stance-phase control especially on more challenging terrains, thus resulting in fewer incidents of stumbles and/or falls. As part of future work, long-term testing will be performed on a larger sample size to further evaluate the potential application of this technology in regions of the “developing” world where highly functional and affordable prostheses are needed.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3821-None]

Paediatric Prosthetics and Rehabilitation

Session Chair
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg543185

Symposium: Paediatric Prosthetics and Rehabilitation
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Children

Congress Lecture [3822-781]

Prosthetic Management of the Lower Limb Deficient Child

Author
Murray, Kevin (Glasgow UK) | Dr.
University of Strathclyde

Abstract
The symposium will discuss the management of upper and lower limb deficient children as a result of both congenital absence and acquired amputation. The development of a paediatric service along with the additional demands on the MDT will also be presented.

Introduction
Presentations will be from a clinical viewpoint and will include medical history and assessment of a wide variety of conditions. Prosthetic prescription criteria will be presented along with a wide variety of case histories to illustrate the clinical problems encountered and the prosthetic solutions available to the practicing clinician.

Conclusion
The development of a paediatric prosthetic clinic along with the importance of a multi-disciplinary team approach will be presented. The role of parent support groups will be discussed.
The epidemiology of this patient group in the United Kingdom will be presented. Specifically, current trends in the management of lower limb deficient children will be presented through a series of case studies covering a wide range of conditions including Tibia and/or fibular aplasia, multiple congenital anomalies, proximal femoral focal deficiency, meningococcal septicaemia. Stump revisions due to growth and development of bone spurs will be discussed.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg543185/cg543780

Symposium: Paediatric Prosthetics and Rehabilitation
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Children

Congress Lecture [3823-766]

Congenital Deficiency and Childhood Amputations - A Formidable Challenge

Author
Morrison, David (GB)
WestMARC

Coauthors
Alison Morton [Prosthetist],, Barry Meadows [Bioengineer] Helen Scott [Physiotherapist]

Introduction

Introduction
The optimal rehabilitation of children with a congenital limb absence or an acquired amputation presents even experienced clinicians with a formidable challenge. There are many factors which make it more difficult to acquire the necessary expertise in this particular field.
Congenital Limb Absence
Congenital limb absence, particularly of the lower limb, is a relatively rare condition. In the majority of cases the causation remains unknown. Not only does the nomenclature used fail to give any indication of the severity of the condition, but it also may distract from relevant associated but less obvious abnormalities. There may be several complex classifications of a particular condition leading to problems of comparison. Surgical, prosthetic and rehabilitation regimes are therefore diverse and complex. Childhood amputations for acquired conditions also present age specific factors which influence the rehabilitation process.

Results

Multidisciplinary Approach
Recognising the truly formidable challenge posed by this patient group we recently adopted a more comprehensive multidisciplinary assessment procedure. In particular we implemented a fuller musculoskeletal assessment and increased our focus on biomechanical issues. Despite pre-existing high patient satisfaction rates and relatively high quality of life scores we identified previously unnoticed musculoskeletal, biomechanical and prosthetic problems. Several of these problems were able to be addressed with a positive outcome

Conclusion

Presentation
This paper outlines the formidable challenge presented by congenital limb absence and childhood amputation. It further explores some of the questions that need to be asked, and some of the resource issues that need to be addressed, if we are to optimise the rehabilitation of these unique young people.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg543185/cg543979

Symposium: Paediatric Prosthetics and Rehabilitation
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Children

Congress Lecture [3824-768]

Prosthetic Management of the Upper Limb Deficient Child

Author
MacEachen, Vincent B. (Glasgow UK)
Southern General Hospital, Glasgow - West of Scotland Mobility and Rehabilitation Centre

Abstract
It is important to have clear understanding of the aims the child's treatment. However with developing children experiencing changes in life, the prosthetist may therefore modify that treatment to achieve a goal.

Introduction
On treating paediatric upper limb deficient children, one faces many questions: would the child benefit from a prosthesis; why are we fitting the prosthesis; when is the right time to begin treatment; and what is a suitable prescription?

Methods
There are different factors, and milestones, which influence prosthetic intervention throughout the child's life. Paediatric prosthetics is a unique field. The clinician must work closely with the family. Children grow; their interests change and refine. The prosthetist has different options available with respect to socket type and materials, and control mechanisms and componentry.
The prosthetist has limited control on the age of referral of the child, which can effect the outcome of the rehabilitation. This reinforces the importance of a multidisciplinary approach with the parents and the child, especially at the initial examination. A child born missing a limb does not feel the sense of loss and special mention must be given where prosthetic intervention may be disadvantageous. When there is a considerable rejection rate, as there is in this demographic, one must consider exactly what is a satisfactory outcome?

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg543185/cg544178

Symposium: Paediatric Prosthetics and Rehabilitation
Friday 2010/05/14 | 15:00 - 16:30 | Subtopic/Track: Children

Congress Lecture [3825-801]

The Role of the Occupational Therapist in Paediatric Prosthetics

Author
Thomson, Lynsey (Glasgow UK)
WestMarc Southern General Hospital - Prosthetics and Surgical

Abstract
The role of the Prosthetic Occupational therapist with children with congenital or acquired limb absence involves team working, a developmental approach and providing a link between the child/family and the prosthetic service.

Introduction
The Occupational Therapist must work as part of a team that includes not only the child and the prosthetic team but also the parents, carers, educational staff and community therapists.

Results
The OT is involved with the child reviewing function at various stages of their development- early years, nursery/pre-school, primary and secondary schooling and moving onto adult life and career choices. The OT can still be involved if the child chooses not to have prostheses.

Conclusion
The OT provides a link for the child between the prosthetic service and the childs life outside the limb-fitting centre.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg543185/cg544377

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3645-None]

The Knee Joint in Sports

Session Chair
Schmitt, Holger (Heidelberg DE) | Prof. Dr. med.
Orthopädische Universitätsklinik Heidelberg - Leitender Orthopäde am OSP Rhein- Neckar

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg191202

Symposium: The Knee Joint in Sports
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Sports

Congress Lecture [3646-None]

Diagnostic Investigation and Therapy of Cartilage Injuries in Sport

Author
Engelhardt, Martin (Osnabrück DE) | PD Dr.
Klinik für Orthopädie, Unfall- und Handchirurgie

Co-Author
Grim, Casper (Osnabrück DE) | Dr.
Klinik für Orthopädie, Unfall- und Handchirurgie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg191202/cg191395

Symposium: The Knee Joint in Sports
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Sports

Congress Lecture [3647-None]

Diagnostic Investigation and Therapy of Ligament Injuries of the Knee Joint

Author
Zantop, Thore (Münster DE) | Dr.
Universitätsklinikum Münster - Klinik und Poliklinik für Unfall-, Hand- und Wiederherstellungschirurgie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg191202/cg191748

Symposium: The Knee Joint in Sports
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Sports

Congress Lecture [3648-779]

Prevention of Knee Joint Injuries

Author
Jöllenbeck, Thomas (Bad Sassendorf DE) | PD Dr.
Klinik Lindenplatz GmbH - Institut für Biomechanik

Abstract
Knee injuries rank among the most frequent sport injuries. So prevention has high importance in particular in contact sports and sports with high rotative loads. Prevention programs should be based on enlightenment as well as on a common and sport specific strength, balance and jump training.

Introduction
Knee joint is with a part of approx. 30% one of the most frequent with injuries affected joints. Knee joint injuries with athletes can lead to clear losses of performance and not rarely also to sport disability, because a complete recovery of strength is not or only in a limited manner possible. Contact sport as well as sport with high rotative loads shows a particularly high incidence of knee injury. The impulse acting onto the joint often also decides about it, whether a meniscus-, ligament- or cartilage/bone injury results. Therefore, it is an essential task of sport medicine and sport biomechanics to develop preventive measures which reduce the incidence of injury.

Methods
A preventive approach should be based on it, by suitable training, to stabilize the locomotion system in general and to prevent respectively to reduce movement mechanisms which promote injuries. Here the individual anatomical conditions of athletes as well as the specifically load characteristics of respective sport are to be considered.

Results
Prevention programs should contain the following elements:
a) Enlightenment of movement mechanisms which promote injuries, and information about remedy possibilities.
b) Static and dynamic strength training of knee leading musculature for stabilization of the knee joint.
c) Balance training in particular with regard to dynamical stabilization and neuromuscular activation of knee leading musculature.
d) Running and jump training in different directions with different loads and speeds, with and without change in direction, as well as with and without partner by avoidance of movement mechanisms which promote injuries and for automatization of motion patterns required in competition conditions.

Conclusion
However it is to be considered that indications of lasting effectiveness of prevention programs can only be obtained by retrospective studies dealing with modifications of the injury incidence related to training programs over a long period of training and competition. Moreover, independent of prevention programs injuries can not be completely prevented in particular under sport conditions with contact actions but be reduced perhaps with regard to their frequency and heaviness.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg191202/cg191909

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3805-None]

Treatment of Lymphedema

Session Chair
Reißhauer, Anett (Berlin DE) | Dr. med.
Charité Campus Mitte Universitätsmedizin Berlin

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg479146

Symposium: Treatment of Lymphedema
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Compression Therapy

Congress Lecture [3806-None]

Lymphedema - a Clinical Overview

Author
Reißhauer, Anett (Berlin DE) | Dr. med.
Charité Campus Mitte Universitätsmedizin Berlin

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg479146/cg479723

Symposium: Treatment of Lymphedema
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Compression Therapy

Congress Lecture [3807-833]

To Objectify Edema of the Legs Using 12 MHz Sonography

Author
Tanneberger, Amelie (DE)

Introduction
In 71 patients with chronic swelling of the legs we determined the skin thickness of the legs using 12 MHz sonography to find out, if there are any differences in skin thickness in different lymphologic diseases.

Methods
From August 2007 until April 2008 we investigated 71 patients with swelling of the legs due to different causes. The study included patients with primary lymphedema, secondary lymphedema and lipedema. At 12 points on the legs the skin thickness was measured and compared to a control group containing patients without leg swelling. Further we examined the influence of different factors on skin thickness.

Results
The patients with primary lymphedema of the legs had an average skin thickness of (ST=1,39 mm $p<0,0005$), the patients with secondary lymphedema of (ST=1,23mm, $p=0,008$). Both groups deviated significantly from the control group, whereas patients with lipedema did not deviate significantly (HD=1,11mm, $p=0,539$) from the control group (HD= 1,14mm). The influence of BMI and age on skin thickness was not significant in any of the groups.

Conclusion
The measurement of skin thickness using sonography in patients with swelling of the legs can be useful to objectify the severity of the leg swelling in addition to the clinical examination. In the furture the method could be useful to evaluate therapy and to objectify the progress of the disease.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg479146/cg479916

Symposium: Treatment of Lymphedema
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Compression Therapy

Congress Lecture [3808-810]

Deep Oscillation Unique Electromechanical Therapeutic Procedure

Author
Sporbeck, Birte (DE)

Author
Reinhold, Jens (Schnaittach/Laipersdorf DE)
PHYSIOMED ELEKTROMEDIZIN AG

Abstract
Deep oscillation (DO) creates resonant vibration through an electromechanical therapeutic procedure based on electrostatic attraction, and friction. It´s gentle non-invasive mode of action allows it to be used in various fields of therapy, including wounds, fresh injuries and acute pain.

Results
Deep oscillation (DO) is a patented electromechanical therapeutic procedure using resonant vibration of the tissue with DEEP OSCILLATION® equipment from Physiomed, Germany. A special design makes it possible, using electrostatic attraction and friction, "to produce mechanical vibrations in treated tissues of the body, not only at the skin on the surface but also in deeper tissues" (Brenke and Siems 1996). Schönfelder and Berg (1991) refer to a "penetrating vibration and pumping effect deep into the tissue". The frequency can be varied in the range from 5-250 Hz. The treatment applicator and the patient are connected to the equipment (voltage source). A vinyl film between the applicator and the patient functions as a dielectric. This results in a weakly conducting capacitative layer between the contact surfaces. In action, pulsed electrostatic attractions draw the tissue to the applicator and release it at the rhythm of the chosen frequency. The therapist sets the pressure gradient, speed and direction of the movements. The patient can treat himself if appropriate. The treatment procedure is characterised by minimal external mechanical effects, which allows it to be used in cases of acute pain, fresh injuries and in treatment of wounds. Numerous pilot studies have demonstrated pain reduction, minimisation of oedema and anti-fibrotic effects.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg479146/cg480109

Symposium: Treatment of Lymphedema
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Compression Therapy

Congress Lecture [3809-930]

An Evidence about Quality of Life in Case of Lymphedema Deficiencies

Author
Taufmann, Ines (Berlin DE) | Dr. med.
Charité - Physikalische Medizin u. Rehabilitation

Coauthors
Taufmann I., Reißhauer A.

Introduction
Improving Quality of Life is one of the central goals in disease management. However, so far little data exist on how physical therapy can improve quality of life in patients suffering from chronic lymphedema. In this report we summarize the results of two different studies. Hereby the effect of manual therapy on life quality was evaluated in patients with lymphedema of their extremities as well as patients with breast lymphedema.

Methods
69 patients suffering on primary and / or secondary lymphedema of their extremities were evaluated as well as 21 women with secondary breast lymph edema. Quality of life was evaluated using QLQ C-30 and SF8 questionnaire. Patients were examined at first contact and during follow up visit.

Results
Physical condition and social life were strongly affected in patients suffering from chronic lymphedema. In patients with limb edema there was a tendency for physical therapy to improve body function, emotional well beeing as well as pain despite of a missing significant correlation to each item. However, a significant impact on physical function and emotional well beeing could be detected in patients with breast lymphedema in the SF 8 questionnaire.

Conclusion
Physical therapy showed a tendency to improve general well beeing, body function and quality of life in patients with chronic lymphedema. However, significant effects could only be detected in a subpopulation of patients with chronic lymphedema. Therefore, further studies with higher patient numbers are needed to completly reveal the impact of physical therapy on overall life
quality.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg479146/cg480302

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3667-None]

Lower Limb Prosthetics - Biomechanics 2

Session Chair
Johannesson, Anton (Kristianstad SE) | PhD
Ortopedteknik AB - Ortopedteknik

Session Chair
Lineham, Marion (Wellington NZ) | MPP
New Zealand Artificial Limb Board - None

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979

Session: Lower Limb Prosthetics - Biomechanics 2
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3460-635]

Design of Transtibial Prosthesis for Humid Environment in Low Income Countries

Author
Quintanilla, Andrea (SV) | Orthopedic Technologist
Don Bosco University - Faculty of Rehabilitation Sciences

Author
Arevalo, Melvin (SV)
Don Bosco University - FACULTY OF REHABILITATION SCIENCES

Author
Castaneda, Monica (SV)

Coauthors
Quintanilla A, Castaneda M

Abstract
Prostheses than usually are delivered to TT amputees in Central America,aren't designed for to be used in humid environments for a long time.The existing for this purpose aren't of easy acquisition. We elaborate one design with appropriate technology that can supplement the needs in the region.

Introduction
The project responds to the necessity of the design of a transtibial prosthesis for uses in humid environment or for the realization of the activities of personal cleanliness of having amputated at this level that is accessible and of low cost.
Carried out a field investigation to know the form in that the users carry out such activities with the prosthesis that use at the moment and the different ones are analyzed alternative existent in the national and international market.
With the practical experience that counts the investigating team, the biomechanics principles and the knowledge of the materials in the field has intended a prosthesis design which will be proven in 5 users to carry out the evaluation of the design.

Methods
The investigation methodology to use in the study for the development of the project, consists on the combination of technical of field investigation, bibliographical and documental investigation.
- Prosthetic chart review: Prosthesis for use in humid environment, common materials and corrosion, etc.
- Questionnaires (Prosthetic Evaluation Questionnaire mobility subscale, Quality of Life Questionnaire) to participants.
To know the necessities of the users, to evaluate the users satisfaction with the prosthesis that has been designed in the present project.
- Protocol of elaboration: It's directed to establish one process for assure the correct elaboration of the prosthesis.
- Elaboration and adaptation of prosthesis. Fig 1

- Analysis of the results of the interviews and questionnaires on the use of the prosthesis for humid environment.

Results

- Design and elaboration of transtibial prosthesis in plastic materials of easy acquisition in the laboratories of O&P in the region.
- Five subjects who consented to participate in the use of new prosthetic were chosen from two different databases, from Don Bosco University and Instituto de Rehabilitación de Inválidos.
- The used of Prosthetic Evaluation Questionnaire (PEQ) to know the acceptance and the satisfaction with this system with regard to the adaptation of prosthetic, natural gait, stability, gait in wet floor, among others things.
- The subjects had used their prostheses for approximately 3 months before the questionnaire was completed.
- The prosthesis was used in Activities of daily living (ADL) that are in humid environments, like taking a shower and for recreation activities like swimming.

In order to improve the design we take the commentary of the users according to the activities that they do.

Conclusion

Prosthesis to accomplish activities in humid environment can be constructed at the different laboratories of O&P at the region, to a low cost and like an alternative for the users that accomplish activities in this type of environment.

Users manifest the benefit of this design of prosthesis, because allows a better integration in the society to recreational or labor activities without limitation for the kind of environment.

Its very important consider that the transtibial amputees need to feel that they continue with a normal life and for that they require the most appropriate prosthesis and that is our work.

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Prosthesis Evaluation Questionnaire (PEQ)

Image: Fig. 1_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979/cg44045

Session: Lower Limb Prosthetics - Biomechanics 2
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2847-62]

Outcomes of a Standardized Surgical and Rehabilitation Program in TT Amputation for Peripheral Vascular Disease: a 10-Year Prospective Cohort Study

Author
Johannesson, Anton (Kristianstad SE) | PhD
Ortopedteknik AB - Ortopedteknik

Coauthors
Johannesson A, Larsson G-U, Ramstrand N, Lauge-Pedersen H, Wagner P, Atroshi I.

Abstract
217 consecutive patients (mean age 77 yr), underwent TT amputation for PVD (51% with diabetes). More than half of all amputees and more than 80% of those who had walking ability prior to amputation and survive at least 3 months can be fitted with prosthesis.

Introduction
Following above-ankle amputation, several factors have been suggested to influence the rate of prosthetic fitting and amputee's mobility, and functional independence. These include age (1), gender (2), diagnosis (3), amputation level (4), postoperative management (5), amputation side and previous surgery on the amputated limb. Preservation of the knee joint is believed to be the most important factor for restoration of function,(1) and the amputee's likelihood of wearing a prosthesis has been shown to be greater following a trans-tibial than a higher-level amputation (4). The aim of this prospective cohort study was to evaluate the outcome of a new standardized treatment and rehabilitation strategy following initial unilateral trans-tibial amputation in patients with PVD with regard to the rate of prosthetic fitting, mortality and potential factors related to function with prosthesis.

Methods
217 consecutive patients who underwent initial unilateral trans-tibial amputation because of PVD at a single orthopedic department were enrolled in a prospective cohort study (Figure 1). The same standardized management procedures and protocol were used throughout the study. Orthopedic surgeons performed all amputations using sagittal flaps. A circular plaster of Paris rigid dressing was applied by the surgeon in the operating room. This rigid dressing was removed after 5 to 7 days and compression treatment with a silicone liner was started. The compression treatment was applied twice each day (morning and afternoon). Training and exercises for standing and weight bearing were started the day after surgery when possible. A prosthetic socket that is cast and made directly on the residual limb using pressure casting techniques, resulting in a volume and shape matched socket, was used (ICEX[a]). All prostheses were produced and delivered on the same visit to the prosthetic workshop.

Results
119 (62 diabetic patients) of the 217 patients were fitted with prosthesis within six month after amputation (55%). The median time to prosthetic fitting was 41 (range 12-147) days. Of the patients who received prostheses 115 (97%) had been able to walk with or without aid prior to the amputation. The first-year rate of re-amputation was 8.2% and of contralateral amputation 5.5%. The 3-month mortality rate was 24% (53 patients) and 1-year mortality rate was 40% (86 patients). The 1-year mortality rate among the patients

who received prosthesis was 17% and among those who did not receive prosthesis or were re-amputated was 67%. The overall median survival time was 587 days. Patients who could walk before amputation and received prosthesis had longer survival than patients not selected for prosthetic fitting. The median survival time for the 115 patients who could walk before amputation and were fitted with prosthesis was 1248 days and for the 102 patients who either could not walk before amputation or could walk but did not receive trans-tibial prosthesis was 108 days.

Conclusion

In conclusion, following initial unilateral trans-tibial amputation in patients with PVD more than half of all amputees can be fitted with prosthesis after a median time of six weeks and almost two-thirds have good function 3 months after amputation. Among amputees who could walk before the amputation and were fitted with prosthesis, no baseline factors were found to be significantly associated with good function with prosthesis. Of the patients who could walk with or without aid prior to the amputation and who survive at least 3 months after amputation more than 80% can be provided with prosthesis with 68% achieving good function. These patients can expect a median survival of approximately 3.5 years.

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Image: Figure_1_62.png (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979/cg32991

Session: Lower Limb Prosthetics - Biomechanics 2
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2971-169]

Elaboration of a New Composite Material with Natural Reinforcement (Alfa) for Manufacturing of Lower Limb Prosthesis

Author
Chaker, Adel (Bardo TN) | Dr.
LRBBO - Research

Coauthors
Pr. SMAOUI Hichem, Pr. BEN CHEIKH Ridha, Pr. SLIMANE Noureddine

Abstract
The elaboration of a nonweaven material from a natural fiber,available in Tunisia (alfa fiber), allows the fabrication of lower limb prostheses which was tested on laboratories and by some patient through a clinical testing delivered by an ethical committee. After one year the result was conclusive.

Introduction
The plastic materials reinforced with synthetic fibers (perlon glass, carbon…) that are currently used in the fabrication of prostheses, are relatively expensive for some countries; this leads to the thought of utilizing other fibers that are less expensive without reducing the material's performance. Hence the idea of utilizing natural fibers, in this case, the fiber of the alfa plants, even more so, as these plants represent local material in Tunisia that is widely available at a reasonable price. The elaboration for the first time of a nonweaven material from alfa fiber shows the performance needed and allows fabricating prostheses. This project needed 6 stages that span from the study of the best fiber extraction process to the clinical testing of the orthopedic devices that are fabricated with the new composite material. The execution of the project requires the implication of 10 laboratories and research centers working together during 3 years. The project's cost is around 150M$.

Methods
The project needed 6 stages:
Stage 1: Optimization of the chemical extraction process
Stage 2: Studies of physical and mechanical characteristics of alfa fibers and of former fibers (Perlon, Nylglass, Glass):
Stage 3: Manufacturing of an appropriate Non Weaven material and of a composite reinforced by this material
Stage 4: Characterization of a those new materials
Stage 5: Fabrication, testing and structural analysis of prostheses by using the guidelines of ISO10328:
Stage 6: Clinical testing of prostheses made with the new material

Results
The study shows that the mechanical performance of alfa fiber wasn't better than the other synthetic fibers. But putting into a matrix like the PMMA as a resin used on prosthetics, it becomes more interesting as a reinforcement material. This interest becomes more evident when we elaborate those fibers into a "solid" structure as a material like PERLON. The first idea was to elaborate a woven material, but it wasn't possible because of the rigidity and weakness of alfa fiber. So we tried to make a nonwoven material by the use of wool carding machine and "shirly analysis" (see pictures)and then the process of nonwoven textile. The

result was very conclusive both when we used this material into composite in order to pass it through some mechanical tests , and when we used it into prostheses for lower limbs in order to pass it through static tests and cyclic tests following the guidelines of ISO-ISPO standard N°10328. Those good results allows us to go along, after
an official and ethical permission, the stage of the clinical testing by manufacturing some lower limb prostheses and giving them to volunteers. The focus was putted on: functioning, wear and tear, environmental effects and user's activity. After one year of using of those prostheses, the feedback from those patients was satisfactory.

Conclusion

The underlying idea of the project is the substitution of the synthetic reinforcement (Perlon, Nylglass, Glass…) currently used in the fabrication of orthopedic devices, which is entirely acquired via import, by the locally available natural fibers called Tenacissima Stipa (or alfa fiber). The composite made by this reinforcement is designed for casting in a mold for the fabrication of the hard socket of lower limb prosthesis. The elaboration for the first time of a nonweaven material from alfa fiber allows the fabrication of lower limb prostheses which was tested on laboratories and by some patient through a clinical testing which was delivered by an ethical committee. After one year of using of those prostheses, the result was conclusive.

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Image: carding machine_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979/cg35000

Session: Lower Limb Prosthetics - Biomechanics 2
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3130-328]

Mechanical Failure Risks and Bone Remodeling after Implantation of Osseointegrated Trans-femoral Prostheses

Author
Tomaszewski, Pawel (Groningen NL)
University Medical Center Groningen, University of Groningen - Department of Biomedical Engineering

Coauthors
Tomaszewski PK(1), Verdonschot N(2,3), Bulstra SK(4), Verkerke GJ(1,3).
(1)University Medical Center Groningen, University of Groningen, Department of Biomedical Engineering, A. Deusinglaan 1, 9713 AV Groningen, The Netherlands
(2)Radboud University Medical Centre, Orthopaedic Research Laboratory, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands
(3)University of Twente, Laboratory for Biomechanical Engineering, Enschede, The Netherlands
(4)University Medical Center Groningen, University of Groningen, De

Abstract
In this study we used the finite element method to assess failure risk and long-term bone turnover around two existing osseointegrated trans-femoral implants. The performed analyses can be used to improve direct bone fixation devices and allow more patients to benefit from their advantages.

Introduction
The conventional prosthetic limb attachment is realized by a stump fitting socket to which the artificial limb is fixed. However, many amputees experience complications leading to unsatisfactory performance of prosthetic socket devices[1].
An alternative solution is offered by direct skeletal attachment of a lower-limb prosthesis. The technique allows direct control of the kinematics of the prosthetic leg and avoid soft tissue problems at the stump-socket interface. Nevertheless direct skeletal attachment of prosthetic component have also its risks like bone overload and fracture, periprosthetic bone loss and infections[2,3,4].
The aim of this study is to analyze the mechanical failure risk after implantation of direct skeletal fixations and predict bone remodeling response around the implants. We considered two different direct trans-femoral devices which are on the market (Fig.1a), namely the OPRA system (Integrum A.B.) and the ISP Endo-Exo prosthesis (ESKA Implants A.G.).

Methods
Finite element models representing the OPRA and ISP systems, implanted in the amputated femora were created (Fig.1b). Geometry, elastic moduli and strength for each bone element were determined from CT scans[5]. The implants were assumed to be fully bonded to the bone as a result of osseointegration. Two loads taken from level walking gait cycle measured in the OPRA implant system were simulated in the analyses[6]. First, we analyzed failure risk of the bone around the fixations by calculating a failure ratio (local von Mises Stress/local strength) and assessed interface failure risk using the Hoffmann failure criterion[7]. Afterwards, we performed strain adaptive bone remodeling simulations to predict long-term bone turnover around implants. Our remodeling simulation results were validated against clinical data[2]. The bone remodeling results were visualized using simulated 2D DEXA scans and a bone mineral density (BMD) change for different zones around both implants was calculated.

Results

For both implants simulations of normal walking did not indicate any direct bone damage. The ISP device showed an up to 30% higher periprosthetic bone failure ratio in comparison to the OPRA system. The elements with highest failure ratio were localized at the proximal tip of the implants (Fig.1c). The risk of bone-implant interface failure for the applied loads did not exceed a moderate level, however, ESKA implant presented on average 60% lower Hoffman numbers, indicating that interface failure would be less likely to occur for the ESKA implant. The calculated BMD change after 2 years was moderate for both implants. The simulated bone remodeling pattern around the OPRA implant was compared with the clinical data showing a close match (Fig.2a,b). The maximum bone loss was found at the osteotomy level (zone 7; OPRA - 24%, ESKA - 21%); no bone resorption was observed in the tip region (zone 4). The simulation representing 5 years time after implantation showed considerably more bone loss in the distal zones (1,7), moderate bone loss in the middle zones (6,7) and a slight bone densification in the proximal zone 4 for both implants (Fig.2b). The maximum bone resorption was calculated in zone 7 as OPRA - 68%, ESKA - 45% (Fig.2c). The total decrease in bone mineral content around implants was: OPRA - 9%, ESKA - 7% after 2 years and OPRA - 24%, ESKA - 14% for a 5 years period.

Conclusion

In this study we used the finite element method to assess failure risk and long-term bone turnover around osseointegrated trans-femoral implants. The simulations were comparable with clinical data of the OPRA implant[2]. The higher periprosthetic bone failure risk was obtained for the ESKA implant, what in case of overloading could cause a bone fracture[4]. The relatively higher bone-implant interface failure risk indicates implant loosening as a more probable failure scenario for the OPRA fixation. Relatively high levels of BMD loss were found for both devices, however, the model predicted more severe resorption around the OPRA implant. This, ultimately, could also lead to bone failure. The simulated implant-bone load transfer was found to be more favorable for the interface and the long-term bone stock preservation in case of the ESKA-type implant. The performed analysis can be used to improve direct bone fixation devices and allow more patients to benefit from their advantages.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979/cg38701

Session: Lower Limb Prosthetics - Biomechanics 2
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2890-88]

NZ Artificial Limb Board Outcomes Measures for Prothetics Results and Organisational Gains

Author
Lineham, Marion (Wellington NZ) | MPP
New Zealand Artificial Limb Board - None

Abstract
The NZALB introduced a package of outcomes measures on 1 July 2006. Results reported in this paper will contribute to benchmarks in the future and provide data for research. The outcomes measures project has provided many benefits to amputees and to the organisation.

Introduction
The accompanying paper on Organisational Outcomes Measures for a Prosthetics Service, describe the background to the New Zealand Artificial Limb Board's introduction of outcome measures on 1 July 2006. High level outcomes chosen and the tools used to measure them were:
1.Mobility: Timed Up and Go test (TUG walking test),Locomotor Capability Index 5 (LCI5 – questionnaire)
2. Independence – as above
3. Health related quality of life – SF12 (questionnaire)
4. Employability – Client survey (December 2009)
5. All: three yearly client random survey, which could be adapted as required
This paper reports on the TUG, the LCI5 and the SF12 tests.

Methods
At all stages of the project consultation with staff and stakeholders occurred. Pre-testing was held. Manuals were prepared and staff were trained. An interim recording system was introduced. The date for implementation was 1 July 2006.
Later the patient data system was adapted to include results of tests. This has provided a powerful data set for all the NZALB's amputee clients.
It was not possible to test all 4,300 patients on an ongoing basis. Testing was confined to new lower limb patients, who were tested three times over their first year. Physiotherapists conducted the testing and extra physiotherapy hours were introduced.
It was 2.5 years from implementation before the first cohort of patients – new patients from 1 July 2006 to 30 June 2007 – had been tested three times. Three analyses were made before determining the optimum date for analysis for the future, when the data was most complete (allowing for delays in healing).

Results
Results for the first cohort of patients, 1 July 2006-30 June 2007, were analysed in December 2008.
There were 237 primary lower limb adult patients in the base group tested. Of the base group of 237, 62 completed only Measure 1, mostly because they were unsuitable to fit (17), deceased (14), health reasons (14), and a variety of other reasons (17).
Mobility and Independence:
LCI: 58% completed all three measures. Of those, the average score went from 28 to 42 out of a maximum possible score of 56. Most people had sufficient mobility to achieve the basic activities of daily life with the median being 25 out of a possible 28.

TUG walking test. 62% completed all three measures. 27% had walking times indicative of normal mobility, 33% achieved normal range for those with a disability, 14% had impaired functional mobility and 16% demonstrated dependency, with the remainder either not starting or not finishing.
HRQoL:
SF-12: 64% completed all three measures. Averages for this group increased from 34 to 38 to 39 for the physical scores, and 43 to 54 to 53 for the Mental Health Scores (US norms are 50 each).
Employability: data will be available from client survey at the conference
With more data it will be possible to benchmark results.

Conclusion

The NZALB has no regrets about introducing its outcome measures. They have:
• provided a feedback loop that has led to many service improvements (e.g. enhanced monitoring, consistent testing across NZ, more physiotherapy for amputees, data for research);
• tracked all patients over their first year, with results of fitting;
• used a mixture of objective and subjective tests that have considerable clinical value;
• provided a motivational tool for patients;
• provided a formal way of testing for mental health problems that led to referrals where needed (SF-12).
Overall results have been positive in their benefits to patients and the NZALB. Further results will be available by May 2010.

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New Zealand Artificial Limb Board Annual Reports, www.nzalb.govt.nz

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg223979/cg33849

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3676-None]

Lower Limb Orthotics

Session Chair
Solomonidis, Stephan (Glasgow GB)
University of Strathclyde - Bioengineering Unit

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg229066

Session: Lower Limb Orthotics
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3166-357]

Functional Evaluation and Indicator Analysis of UC-BL Foot Orthosis in Paediatric Patients with Symptomatic Flexible Flat Feet

Author
Wu, Kit (HK) | Mr.
Hospital Authority - Prosthetic & Orthotic Department

Coauthors
Leung AKL

Abstract
UC-BL foot orthosis is commonly prescribed to correct the alignment and relieve the symptom of flexible flat foot , but its ability of functional improvement is still unclear. In this research, the effect of UC-BL foot orthosis in physical and functional modulation was determined.

Introduction
Flexible Flat Feet (FFF)is one of the commonest lower limb conditions in children (Leung et al. 1998), in Hong Kong, around 15 to 20% of young Chinese population (4-18 years old) are having low arch (Leung et al. 2005).
Different level of lower limb problems and co-morbidity (Mereday et at, 1972)can occur in some patient with symptomatic FFF.
UC-BL foot orthosis is frequently prescribed to correct the alignment of FFF, but its ability of functional improvement is still unclear. In this research, the effect of UC-BL foot orthosis in physical and functional modulation was determined.
Descriptive information and foot characteristics were integrated to determine the effect and range as predicator to determine the functional status of paediatric patient with symptomatic FFF; based on the findings, to establish the optimum indication for the prescription of UC-BL foot orthosis for function improvement and symptomatic relief for paediatric patient with symptomatic flexible flat feet.

Methods
Twenty-one subjects, 15 male and 6 female, mean age of 10.4 years were recruited. American Academy of Orthopaedic Surgeon (AAOS) Lower Limb Outcomes Assessment-Foot and Ankle Core Scale was used to determine the functional status of the subjects before and after the orthotic treatment. Resting Stance Calcaneal Angle (RSCA), Arch Index (AI), Inter-Malleolar Distance (IMD) at RSCA position, Contact Force Ratio (CFR) and plantar loading information were recorded based on standard procedure to determine the characteristics of the foot. All subjects were provided with UC-BL orthosis for ten weeks. The foot characteristics were recorded before, during and ten weeks after the first day of treatment.
Descriptive information, including gender, Body Mass Index, age, foot dimensions and Beighton Score together with the foot characteristics were integrated to determine the effect and extended as predicator of the functional status of the subjects.

Results
The improvement of total AAOS score (p=0.000), pain domain (p=0.000), function domain (p=0.000) and giving away domain (p=0.000) was found to be statistically significant. For stiffness and swelling

domain, 56.08 % of improvement was found (p = 0.18). The function domain had the highest percentage of improvement (85.82 %) while compare with other domains and the total score.
For the correlation part, only mean RSCA and mean IMD shown a significant correlation with the AAOS score and sub-domain score. The Mean RSCA was highly correlated with the AAOS total score(r=-0.739,p=0.000), pain sub scale(r=0.751,p=0.000), and function sub scale (r=0.621,p=0.003)and was mildly correlated with giving way sub scale(r=0.455,p=0.038). The Mean IMD was mildly correlated with the AAOS total score(r=-0.544,p=0.011), pain sub scale(r=0.492,p=0.024), function sub scale(r=0.510,p=0.018) and giving way sub scale(r=0.444,p=0.044).
The correlation between percentage change of before and after treatment of AAOS total score, sub-domain score and instantaneous percentage difference of wearing UC-BL during treatment when compare with before treatment was analyzed,such that, instantaneous percentage change of mean RSCA (r=0.433,p=0.05)and percentage change of mean IMD (r=0.474,p=0.03)have shown a mild correlation with the percentage change of AAOS total score.

Conclusion

The results showed that the UC-BL foot orthosis can improved various aspects of the functional score significantly. On the other hand, the instantaneous change of the RSCA and IMD induced by the UC-BL foot orthosis was the major factors which contributed to the significant improvement of the functional score of the subjects. A greater change of these factors induced a greater extent of functional improvement to the paediatric patient with symptomatic flexible flat foot.
Based on the findings, the Resting Stance Calcaneal Angle and the Inter-Malleolar Distance at RSCA position can be used as an indicator for the prescription of UC-BL foot orthosis to paediatric patient with symptomatic flexible flat foot for functional improvement and symptomatic relief. Maximal correction should be provided to the abnormal pronation of the subtalar joint in order to have a greater extent of functional improvement.

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Session: Lower Limb Orthotics
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [2907-105]

The Orthoses Applying into the Scissors Gait

Author
Yin, TianQiao (CN)
Beijing Huici Artificial Limb medical Appliances Co., Ltd. - Technical adviser

Coauthors
Dr Hou huifang

Abstract
Objective To investigate the cause of spastic disorders of scissors step (adductor muscle increased muscle tension) in syndrome, by wearing braces to overcome the scissors-step to achieve the symptom improvement.

Introduction
Objective To investigate the cause of spastic disorders of scissors step (adductor muscle increased muscle tension) in syndrome, by wearing braces to overcome the scissors-step to achieve the symptom improvement. Regular period may be alleviated, to correct abnormal gait. Application of Bobath neurodevelopmental treatment and Vojta therapy in theory, solve the spasticity of both lower extremities, so that it can wear a brace in the next seat, standing and walking.

Methods
Methods from February 2006 to August 2007 the state of children diagnosed with spastic, while accepting the formal rehabilitation and orthosis treatment of 74 people, divided into two groups over the same period, the rehabilitation group, 47 people, orthoses group 27.Aged 2-4 years with a mean age of 3.1 years. First to identify children with bilateral adductor muscles of the muscle strength and muscle tone. Filter no obvious mental retardation and other disease complications, choose a suitable pair of scissors step brace to guide children, under the walkers walk, follow-up 6 months to 15 months, follow-up analysis of therapeutic effect.

Results
Results According to inclusion criteria, 74 were randomized controlled clinical trials, rehabilitation group 47 and the orthosis group of 27 people in follow-up time of 6 to 15 months, all license Bobath neurodevelopmental treatment and Vojta therapy training, on their children seat balance, standing balance, walking balance, gait, through the SPSS statistical Scale of statistical analysis.

Conclusion
Conclusion 1. Sitting balance improved sound. 2. Upright to correct a good balance. 3. Walking improved significantly raise the degree of balance between the daily basic self-care. 4. Gait stability was enhanced. Application of step to overcome the scissors support lower limb spasticity with significant improvement in gait, their childrens balance, gait, posture, significantly improved the stability of long-term wear braces have therapeutic efficacy, is to improve the spasticity of the scissors a good step appliances. Worthy of popularization.

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Session: Lower Limb Orthotics
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3302-477]

What would be the Best Performance of Paraplegic Subjects During Walking with a RGO Orthosis?

Author
Solomonidis, Stephan (Glasgow GB)
University of Strathclyde - Bioengineering Unit

Coauthors
Spence W. Nicol A.
S. Solomonidis

Abstract
Different types of orthoses have been designed for SCI subjects, however all of them have problems. A new type of orthosis was designed and tested during walking of normal subjects. The result showed there is a huge gap between the function of the normal subjects in walking with and without orthosis

Introduction
Spinal cord injury (SCI) is damage to spinal cord that results as loss of function and mobility. SCI patients use orthosis or wheelchair to transfer from one place to another place. A variety of orthoses have been designed for paraplegic subjects, however the best one is Hip Guidance Orthosis (HGO) (Stallard et al, 1993, Jefferson and wittle 1990). According to the different research the performance of the paraplegic subjects is significantly less than that of normal subjects (Stallard et al, 1998). So it was necessary to design an orthosis to overcome the problems of the previous orthoses, especially the problem regarding donning and doffing the orthosis. There is no information in literature to show the best performance of the paraplegic subjects in walking, which is the function of the normal subjects in walking with orthosis. So the main aim of this research was to show the function of normal subjects in walking with orthosis which represents the best functions of SCI subjects.

Methods
A new type of RGO orthosis with an open structure is designed, which allows alignment of various components whiles the subjects wearing the orthosis. The cosmetic of the new orthosis is better than other orthoses. Three normal subjects, without any medial problems, participated in this study. The performance of the subjects in walking with and without orthosis was evaluated by gait analysis, standing stability analysis and by energy consumption tests. For stability analysis some parameters such as excursion of centre of pressure (COP) was measured in both anteroposterior and mediolateral planes. For gait analysis Spatio temporal parameters, the moments applied at the hip joint, the force transmitted trough the foot and crutch were measured. The energy consumption test was done by using physiological cost index (PCI) which is based on heart rate monitoring. The subjects asked to stand and walk with the orthosis with different hip joint configurations and without orthosis.

Results
The walking speed and cadence of the participants was nearly one third and a half, respectively during walking with the orthosis in contrast to those walking normally. The moments around hip joint decreased significantly in particular this was true of the extension moment. The flexion moment applied on the hip joint was 0.88 Nm/kg during normal walking, however, it was between 0.447 and 0.646 Nm/kg during

walking with the orthosis. The abduction adduction excursion during walking with and without the orthosis was 6.1 and 12.34 degrees, respectively. The results of the energy consumption tests showed that the energy consumption during walking with orthosis was between two and three times more than that in normal walking. Inserting some degrees of abduction in the hip joint decreased energy consumption during walking with orthosis. The PCI was 0.311 beats/min in normal walking, 0.85 beats/min in the orthosis that was aligned naturally and 0.74 beats/min in the orthosis aligned in a slight abduction. The force applied on the crutch also decreased in the orthosis that was aligned in abduction. The amount of stability during standing with the orthosis was significantly better than that with normal standing. Restriction, hip joint range of motion and the allocation of some degrees of abduction increased standing stability. Figure 1 shows the flexion extension moments applied at the hip joint in walking with orthosis.

Conclusion

Allocating some degrees of abduction (5 degrees) in the hip joint of the orthosis improved the walking performance and energy saving in walking with the orthosis. The amount of the force applied on the crutch could be decreased by using an abduction angle in the hip joints. It may be related to better utilization of the crutch force by subjects. Moreover, it was much easier for the subjects to take the swing leg off the ground when it was aligned in abduction. The results of this research highlighted the best walking performance that a SCI subject could hope to achieve in walking with this type of orthosis. Inserting an abduction angle and using a special hip joint, which allows users to have a different hip joint range of motion according to their need, could increase the efficiency of the orthosis. In compare to the performance of the paraplegic subjects there is a hug gap between normal and paraplegic subjects in using orthosis.

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Session: Lower Limb Orthotics
Friday 2010/05/14 | 17:00 - 18:30 | Topic: Orthotics | Subtopic/Track: Orthotics

Congress Lecture [3136-334]

Dynamics of Reciprocating Gait Orthosis (RGO) Assisted Gait

Author
Gard, Steven A. (Chicago, IL US)
Northwestern University Prosthetics Research Laboratory & Rehabilitation Engineering Research Program - Physical Medicine & Rehabilitation, Feinberg School of Medicine

Coauthors
Fatone S, Gard S

Abstract
The gaits of 5 RGO users were analyzed to identify ways to improve gait efficiency. Heavy load bearing through the arms, limited action of the reciprocal link, and poor conservation of mechanical energy were observed. The causes of these phenomena and their effects on gait efficiency are discussed.

Introduction
The RGO is a device that enables people with lower limb paralysis to stand and walk upright in a reciprocal gait pattern with crutches or a walker[1]. The RGO is characterized by a reciprocal link which couples the motion of the hip joints so that flexion at one hip leads to extension at the other and vice versa. Ambulating with RGOs is exhausting[2], and has been cited as a major cause for their limited use and abandonment[3]. Therefore, the efficiency of ambulating with RGOs must be improved so that persons with lower limb paralysis can enjoy the benefits of ambulating upright[4] more often. Understanding the dynamics of RGO assisted gait would be useful in finding ways to improve its efficiency; however, investigations of RGO assisted gait dynamics have been few and are often limited by small study populations[5], measurements within a single plane[2], or measurements within a single phase of gait[6]. This study was conducted to increase the knowledge of RGO assisted gait dynamics.

Methods
The informed consent of persons with lower limb paralysis who ambulated with a RGO was obtained. Passive reflective markers were placed on the subjects, their orthoses, and their walking aides, and a video motion capture system recorded the trajectories of these markers as the subjects ambulated over level ground. Force plates embedded flush in the ground measured the ground reaction forces acting on the subjects' feet and walking aides. These data were used with anthropomorphic data to calculate trunk flexion angle, hip flexion angle, net hip moment, the rate of work done by the net hip moment, the rate of work done by the net hip joint reaction force, and the mechanical energy of the trunk. These variables were ensemble averaged over the gait cycle for each subject.

Results
5 subjects were recruited for this study which varied widely in age, spinal lesion level, and type of walking aide used. All subjects walked with flexed trunks for almost the entire gait cycle with the trunk becoming more flexed during periods of double support and less flexed during periods of single support. All subjects exhibited similar hip flexion motion where most of the motion occurred during periods of single support, while the hip remained relatively stationary during periods of double support. 3 of the subjects exhibited hip extension just prior to swing. The vertical ground reaction forces acting on the walking aides of all subjects exceeded half of their body weight during portions of single support. The ground reaction forces were found to be posteriorly directed for most of the single support phase for all subjects. The net moment

acting on the hip was found to encourage extension at the beginning of swing, and the flexion moments acting at the hip during swing were small compared to able bodied persons for subjects without active hip flexors. The rate of work done by the net hip moment was found to be smaller than the rate of work done by the net hip joint reaction force for all subjects. The change in the potential energy of the trunk was found to be at least twice as large as the change in kinetic energy for 4 of the subjects.

Conclusion

Load bearing through the arms is likely a source of high energy expenditure. The load bearing is caused in part by chronic trunk flexion, where forces at the shoulders promote trunk extension and forces at the hip promote flexion. In order to extend their trunk during single support phase, RGO users must create an extension moment by increasing their shoulder joint forces and decreasing their hip joint forces. Walking more erect may encourage RGO users to bear less weight with their arms. The flexed trunk posture also contributes to hip flexion, which causes the reciprocal link to promote hip extension. This predisposition to extension may prevent the development of hip flexion moments during swing. Walking more erect may improve walking efficiency by encouraging the link to promote hip flexion. The change in potential energy of the trunk was at least twice the change in kinetic energy, which indicates energy loss. This loss may come from posterior forces acting on the walking aides.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3719-None]

Paraplegiology

Session Chair
Meiners, Thomas (Bad Wildungen-Reinhardshausen DE) | PD Dr. med.
WERNER-WICKER-KLINIK Zentrum für Rückenmarkverletzte

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg282854

Symposium: Paraplegiology
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3720-857]

Advances in the Neuroregeneration and Rehabilitation After Spinal Injuries

Author
Curt, Armin (Zürich CH) | Prof.
Uniklinik Balgrist - Paraplegiker-Zentrum

Abstract
Clinical recovery after spinal cord injury (SCI) can be attributed to mechanisms of functional compensation, neural plasticity and/or repair as has been established for other disorders of the central nervous system (CNS), i.e. stroke.

Introduction
The relative impact of each of these mechanisms has been explored in a large prospective European multi-centre study in acute traumatic SCI subjects. The combined examination of functional (activities of daily living and ambulatory capacity) and neurological (sensory-motor deficits) measures related to assessments of spinal conductivity (motor- and somato-sensory evoked potentials) followed over 12 months revealed that functional recovery to a large extent occurs by compensation, both in complete and incomplete SCI. But probably also neural plasticity will contribute to some degree to a greater improvement in SCI. Relevant repair of damaged spinal pathways does not take place. The provided combined assessments are able to estimate treatment effects and to proof biological activities related to drugs or implanted cells (OEC, bone marrow or neural stem cells) as being proposed by preclinical studies and translated into novel interventions in human SCI.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg282854/cg283484

Symposium: Paraplegiology
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3721-790]

MotionTherapy@Home – First Results of a Study with a Novel Robotic Device for Home-based Locomotion Therapy in Incomplete Spinal Cord Injured Subjects

Author
Rupp, Rüdiger (Heidelberg DE) | Dr.-Ing.
Stiftung Orthopädische Universitätsklinik Heidelberg - Zentrum für Paraplegiologie / Forschung

Coauthors
Plewa H, Hofer EP, Knestel M

Abstract
A pneumatically driven orthosis “MoreGait” has been developed for an automated locomotion training at home. It generates the key afferent stimuli for the central pattern generator. First applications in chronic spinal cord injured subjects show significant improvements of gait speed and endurance.

Introduction
In incomplete spinal cord injured (iSCI) subjects task oriented training regimes are applied for enhancement of neuroplasticity to improve gait capacity. However, a sufficient training intensity for enhancement of this neuroplasticity can only be achieved during the inpatient phase, which - due to economical restrictions - is getting shorter and shorter [1]. In the clinical environment complex and expensive robotic devices have been introduced to maintain the duration and the intensity of the training [2], but up to now only a few exist for continuation of an automated locomotion training at home. For continuation of the automated locomotion training at home the compact, pneumatically driven orthosis “MoreGait” has been developed, which generates the key afferent stimuli for activation of the spinal gait pattern generator [3]. The objective of this pilot study is to test the feasibility of the home-based training with the novel device and its efficacy.

Methods
Eight chronic (time since injury: 8.5 +/- 6.94 y) SCI (1 tetraplegic, 7 paraplegic) individuals (5 female, 3 male, mean age: 44 +/- 9.48 y) with a traumatic incomplete lesion (4 ASIA Impairment Scale C, 4 ASIA Impairment Scale D) have been included in the pilot study. All study participants have been able to walk with the support of walking aids or one therapist at the time of study inclusion. Exclusion criteria were body weights higher than 130 kg, body heights greater than 200 cm, severe osteoporosis, joint contractures and spasticity and the ability to walk without any walking aid and standing on one leg for more than 3 sec..
Training was performed for 8 weeks (45 min./day for a min. 4 days/week). Prior to the onset of the training 3 assessments were performed every 2 weeks to obtain reliable baseline data. Primary outcome measures were 10m and 6-min. walk tests.
Statistical analysis was done with Wilcoxon matched-pair-test and Bonferroni-correction for multiple comparisons.

Results
In contrast to ergometer or continuous passive motion devices the novel “MoreGait” system is capable of generating the proprioceptive and sensory stimuli for activation of the spinal gait pattern generator in particular the gait-phase dependent loading of the foot soles. Artificial pneumatic muscles with excellent weight-to-force ratio have been integrated as actuators for ankle joint and combined hip-knee movements (figure 1). Their inherent low stiffness efficiently supports the safety concept of the device, which can is intended to be operated by the handicapped users completely on their own including transfers from the wheelchair. For safety reasons a semi-recumbent position of the user has been foreseen, in which a foot loading cannot be achieved by the users’ own body weight. Therefore the Stimulative Shoe has been developed on the basis of pneumatically actuated medio-lateral bars mimicking the physiological foot loading pattern. The users operate the device via an intuitive user interface and receive feedback about their training activities through a graphical representation of model-based derived joint torques.
All participants of the pilot study performed the training with the device on a daily basis. Only one adverse event (pressure ulcer) directly related to the device occurred.
A significant ($p<0.025$) increase of the mean gait speed (4 weeks: 42%, 8 weeks: 80%) compared to baseline has been observed. Mean gait endurance improved by 44% (4 weeks) and 68% (8 weeks).

Conclusion
A novel locomotion training device based on artificial Fluidic Muscles has been developed. The system has explicitly been designed for independent use by handicapped users in their home environment. Additionally, special focus was put on achieving a high standard of users’ safety, while still providing the necessary therapeutic functionality. The so-called Stimulative Shoe was integrated to apply a physiological loading pattern to the foot sole for activation of the spinal pattern generator.
A home-based robotic training with the novel MoreGait is feasible and was well accepted by the users. The improvements of gait function seen in the first 8 iSCI study participants are at least in the range of those achieved with complex locomotion robots used in clinics and other inpatient rehabilitation settings.

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Image: Rupp_790.jpg (see online)

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Symposium: Paraplegiology
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3722-906]

The Role of the Diaphragm Pacing in Replacing, Delaying and Decreasing Mechanical Ventilators: From Spinal Cord Injured Patients to the Future Role in a Pandemic

Author
Onders, Ray (Cleveland, Ohio US) | Dr.
University Hospitals Case Medical Center , Case Western Reserve University Schoo. of Medicine - Surgery

Coauthors
Raymond P. Onders MD

Abstract
Diaphragm Pacing (DP) can replace ventilators in tetraplegics greatly increasing their quality of life. For any patient on a ventilator, DP would decrease the time on ventilators by maintaining Type 1 muscle fibers and improving posterior lobe lung ventilation.

Introduction
Diaphragm pacing (DPS) has been used in a series of trials to help respiration ranging from spinal cord injured (SCI) patients with pure upper motor neuron (UMN) loss of respiratory control to patients with pure lower motor neuron (LMN) loss from phrenic nerve transaction. This report will describe the results at the largest single institution and how the technology could be utilized in a flu pandemic.

Methods
Prospective, nonrandomized, controlled, interventional trials under IRB and/or FDA approval for use of DP in human subjects at a single institution. DP involves outpatient laparoscopic diaphragm motor point mapping to identify the optimum site where stimulation will cause maximum diaphragm contraction. Two percutaneous intra-muscular electrodes were implanted in each hemi-diaphragm and diaphragm conditioning ensues through with a programmed pacing unit to maximize diaphragm movement for respiration.

Results
From 1999 to 2010 over 150 human diaphragms were surgically evaluated for motor point stimulation for ventilation with over 250 patient-years of DPS use. Subjects ranged from 12 weeks to 77 years old. Diaphragm evaluations and implantations included normal subjects undergoing elective laparoscopy, tetraplegics on ventilators over 25 years, phrenic nerve injured patients, acquired central sleep apnea patients, transverse myelitis patients and Amyotrophic Lateral Sclerosis/Motor Neuron Disease(ALS/MND) patients with forced vital capacity of 89% predicted to continuous mechanical ventilation with tracheostomy for 18 months. DPS provided tidal volumes to free 100% of tetraplegics from ventilators with a 60% reduction in secretions. ALS/MND results showed a decrease in the decline of forced vital capacity with a one year survival of 78%. In ALS patients the use of DPS at night overcomes centrally mediated sleep hypoventilation. DPS use causes a conversion of fast twitch glycolytic (IIb) to functional slow twitch oxidative muscle (I) fibers overcoming the rapid conversion to the non-functional Type IIb fibers that a day of mechanical ventilation causes. DPS use during simultaneous mechanical ventilation allowed a

21% decrease in peak airway pressure, 19% increase in respiratory compliance and a subsequent 24% increase in tidal volume.

Conclusion
DP can replace ventilators in spinal cord injured patients and significantly reduce their costs. DP technology would decrease the time on ventilators and decreases the secondary bacterial ventilator associated pneumonias that occurs during a pandemic when there is a shortage of ventilators. Most importantly functional electrical stimulation has a neuroplasticity effect allowing natural ventilation to recover.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg282854/cg283806

Symposium: Paraplegiology
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3723-887]

Robot Assisted Rehabilitation in Quadriplegics

Author
van Hedel, Hubertus (Zurich CH) | PhD
Balgrist University Hospital - Spinal Cord Injury Center

Abstract
Robotic devices have been developed to train upper extremity function, especially for patients with stroke, and are currently being applied to patients with quadriplegia. First experiences will be presented on the applicability of the upper extremity robotic devices in quadriplegic patients.

Introduction
Patients with a cervical spinal cord injury (SCI) suffer from impaired strength and sensation of the upper extremity. It is known from literature that these patients prioritize the recovery of upper extremity function above all other impairments [1]. Training hand and arm function is often performed by occupational and physical therapists and can target joint mobilization, strength, fine motor skills or activities of daily life. In addition, functional electrical stimulation can be applied to ameliorate strength development and support motor learning. Robotic devices have been developed to train the upper extremity, especially for patients suffering from a stroke. Several of these devices, e.g. the ARMEO (Hocoma AG, Volketswil, Switzerland), which is based on the T-WREX [2] or the ARMin (developed by the SMS Lab, ETH Zurich, in cooperation with Balgrist; see [3]) are currently tested for feasibility in the SCI population. Besides possible therapeutic effects, these devices might also ameliorate the assessment

Results
At the conference, first experiences with these devices in patients with quadriplegia will be presented.

Conclusion
The possibilities and shortcomings of these robots, as currently tested in patients with quadriplegia will be discussed from a clinical point of view.

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Symposium: Paraplegiology
Friday 2010/05/14 | 17:00 - 18:30 | Subtopic/Track: Neuroorthopaedics

Congress Lecture [3724-None]

Biomechanic of Decubitus Ulcer

Author
Meiners, Thomas (Bad Wildungen-Reinhardshausen DE) | PD Dr. med.
WERNER-WICKER-KLINIK Zentrum für Rückenmarkverletzte

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3750-None]

Clubfoot

Session Chair
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg388784

Advanced Instructional Course: Clubfoot
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3751-804]

Changing Concepts in Clubfoot Treatment - The Historical Perspective

Author
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Abstract
Since Hippocrates treatment concepts in clubfoot underwent significant changes. Based on a concise historical overview of the main therapeutical approaches the lecture will focus on the detection of an underlying pattern.

Introduction
The pendulum swung between soft and a hard treatment procedures. After a long period of soft management from the antiquity to the Age of Enlightenment followed by an aggressive era from the 19th to the 20th century the Ponseti method lead us back to a soft approach at the turn of century.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg388784/cg389225

Advanced Instructional Course: Clubfoot
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3752-817]

Pathoanatomy Based Treatment of the Clubfoot in Children - the Ponseti Method

Author
Rödl, Robert (Münster DE) | PD Dr. med.
Universitätsklinikum Münster - Kinderorthopädie, Deformitätenrekonstruktion und Fußchirurgie

Coauthors
Horter M, Vogt B, Tretow H, Schiedel F

Abstract
The patoanatomy of the clubfoot can be understood as a maximum supination of the hind foot with disrupted fore-hind foot alignment. Under this assumption the Ponseti method corrects the fore-hind foot-alignment and reduces the hind foot with manipulation of the calcaneo-pedis-block. Serial casting and consequent splinting maintains the results of the manipulations.

Introduction
The clubfoot is a result of changes in the soft tissues, the shape of the bones and the position of the bones to each other. The therapy of clubfeet in the newborn can only address the malposition of the bones. The pathoanatomy needs to be understood to manipulate correctly. Otherwise secondary deformities will occur.

Methods
The disrupted fore-hind foot alignment is a pronation deformity of the forefoot when compared to the hind foot. The first manipulation corrects that malposition with a supination of the forefoot. This will also lengthen the whole foot. The position is maintained by a cast which includes the thigh and the knee in 90° of flexion. The following manipulations address only the forefoot which is connected to the calcaneal bone as one block. A sliding motion which abducts the forefoot without correcting the equinus of the hind foot reduces the supination deformity. This is done stepwise with casts maintaining the position between the manipulations. After achieving a 70° abduction of the forefoot, the achilles tendon needs to be cut if dorsifexion is less than 10°. After another casting of 3 weeks, the result is maintained by a Dennis-Brown-splint until the age of 5.

Results
All idiopathic clubfeet in the new born can be reduced with this method. 95% of the feed need tenotomy of the achilles tendon. Older patients with neglected clubfeet may be also treated with serial casting, but additional surgery is needed in half of the patients. Very rigid or so called atypical clubfeet are very difficult to manipulate. They are stiff and short with a deep crease in the sole of the foot and behind the ankle. They have a shortening of the first metatarsal bone with hyperextension of the metatarsal phalangeal joint. In those cases the manipulation needs to be modified and often added be more extensive surgery.
The splinting to maintain the reduced position of the foot is sometimes difficult. The modular splint on the market needs customized adjustments in several cases.

Conclusion
The patoanatomy based treatment of the clubfoot following the Ponseti method is the treatment of choice in all idiopathic clubfeet. In other indications serial casting using the manipulation technique of Ponseti is

almost always reducing the amount of surgery. The splinting needs to meet the principle of the Dennis-Brown-splint. Modification of the foot fitting of those splints needs to be discussed, because the feet of the newborn are very different.

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Advanced Instructional Course: Clubfoot
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3565-662]

Attitudes of Orthopedist and Orthopedic Technician to the Treatment of Pes Equinovarus Congenitus

Author
Huraj, Emil (Bratislava SK) | MD, PhD, assist. prof.
Children University Hospital, Bratislava - Department of Orthopedics

Coauthors
A. #erná

Abstract
The Authors present surgical and nonoperative treatment of pes equinovarus congenitus with a special attention being paid to Ponseti's method combined with a substantial share of orthotic treatment on the therapeutic results.

Introduction
Pes equinovarus congenitus (clubfoot or more properly called congenital talipes equinovarus) is the second most frequent congenital disorder of osteoarticular apparatus. The disorder is highly variable with regard to severity, rigidity, and response to treatment. The condition is bilateral in about 50% of cases. The complexity of the pathoanatomy of clubfoot requires nonoperative treatment since the very first days after birth. The treatment begins with redressing bandages, usually plaster ones, thermoplastic splints can be used as well. In the case of failure of nonoperative treatment, the surgical methods are applied. However, these days Ponseti's nonoperative method of redressing is being preferred. This method includes intensive use of orthotic devices.

Methods
The authors describe various types of surgical corrections performed by the Department of Orthopaedics of the Children University Hospital in Bratislava in the amount of approximately 20 cases per year. The application of Ponseti's method on a group of patients of this one and only specialized department in Slovakia is also demonstrated.

Results
More than 50 clubfoot patients was treated by the Department of Orthopaedics of the Children University Hospital in Bratislava during 2007 - 2008 period using Ponseti's method. 40 children patients are being evaluated, of which 26 cases with bilateral condition, male-female ration of 3 : 1. The results - evaluated using Pirani's score – were good in 80%, whereas in 8 patients recidive of the condition occured. Positive results of some orthotic solutions and their innovations were demonstrated.

Conclusion
The treatment of pes equinovarus congenitus is time and patience intensive on both sides of physician as well as parents. Nonetheless, the most important is an exact use of inaugurated method as demonstrated by the authors with the results of treatment by Ponseti's method.

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Advanced Instructional Course: Clubfoot
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [2874-74]

Outcome of the Ponseti Method in Treatment of Clubfoot in Tanzania

Author
Tuni, Walter A. (Dar es Salaam TZ)
Comprehensive Community Based Rehabilitation in Tanzania (CCBRT) - Disability Hospital - Department of Rehabilitation Medicine

Introduction
The Ponseti method has been demonstrated to be an effective method of treatment for congenital idiopathic clubfoot. To my knowledge; no study has been done to assess the potential outcome of this method in Tanzania. The purpose of this study is to assess the outcome of the Ponseti method in the treatment in Tanzania.

Methods
Consecutive case series were retrospectively selected from the period January 2002 to December 2006. Fifty subjects (34 male and 16 female) with 79 clubfeet were assessed. Serial manipulation and casting were performed to all as described by Ponseti. Pirani total score before and after treatment was compared.

Results
Before treatment (Mean clinical total score = 4.7, mean clinical midfoot score = 2.1, mean clinical hind foot score = 2.5). After treatment, Sixty six feet (83.5%) responded to treatment. Mean total score 1.8, (mean midfoot score = 0.9 and mean hind foot score = 0.9), SD 0.757 with casts between 4 and 6 per foot.

Conclusion
The method as proved successful rate of 83.5%, delayed treatment was the indication for reconstructive surgery. These results indicate that, the technique is cheap and easy to adapt. I recommend the method to other treatment centres in Tanzania.

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Advanced Instructional Course: Clubfoot
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3753-910]

The Balgrist Clubfoot Orthosis in the Post-Treatment of the Infant Clubfoot

Author
Lentz, Sharon (Zürich CH)
Balgrist Tec AG

Introduction
Despite the excellent results of the early conservative treatment of the congenital clubfoot by the Ponseti method, there is still some need for a clubfoot orthosis to maintain correction in cases of delayed beginning or failed conservative and/or surgical treatment. The rationale of the custom-made Balgrist Clubfoot Orthosis designed by Tschanz is a dynamic mounting of the heel and ankle for reposition and retention of the clubfoot. For the manufacturing of the Balgrist Clubfoot Orthosis the following steps are essential: casting in a corrective position of the foot, improvement of the correction by modifying the plaster model and choosing well the shape of the margins. Starting by the casting, followed by the moulding of the plaster model up to the final fitting attention must be paid to some key points. The lecture will give an overview of the biomechanical principles and manufacturing steps of the dynamic Balgrist Clubfoot Orthosis.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3792-None]

Optimizing the Use of CAD/CAM in Orthotics

Session Chair
Saunders, Carl (Vancouver CA)
Vorum Research Corporation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg439708

Advanced Instructional Course: Optimizing the Use of CAD/CAM in Orthotics
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3793-838]

Overview of Canfit CAD/CAM for Orthotic Devices

Author
Saunders, Carl (Vancouver CA)
Vorum Research Corporation

Introduction
The Canfit ™ System is a revolutionary advancement in CAD/CAM technology for the orthotics and prosthetics industry. It allows the practitioner to increase efficiencies in the design and manufacture of a wide range of custom orthotic devices. Within each clinical application - spinal, seating, KAFO, AFO, and foot orthoses - there exist patient cases of varying complexity. The new design tools featured in the Canfit ™ Version XII Design software provide powerful manipulation of both 3D shape scans and clinically proven library shapes. Digital photos and patient measurements are also supported. This discussion will introduce the most effective design processes for each of the above orthotic devices.
Canfit ™ Design software … design without limits.

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Advanced Instructional Course: Optimizing the Use of CAD/CAM in Orthotics
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3794-839]

Clinical Case Studies of Complex Seating Solutions Using CAD/CAM

Author
Flageul, Jean-Yves (Groffliers FR)
Orthopedie Regnier SAS

Introduction
In the CAD/CAM process, complex seating can be created by scanning a vacuum bag in which a patient has been optimally positioned. Once the 3-dimensional shape has been scanned, it can be imported and modified to account for asymmetries in length, width, hip/knee flexion, abduction/adduction, and inversion/eversion. Patient photographs can be uploaded into the software to further aid the design process. Using features within the design software, it is also possible to choose an existing symmetric shape from a library and modify it to suit the scanned patient shape. This portion of the instructional course will focus on the technical process for producing complex seating shells using CAD/CAM technology. Different approaches for acquiring key patient shape data will be presented. Interactive software tools and functions for designing the final seating shell will be demonstrated. Finally, the manufacturing methods will be reviewed. This will include carving positive models from polyurethane hard foam, carving ne

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Advanced Instructional Course: Optimizing the Use of CAD/CAM in Orthotics
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3795-840]

CAD/CAM Design Manufacture of Standing Shells

Author
Ceder, Michael (SE)
Team Ortopedteknik AB

Introduction
Using CAD/CAM design software, custom standing shells can be created by entering measurements of the foot, leg and torso. Once the 3-dimensional image has been created, the shape can be modified to account for asymmetry in leg length, hip/knee flexion, abduction/adduction, and inversion/eversion. Patient photographs can be uploaded into the software to further aid the design process. Using the features within the design software, you may add insoles for foot comfort, add straps to assist with patient stability, and apply pressure or relief to specific areas for an intimate fit. This portion of the instructional course will focus on the technical process for producing standing shells using CAD/CAM technology. Different approaches for acquiring key patient shape data will be presented. Interactive software tools and functions for designing the final standing shell will be demonstrated. Finally, the manufacturing methods will be reviewed – carving positive model segments from polyurethane plastic, creating a loc

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Advanced Instructional Course: Optimizing the Use of CAD/CAM in Orthotics
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3796-841]

CAD/CAM for AFOs - the Central Fabrication Process

Author
Dowell, Jennifer (Newport Beach CA)
Orthomerica Productions Inc

Introduction
CAD/CAM applications for the prosthetic and orthotic industry now include options for AFO applications. This discussion will focus on the different methods utilized to create AFO shapes specifically using CAD/CAM. Different methods for AFO shape creation and shape captures will be covered ranging from taking measurements and using a shape library, imaging of a negative cast to imaging of the patient directly. Once the shape is created, specific surface and alignment modifications are achieved within the design software. These modifications can range from basic reliefs over bony prominences to correction of equinovarus. Then, concluding the process of fabrication with the final step of carving of the positive model and thermoforming.

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Advanced Instructional Course: Optimizing the Use of CAD/CAM in Orthotics
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Orthotics

Congress Lecture [3797-842]

CAD/CAM Technology for Custom Orthopedic Insoles

Author
Handford, Chris (Vancouver CA)
Vorum Research Corporation

Introduction
Using new CAD software, custom complex insoles can be created from a scanned 3D image of the plantar surface of the foot and weight-bearing imprint information. Modification tools allow clinicians to design insoles with their patients' orthopedic needs in mind: applying metatarsal pads, adjusting heel height and toe spring, adding relief for ulcers and heel spurs,
creating various depths of heel cup, and correcting over-pronation/supination. This portion of the instructional course will focus on the technical process for producing custom orthopedic soft insoles using Canfit TM CAD/CAM technology. Different approaches for acquiring key patient shape data, as well as the interactive software tools for designing the final soft insole will be demonstrated. Finally, the manufacturing methods will be reviewed – carving foot orthoses directly out of EVA, as well as producing positive moulds for vacuum forming.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Advanced Instructional Course [3855-None]

Artisan Prescription Footwear - Blending Tradition and Mass Customisation Technology

Session Chair

Jones, Derek (Glasgow UK) | PhD, M.B.A.
University of Strathclyde

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg632400

Advanced Instructional Course: Artisan Prescription Footwear - Blending Tradition and Mass Customisation Technology
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3856-783]

Introduction

Author
Jones, Derek (Glasgow UK) | PhD, M.B.A.
University of Strathclyde

Abstract
This instructional course examines the challenges and opportunities of providing fashionable prescription footwear across the full spectrum of stock, modular and bespoke designs.

Introduction
In this course, prescribed footwear is examined from a number of critical viewpoints with a faculty of clinicians, engineers, shoe manufacturers and designers. Whether shoes are required due to diabetes, arthritis, or other orthopaedic intervention, their role is to provide an essential prescribed function as well an acceptable appearance; and they must be provided in a timely and cost effective manner. The course considers the skills and resources to achieve this and presents some individual viewpoints on the state of the art.

Methods
Mr William Munro describes a rational approach to determine a prescription and specification for footwear based on an assessment of individual patient need. When, for example, is a bespoke solution indicated?
Mr Jonathon Bolton will review the challenges of providing bespoke footwear; stressing the importance of accurate plus necessary and sufficient measurements. The importance of good communication with the prescriber is stressed.
Mr Bjorn Klaveness will consider how technology is improving the provision of prescription footwear; making fashionable and functional shoes available to many more people.

Results
The demand for prescription footwear is high, prescribers of footwear are not always aware of what is possible and the traditional skills of footwear manufacture are not always available. In addition, economic pressures are demanding that provision is cost-effective and based on rational practices. In this scenario, technology should have a strong role to play so we consider the state of the art and what could be better.

Conclusion
In recent years the development and refinement of stock and modular designs has allowed many individuals to receive cost-effective and fashionable footwear. We will discuss the application of technology in this area and extended to fully bespoke solutions; pointing to examples of success as well as for areas of improvement.

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Advanced Instructional Course: Artisan Prescription Footwear - Blending Tradition and Mass Customisation Technology
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3857-806]

The Clinical Requirement for Prescription Footwear

Author
Munro, William (Clydebank UK)
Anatomical Concepts (UK) Ltd - Rehabilitation Engineering

Abstract
It is important when assessing patients for the prescription of footwear that a systematic approach is taken. The aim of this presentation to describe such an approach, which ensures that clinical requirements are specified and captured in a way that appropriate footwear can be designed and manufactured.

Introduction
Whether footwear are required due to diabetes, arthritis, pain or other orthopaedic intervention, their role is to provide an essential prescribed function as well an acceptable appearance; and they must ideally be provided in a timely and cost- effective manner. Significant public expenditure is made on prescription footwear. Many individuals require these items to protect their feet from pressure or shear or to provide pain relief. In these times of fiscal restraint it is vital that we resist the temptation to prescribe without regard to a systematic analysis of each patients' clinical need.

Methods
Traditionally, prescribed footwear has been classified as "stock", "modular" or "bespoke" based on how it is produced; based on the nature of any adjustments made to the last shapes on which the shoes are formed. Bespoke shoes are appropriate for individuals who cannot be accommodated on standard last shapes due to significant foot deformity and elevated clinical risk.
As a clinical associate at the University of Strathclyde P&O School with responsibility for teaching footwear measurement and prescription, I adopt a matrix or algorithm method to ensure clarity in the decision making process. This sets the parameters of what we believe to be an effective way of creating an audit trail, both in terms of clinical effectiveness and fiscal efficiency.
The matrix of possibilities guides the team in their efforts to optimise treatment and can be constructed from the following criteria:
• Deformity
• Ambulatory Status
• Biomechanical Analysis
• Neuropathic status
• Ischemic status
• Pain
• Environment

Results
The matrix we will outline is used alongside specific pathology risk factors to allow the shoe design to match the clinical requirements, and ensure optimisation of the features necessary to protect, control, correct or support the foot, whilst ensuring a cosmetic element meets the patient's expectations. We work closely with our footwear manufacturers to ensure that the specification and all necessary measurements are meaningful so that footwear can actually be made as we envisage.

Conclusion
It is important that clear instructions are given to the manufacturers on the specific features necessary to treat the foot and that the measurements required, taken by whatever method, reflect the dimensions of the presenting foot pathology. By engaging with the patient in this way, it is my experience that patient compliance with the resulting footwear is enhanced.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg632400/cg633780

Advanced Instructional Course: Artisan Prescription Footwear - Blending Tradition and Mass Customisation Technology
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3858-816]

Bespoke Prescription Footwear - The Challenge and the Opportunity

Author
Bolton, Jonathan (Newcastle Upon Tyne UK)
Bolton Brothers Ltd

Abstract
Bolton Bros Ltd have specialised in made-to-measure and bespoke shoes since 1952 and have refined their design and production technology over the years. With bespoke footwear, technology helps - but doesnt yet guarantee success. We look at critical success factors.

Introduction
With modular footwear we have seen technology emerge that can ease last selection for the practitioner and ensure that selecting shoe modifications, fitting and delivery are becoming easier processes. As this approach depends on limited modifications to a selected standard last, the processes may be streamlined for efficiency. However, bespoke footwear is made, for clinical reasons, to a unique last designed to accommodate a foot perhaps with significant deformity.

Methods
The skills involved in making bespoke footwear are high and in short supply. Developments in technology allow many persons who once received bespoke footwear to be accommodated with modular approaches but a significant number still require a truly bespoke solution. This presentation will explore the challenge of providing such footwear and how technology assists.
Clinical practitioners often poorly understand the techniques of bespoke shoes and the constraints on design, manufacture and fashion. There is a perception problem. Too often shoes have been seen as the cause of problems when actually the initial prescription was at fault. Bystanders may see the shoes as expensive when actually they represent just a fraction of overall treatment costs. And sadly they have often been perceived as ugly or unwelcome by patients.

Results
This presentation will review the challenge and opportunity for bespoke shoes. How measurements and specifications for bespoke footwear are taken is critical. We discuss what this means for 2 and 3d scanning systems and computerised design and manufacturing techniques.

Conclusion
Sophisticated scanning approaches and flexible design software are valuable advances. However, successful bespoke shoes start with clear communication between the orthotist and the manufacturer. Mutual appreciation of the possibilites for each patient and a skilled understanding of the requirement are essential.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg632400/cg633993

Advanced Instructional Course: Artisan Prescription Footwear - Blending Tradition and Mass Customisation Technology
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Foot and Shoe

Congress Lecture [3859-788]

Technology to Produce Fashionable and Functional Prescription Shoes

Author
Klaveness, Björn (Sandefjord NO)
Klaveness Skofabrikk AS

Coauthors
Bjorn Klaveness

Abstract
Technology for the design and manufacture of prescription footwear must address the issues of “Function”, “Form” and “Fashion” to be of value. The clinical and manufacturing demands must be met. In addition, individuals who require prescription shoes want to be delighted by what they receive. This session will examine some of the technologies that aim to make this possible.

Introduction
In many countries across the world educational programmes for orthopaedic shoemakers don’t exist. Competent people can be difficult to find. An interesting question to ask is do we still need them? Can technology help us deal with the needs of society?
For the High Street we can mass-produce footwear in a range of styles and sizes to satisfy the consumer. Prescription footwear is different. To apply design and manufacturing technology to prescription footwear is an exciting challenge. It means using technology to meet individual needs but with the economies of mass production. It offers the prospect that many more persons who require such footwear can enjoy both fashion and function.

Methods
Whilst 30 years ago an orthopaedic shoemaker made the diagnosis, took the measurements and made the shoes, the process has now been divided between specialists. A doctor makes the diagnosis, an orthopaedic engineer or orthotist makes measurements and specifies the order and a specialised factory produces the footwear - which of course is expected to fit first time. Some prescription footwear can be referred to as "stock" or so called “off the shelf”. Some can be based on a limited range of modifications from standard (modular approach) and some must be truly bespoke or custom made to an individual foot shape. The choice of approach depends on the clinical requirement of the patient and the constraints of the manufacturing technology.

Results
With our technology we try to permit prescribers who have the skills to get exactly what they need for their patients most efficiently. However, by using a range of technologies such as foot scanners, computerised data forms, web based solutions and the latest manufacturing technology we try to guide any user, whatever their skill level, through all the necessary processes and reduce the risk of mistakes. By careful choice of technology we can ensure that foot shape measurements are accurate, necessary and sufficient and we can verify that last selection, materials choices and so on are consistent and appropriate. By using computer-based methods we also have ideal tools for learning and continual improvement.

Conclusion

In this instructional course session we will explore contemporary processes for measurement, design and manufacture of prescription footwear; including their advantages and disadvantages. These approaches are not yet a replacement for traditional skills. At this stage they do represent a systematic approach for learning and improvement. They are allowing many more patients to receive fashionable prescription shoes in an efficient manner.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg632400/cg634206

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Basic Instructional Course [3618-None]

ICF and ISO Terminology to Specify Intended Use and Functionality of P&O

Session Chair
Bougie, Theo (Echt NL)
BRT-ADVIES

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg116685

Basic Instructional Course: ICF and ISO Terminology to Specify Intended Use and Functionality of P&O
Saturday 2010/05/15 | 08:00 - 09:15 | Subtopic/Track: Miscellaneous

Congress Lecture [3619-904]

Terminology on Prostheses and Orthoses from ICF and ISO 9999

Author
Heerken, Yvonne (Doorn NL)
NPi

Introduction

ICF3 is a widely used framework and classification to describe the status and situation of a person with disability. It has been published in 2001 by the World Health Organisation and is increasingly used by policy makers, health and rehabilitation care providers and for clinical and epidemiological research applications. ICF is presenting three scopes for describing human functioning (between brackets the negative approach of functioning): functions and structures (impairments), activities (limitations) and participation (restrictions). Human functioning is influenced by disease, environmental factors and personal factors. ISO 99994 is a standard on classification and terminology of assistive products. The standard follows the ISO regime on maintenance which means that a new version is published approximately every five years.

Methods

The latest version is from 2007 and defines an assistive product as any product (including devices, equipment, instruments, technology and software) especially produced or generally available, for preventing, compensating, monitoring, relieving or neutralizing impairments, activity limitations and participation restrictions. The classification is based on the function of the assistive product and includes all areas of human functioning. Prostheses and orthoses are included as class 06. The Instructional course will present a framework enabling matching ICF and ISO9999. This gives the opportunity to link problems in functioning of persons to the intended use of assistive products. This match is based on person related characteristics (ICF) and product related characteristics (intended use of a product in conformity with e.g. EU-legislation). The main intended use of orthoses relates to body functions and structures while with prostheses activities are relevant (e.g. walking).

Results

The orthoses and prostheses (components) as are on the market contain information on what the product is intended for and what the characteristics of the intended user in terms of ICF are. This information is increasingly moving into the intended direction. This enables a match between the characteristics of the user and characteristics of the intended assistive product.
The instructional course will introduce several tools to support this match.

References

3 International Classification of Functioning, Disability and Health; more information on ICF can be found on www.who.int/classifications/icf/en;
4 ISO 9999 Assistive products for persons with disability - Classification and terminology; Geneva 2007

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg116685/cg117015

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Keynote Speech [3791-None]

40 Years Sports Shoe Research – an Interim Result

Keynote Author
Milani, Thomas (Chemnitz DE) | Univ.-Prof. Dr.
Technische Universität Chemnitz - Institut für Sportwissenschaft Lehrstuhl Bewegungswissenschaft

Abstract
About 40 years ago sports shoes moved to the center of biomechanical research. Since then, intensive research has focused on the injuries caused by sports and sports shoes. Numerous studies conducted with a view to increasing knowledge about the interaction between the athlete and their sports shoes have even covered scientific areas such as neurophysiology or psychology – fields, which, at a first glance, would not be associated with sports shoes. This presentation will look at the indings from several studies and their influence in sports shoe development over the past 40 years.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg417748

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [3668-None]

Lower Limb Prosthetics - Functional Foot Components

Session Chair
Alimusaj, Merkur (Heidelberg DE) | Dipl.-Ing.
Orthopädische Universitätsklinik Heidelberg

Session Chair
Gauthier, Pierre (Geneva CH)
International Committee of the Red Cross - Physical Rehabilitation Programme- Health Unit

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2960-158]

User Oriented Selection of Prosthetic Feet Based upon their Mechanical Properties

Author
Schneider, Gregory (US)
Otto Bock HealthCare LP - R&D

Coauthors
Vossler S

Abstract
The presentation will focus on mechanical testing of prosthetic feet and how testing can be related to clinical practice. Mechanical testing methods, correlations to clinical and biomechanical properties and methodologies for prosthetic foot selection based on verifiable properties will be discussed

Introduction
The purpose of this work is to create a method for characterizing prosthetic feet by their mechanically verifiable properties. Through this work, a more objective method for prosthetic foot prescription can be constructed which should lead to better outcomes for the amputee.

Methods
The challenge of this work is to develop methods that provide relevant and repeatable data for the evaluation of prosthetic feet. In order to provide this data, a servohydraulic test machine fitted with a Kistler force plate was used to load and move prosthetic feet in many different configurations in order to simulate different aspects of the gait cycle. Different experiments were devolped using this test machine in order to correlate the outputs with both data gathered in a motion analysis laboratory and subjective feedback from amputees. The data was analyzed by a multi-disciplenary team of engineers, motion analysis experts and prosthetists to verify the accuracy and relevance of the data. Methods were developed to evaluate and rank the data in order to properly rate how an individual foot performs with respect to several clinically relevant parameters. The final step in the process is to create a system for propogating this information for everyday clinical usage.

Results
The result of the work is a system for evaluation of prosthetic feet. The system utilizes a set of parameters that are essential to the function of prosthetic feet. These essential parameters have a score that can be used to evaluate how well a foot performs that function. The scores can be evaluated across different patient activity levels since certain features of a foot may work well for a certain patient and may not work well for a patient at a different activity level.

Conclusion
This work shows that it is possible to develop an accurate and repeatable method to evaluate the mechanical properties of prosthetic feet. This method can be used to help the prosthetist objectively determine the best possible foot option for their patient. This determination is based upon clincially relevant information of the individual. Such information should help to improve clinical outcomes.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg34884

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3184-371]

Joint Kinematics and Kinetics in Unilateral Transtibial Amputees when Walking with an Adaptive Prosthetic Ankle Foot System on Stairs and Ramps

Author
Alimusaj, Merkur (Heidelberg DE) | Dipl.-Ing.
Orthopädische Universitätsklinik Heidelberg

Coauthors
Fradet L, Heitzmann D, Braatz F, Wolf SI

Abstract
The effects of a new adaptive prosthetic ankle were investigated in transtibial amputees (TTA) during ambulation on stairs and ramps using instrumented 3D-gait analysis. Significant improvements in kinematics and kinetics were found when walking with the adapted compared to the non-adapted ankle.

Introduction
Stair and ramp ambulation constitutes a particular problem for amputees showing most prominently the functional deficits relative to normal walking. However, typically prosthetic devices are first of all designed to support level walking. The recent development of computerized knees for transfemoral amputees led to better support when descending stairs and ramps [1]. Contrarily, the design and the function of prosthetic feet has not been considerably modified and commonly is still based on a combination of elastic carbon springs, polyurethane keels, and simple mechanical axes. The ankle function is therefore limited by the design of the artificial joint that is usually adjusted for walking on level ground. Due to the lack of recognition of the specificities related to stair and ramp ambulation and the prosthetic shortcomings, TTA are particularly handicapped and subject to different compensation mechanisms induced by the fixed ankle position of traditional prosthetic ankles.

Methods
Sixteen non vascular unilateral transtibial K3 amputees (50.3±12.0 years) and sixteen healthy control subjects (31.1±10.3 years) were provided with the new ankle including a practical and theoretical introduction to it before they underwent a conventional 3D gait analysis (VICON & Kistler) [2]. They were instructed in how to use the different features of this new device according to the manufacturer's recommendations. After an adaptation period of at least 14 days joint kinematics and kinetics of the lower limbs were analyzed during ambulation on an instrumented stair case with five steps and an instrumented ramp with an incline of 7.5° [3]. The condition of the adapted ankle was compared to the non-adapted ankle in neutral position using the norm-distance (ND) [4] to corresponding data of healthy controls. T-Tests were applied using SPSS 15.0 ($p<0.05$).

Results
In stair descent, the adapted ankle showed reduced ND's both in the involved and in the sound side. For the involved side, the ND for the hip angles, moments and power as well as the ND for knee moments were smaller when walking with the adapted ankle. In stair ascent with the adapted ankle, sagittal kinematics and kinetics were closer to the data of controls, both in the involved and the sound side. In the involved

side, this is shown by the ND's that were significantly smaller with the adapted ankle than with the neutral ankle for the hip moments and power as well as for the knee moments.
In the adapted mode, differences were observed between patients and controls for the knee kinematics and kinetics during ramp ascent. The ND's were smaller for the knee angle, moment and power. Particularly, knee flexion increased whereas the abnormal knee moment observed at the beginning of stance phase diminished. In the adapted mode, both the hip flexion observed at heel strike and the maximum hip power absorption was increased, becoming thus closer to normal. During ramp decent, the maximum plantarflexion moment was significantly increased. In the adapted mode, the lack of knee flexion and knee moment during mid-stance observed on the patient's involved side was increased, which increased the ND for the knee angle. Regarding hip kinetics, the differences between patients and controls decreased for the hip moment but increased for hip power in the adapted mode in terms of ND.

Conclusion

During stair ambulation the increased dorsiflexion of the adapted ankle had the tendency to diminish the ''hip strategy'' described by Yack et al. [5] leading to a more physiological behavior on the involved side. This was shown by the norm distance which was smaller for the parameters characterizing the kinetics of the involved hip, i.e., the hip moment and power and for the knee moment.
The increased dorsiflexion of the prosthetic ankle during ramp ascent led to a gait pattern which was closer to controls, namely an improvement in knee kinematics. Conversely, during ramp descent, the increased plantarflexion induced less physiologic joint kinematics and kinetics. However, the patients reported that they felt safer when walking in the adapted mode. Further investigations of the coefficients of friction on the incline are underway which might explain this safety aspect.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg39520

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3226-408]

Do Prosthetic Ankle Units Benefit Persons with Bilateral Transfemoral Amputations?

Author
McNealy Jackson, Lexyne (Chicago, IL US)
Northwestern University - Biomedical Engineering

Coauthors
Gard SA

Abstract
Quantitative analyses were conducted on 4 male subjects with bilateral transfemoral amputations that walked with and without prosthetic ankle units. Increased ankle motion in the sagittal plane may improve the gait of persons with lower limb amputations while providing a more versatile prosthesis.

Introduction
Persons with lower limb amputations are typically fitted with prostheses that provide less function than their anatomical counterparts. Additionally, slower walking speeds [1] and higher energy expenditures [2, 3] during gait are common characteristics of persons with lower limb amputations compared to able-bodied individuals. Studies of persons with bilateral transfemoral amputations (BTFA) generally report the qualitative nature of rehabilitation programs [4, 5]; however, none of these studies quantified the effect that prosthetic ankle motion has on gait. Persons with BTFA may benefit from the addition of sagittal plane ankle motion during the stance phase of gait to aid in the forward progression of the body over the ankle rocker [6] while the knee is fully extended. Therefore, the purpose of this investigation was to determine if increased prosthetic ankle motion in the sagittal plane improves gait in persons with BTFA.

Methods
Four males with BTFA, who used their prostheses daily, were recruited and consented for the study. Two test conditions were examined during the gait evaluations: (1) a baseline condition with only two Seattle LightFoot2 prosthetic feet, and (2) with the addition of Endolite Multiflex Ankle units. Each gait analysis consisted of the study participants walking at three self-selected speeds (slow, freely-selected, and fast). Three-dimensional kinematic and kinetic data were acquired from reflective markers positioned on the body and force platforms embedded in the floor, respectively. A minimum of 5 trials containing both initial contact and ipsilateral toe-off of the prosthetic foot were collected per speed per condition. Analyses of the gait evaluations were compared between test conditions and with a control group of able-bodied subjects. Subject questionnaires were administered following the study to gauge the study participant's perception of the prosthetic ankles.

Results
The amputee group walked slower than the control group over all three speeds. The addition of the Multiflex Ankle units did little to change the speed as only the slow speed of the able-bodied subjects was within the range of walking speeds in the amputee group. Sagittal plane ankle range of motion increased by a maximum of 8 degrees with the Multiflex Ankle units during the stance phase of gait. Additionally, the prosthetic ankle units had little effect on the peak magnitude of the joint moment and joint power profiles. Results from the subject questionnaire revealed that the subjects believed that the prosthetic feet alone

did not provide enough motion, while the ankle units made the prostheses feel less rigid without increasing the effort needed to walk. Moreover, the subjects agreed that the prosthetic ankles made it easier to walk on uneven surfaces and up inclines. Overall, the BTFA group perceived that the ankle units improved their walking performance.

Conclusion

Sagittal plane ankle range of motion increased in the BTFA group with the Multiflex Ankle units allowing the prosthetic feet to passively dorsiflex/plantarflex during loading. No other substantial differences in the data were found between the two test conditions. However, the subjects clearly preferred the addition of the ankle components in their prostheses than not as there was no perceived increase in effort needed to walk. Therefore, even though the results did not conclusively show that the Multiflex Ankle units improved gait, the results from this study suggest that sagittal plane ankle motion provides a more functional prosthesis and benefits persons with BTFA.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg40492

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3031-229]

Sagittal Plane Kinematics of Prosthetic Foot/Ankle Mechanisms: Calculated Joint Centre and ROM

Author
Rusaw, David (Jönköping SE) | MSc
Jönköping University - School of Health Sciences - Rehabilitation

Coauthors
Ramstrand N

Abstract
This study aimed to evaluate various prosthetic feet in ROM & centre of rotation in the sagittal plane. The results suggest that not only are prosthetic foot kinematics different from intact feet, the marker setup has an effect & results may not be generalizable between different prosthetic feet.

Introduction
The use of motion analysis techniques in amputee rehabilitation has made it possible to objectively measure the effects of prosthetic components on amputee gait and to track improvements in performance during the course of rehabilitation. There is currently no standard protocol for placement of markers on a prosthesis in order to define the ankle axis. The influence of marker position and movement artifacts has been demonstrated to significantly influence kinematic results in normal clinical situations (Della Croce et al., 2005,Leardini et al., 2005) and within the area of amputee rehabilitation. The aims of the current study were to evaluate a variety of prosthetic feet to determine how different kinematic models based on different marker placement configurations may affect sagittal plane kinematics, and to define the functional joint centre of each prosthetic foot in an attempt to make marker placement recommendations for future studies of amputee biomechanics.

Methods
A single-subject repeated measures design was used to investigate 6 different prosthetic feet (Advantage DP2,Trias,Axion,C-Walk,1H38 Single-Axis,and 1S37 SACH (Otto Bock Healthcare GmbH). On two occasions three dimensional lower-limb kinematics were collected using an 8-camera motion capture system (Qualysis AB). Position of the markers on the prosthetic foot were tested in two separate arrangements,one using an anthropometric value and one measured from the contralateral limb. Using these two marker arrangements, data was exported to and processed in Visual 3D (C-Motion Inc.) to provide the range of motion using 3 kinematic models (Figure 1) and calculated joint centre(COR) for each of the 6 prosthetic feet. One-way repeated measures ANOVA were used to compare means of max DF/PF and x-y coordinates of the COR for each foot. Adjusted post-hoc comparisons were used where appropriate. Paired t-tests were used to intra-test reliability of the data.

Results
In the ROM analysis, there were significant differences ($p<0.05$) within kinematic models for both DF and PF ranges of motion when comparing the anthropometric method compared to measured. In the DF range M1 differed with M2 and M3, yet M2 and M3 did not always differ from each other. In the PF range the Advantage foot differed in all configurations, Axion between M1 and M3, Cwalk M2 and M3,

Dynamic M1 and M2, M1 and M3, and Single-axis and SACH feet had no significant difference between any arrangements. Reliability analýsis showed greatest agreement between tests with the M3 model.
In the COR analysis, significant differences existed between the control foot and prosthetic feet in the X (horizontal) and Y (vertical) directions [(X=12.8cm (12.7,13.0);Y=4.3cm (4.0,4.6)] in both the anthropometric marker configuration, as well as the measured marker configuration. Posthoc analysis showed a significant difference between all feet in the X direction in both marker arrangements. In the anthropometric arrangement all feet differed in the Y direction with the control except for the Axion and the Single-axis. In the measured arrangement all feet differed in the Y direction except the Advantage and the SACH. Reliability analysis showed agreement between testing occasion one and two in all X position data for both marker positions (anthropometric and measured) except the Advantage foot. Y position was significantly different between all test occasions and configurations.

Conclusion

Prosthetic feet exhibit motion in the sagittal plane which is not purely rotational and therefore using reflective markers at the ankle to define sagittal plane motion are subject to error due to translational motion and motion due to deformation of the prosthetic foot. This systematic error is different and cannot be generalized between all prosthetic feet. The sagittal plane ROM of prosthetic feet are affected by the kinematic model an investigator uses.

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Image: Marker setups (x3)_None.JPG (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg35344

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3419-594]

Investigation of the Effect of Prosthetic Foot/Ankle Properties on Balance Efficiency while Standing on Inclined, Declined, and Level Surfaces

Author
Gard, Steven A. (Chicago, IL US)
Northwestern University Prosthetics Research Laboratory & Rehabilitation Engineering Research Program - Physical Medicine & Rehabilitation, Feinberg School of Medicine

Coauthors
Hansen AH
Gard SA

Abstract
Persons with transfemoral amputation increased energy consumption while standing on non-level surfaces with current prosthetic foot/ankle devices using a single stiffness value and alignment. Adapting foot/ankle alignment to sagittal plane surface slope significantly reduced oxygen consumption.

Introduction
Prosthetic foot/ankle stiffness and alignment are set by a prosthetist in a clinic on a level surface. The majority of prosthetic foot/ankle devices cannot dynamically change these properties; therefore, persons with transfemoral amputation employ hip joint and trunk compensations to maintain standing balance. These joint compensations are increased while standing on non-level surfaces, and may occur because passive foot/ankle devices do not adapt to surface changes. Increased energy consumption may be necessary to maintain balance on sloped compared to level surfaces with current passive prosthetic foot/ankle technology. It was hypothesized that: (1) decreasing prosthetic foot/ankle stiffness (without changing alignment) will decrease joint compensations reducing oxygen consumption, and (2) using adapted prosthetic foot/ankle alignment for non-level terrain will lead to oxygen consumption, joint kinematics, and kinetics that are similar to standing on level surfaces.

Methods
Ten persons with unilateral transfemoral amputation were studied to quantify their energy consumption and kinematic compensations while quietly standing on declined, inclined, and level surfaces. Five foot/ankle conditions were tested: three ankle stiffness values with standard clinical alignment and two sagittal plane adapted alignments with a rigid foot/ankle. The foot/ankle used in this study was a modified Shape-and-Roll foot with a commercial multi-axial ankle unit. Oxygen consumption rates were measured using the Cosmed K4b2 portable spirometer (Cosmed, Rome, Italy) and kinematic data were recorded at 120 Hz using an eight camera Eagle Digital RealTime motion capture system (Motion Analysis Corporation, Santa Rosa, CA). Data were collected while subjects quietly stood for five minutes; foot/ankle condition and surface slope were randomized. Subjects rested for five minutes between each trial. A repeated measures MANOVA was used to determine statistical significance.

Results
The different prosthetic foot/ankle stiffness conditions tested did not have a statistically significant effect on oxygen consumption ($p=0.220$) while standing on sagittal plane surface slopes. However, the different

sloped surfaces did have a significant effect on oxygen consumption (p=0.044). Specifically, oxygen rate significantly increased when comparing the level to the incline slope while standing with the high stiffness foot/ankle (p=0.023). Kinematic compensations primarily occurred while standing with the high stiffness foot/ankle device. The residual hip flexion angle significantly changed when comparing the level to the inclined slope (p=0.017). The different prosthetic foot/ankle alignment conditions that were tested had a statistically significant effect on oxygen consumption (p=0.003) while standing on sagittal plane surface slopes. Specifically, when persons with unilateral transfemoral amputation stood on the inclined slope with the adapted aligned foot/ankle, their oxygen consumption was significantly decreased compared to the standard aligned foot/ankle condition (p=0.034). The kinematic data support the oxygen consumption results. A significant change was found in the hip flexion angle when comparing the standard alignment to the adapted alignment foot/ankle conditions on the incline surface (p=0.005).

Conclusion

The results from this study suggest that current prosthetic foot/ankle designs that implement one alignment and a set stiffness value do not sufficiently accommodate to uneven surfaces. Persons with amputation using these devices adapt to surface changes with their anatomical joints resulting in poor postures and increased energy consumption. Decreasing stiffness values did not result in decreased oxygen consumption when comparing these conditions on the same surface. Only marginal improvements were observed in the kinematic data. Adapting the alignment of foot/ankle device decreased energy consumption compared to standard alignment while standing on inclined surfaces. Also, when standing on inclines, kinematic data were similar to standing on the level surfaces. These results indicate that designs of adaptable prosthetic foot/ankle devices should address realignment of the foot/ankle to match the sagittal plane surface slope, and thus improve energy consumption while standing.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg44004

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [2888-86]

Field Test and Follow Up on Foot Lifespan used in Low-income Nations

Author
Gauthier, Pierre (Geneva CH)
International Committee of the Red Cross - Physical Rehabilitation Programme- Health Unit

Abstract
Thousands of prosthetic feet are used each year in many low-income countries. Following 2006*ISPO recommendations, manufacturing process improve over the years and continued monitoring on foot life span remains crucial. A part of laboratory test,field test play an important role in that prospect.

Introduction
Monitoring prosthetics product life span used in developing countries remains a major challenge where patient follow up is often lacking due to difficult accessibility to the services. In the ICRC and SFD supported P&O projects more than 30.000 CRSACH feet are used every year, efforts have been made to optimize foot quality through various field test and labs research. Steps were taken to tackle the main problem, which is foot cover deterioration due to tropical climate and high humidity exposure. To overcome those weaknesses, right after the production, feet are placed in a steamer and exposed to dry air and 80° celsius during 8 hours. The process aims at completing the polymerising process and renders PU cells inert. PU characteristics are not changed.
The article reports the findings of the internal test on the modified CRSACH feet, using the same questionnaire and under similar conditions as the ISPO test published in 2006 and ICRC test published in 2007.

Methods
A prospective study has been carried out on 40 feet that have benefited of the new steamer. Those feet were fitted to 40 randomly chosen amputees with trans-tibial prostheses at the MOLISA, ICRC-SFD supported centre in Ho Chi Minh City. The study was conducted by CAT II P&O and supervised by CAT I P&O. Patients were recalled for follow up after 9. Next follow up will be held in December 2009 at 18 months. Data collection is based on the ISPO system and clinical field test forms. (Jensen/Heim1999).

Results
Functional and prosthetic follow up:
Half of the patients stumps were in good conditions with a good tonicity. Quality of Fit ranges from very good (12.5%) to good for (87.5%). After 9 months, some sockets had to be padded (17.5%). The majority of fitting were adequate and comfortable. All prostheses seen appeared to be well used (82, 5 %) after 9 months.
Foot comfort and durability:
After 9 months, a large majority of the patients were very satisfied of their PU foot 62% while 38% very satisfied. The PU foot is more comfortable than their previous foot made out of rubber. It is lighter, softer. Compared to ISPO 2003 test in Cambodia and ICRC test in 2006, the foot replacement rate after 9 months is as follows:
Test CR SACH Foot Failure Foot Failure
After 9 months After 18 months

ISPO/ Cambodia 2003 44% 78%
ICRC/ Vietnam 2006 15% 27%
ICRC/ Vietnam 2009 11% Outcome in Jan 2010
After 9 months of use, results are significantly encouraging. The failures are mainly due to intensive exposure to chemicals during patients work for four patients. The polymerisation completion through steaming is a good step to improve CR SACH foot. The Outcome after 18 months of use is still awaited.

Conclusion
Monitoring product lifespan is essential in low-income countries. While new manufacturing techniques and product design may evolve over the years, it is essential to follow up products life span on users. On CR SACH foot, the internal test brought encouraging results. Field reports confirm it in many countries like Sri Lanka, Myanmar and Nicaragua where foot PU early deterioration has been seen in the past years.

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Image: Pictures_Abstract_PGH_86.png (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg33828

Session: Lower Limb Prosthetics - Functional Foot Components
Saturday 2010/05/15 | 10:30 - 12:00 | Topic: Prosthetics | Subtopic/Track: Amputation/Prosthetics

Congress Lecture [3138-336]

The Effect of Prosthetic Ankle Units on the Gait of Persons with Bilateral Transtibial Amputations

Author
Gard, Steven A. (Chicago, IL US)
Northwestern University Prosthetics Research Laboratory & Rehabilitation Engineering Research Program - Physical Medicine & Rehabilitation, Feinberg School of Medicine

Coauthors
Su PF, Lipschutz RL, Kuiken TA

Abstract
The purpose of this investigation was to determine if increased prosthetic ankle motion improves walking performance of persons with bilateral transtibial amputations. Results indicate that prosthetic ankle components that permit greater motion provide substantial benefit during walking.

Introduction
The inferior walking performance of persons with amputations may, in part, be attributed to the current state of prosthetics technology. More functional prosthetic components may produce significant improvements in users' walking performance [1]. Many studies have analyzed and compared the gait of persons with unilateral transtibial amputations walking with different prosthetic feet and ankles [2-7]. However, unilateral amputees often exhibit compensatory actions on the sound side and display asymmetrical joint motions and forces [4, 8-11], making it difficult to assess prosthetic performance. Studying people with bilateral amputations offers a unique opportunity to observe prosthetic gait because they generally ambulate with greater symmetry [12] and they don't have the ability to compensate with a sound leg. The purpose of this study was to determine if the provision of prosthetic ankle motion in persons with bilateral transtibial amputations improves their walking performance.

Methods
Subjects were a minimum of two years post-amputation; used prostheses as their primary means of mobility; and were without serious health issues that would affect gait. At the beginning of each phase subjects were fitted with a different configuration that they used for a minimum of two weeks, concluding with a data collection session. During phase I, subjects were fitted with Seattle Lightfoot II feet (baseline). For Phase II, subjects were fitted bilaterally with either Endolite Multiflex Ankles (flexion) or Otto Bock Torsion Adapters (torsion). During phase III, each subject received the alternate components to those assigned in phase II. In the final phase, both the Endolite Multiflex Ankles and the Otto Bock Torsion Adapters (combined) were fitted into the subject's prostheses. Quantitative gait data were acquired in the VA Chicago Motion Analysis Research Laboratory for each condition. Surveys were used to document the subjective perceptions following each gait analysis.

Results
19 subjects were enrolled in the study. With the baseline configuration, subjects displayed wider step widths compared to the flexion ($p=0.009$), the torsion ($p=0.046$), and the combined configurations ($p=0.006$). Sagittal plane ankle motion increased 6 degrees with the flexion unit ($p<0.001$). Transverse plane motion increased by 2 degrees with the torsion unit ($p=0.026$ for baseline vs. torsion; $p=0.002$ for flexion vs. torsion;

p= 0.014 for baseline vs. combined; p<0.001 for torsion vs. combined). Peak ankle plantar/dorsiflexion moments decreased with the flexion unit, and peak ankle power absorption was greater with the flexion unit. With the flexion unit, peak ankle power “generation” was increased at the end of stance phase (p<0.001 for baseline vs. flexion; p<0.001 for baseline vs. combined; p<0.001 for flexion vs. torsion; p=0.003 for torsion vs. combined). Peak hip power absorption during late stance was greater with the combined configuration compared to baseline (p=0.009). Subjects perceived they were able to walk longer distances using the combined configuration than with the baseline and torsion configurations; that walking was smoother with the flexion configuration than with the baseline configuration; that walking on uneven ground was easier using the flexion, torsion, and combined configurations compared with baseline. When asked which configuration they preferred, 14 subjects chose the combined, 3 subjects chose the flexion, and 2 subjects chose the torsion.

Conclusion

Evaluating prosthetic components in persons with bilateral amputations is beneficial because the absence of sound limb compensations enables the advantages and disadvantages to be more easily identified. Results from this study should encourage clinicians to provide transtibial amputees with prosthetic ankle and foot systems that increase sagittal and transverse plane motions. Nonetheless, clinicians are encouraged to perform individual and appropriate assessments of their clients to insure that they capable of using a component that may cause them to sacrifice some degree of stability for potentially improved mobility. Understanding this trade-off between stability and mobility is important but is currently lacking. Additionally, it is important to recognize that the stiffness requirements for the prosthetic foot and ankle components may very well be different for standing, for walking on level ground, and for ascending and descending slopes and stairs.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg224394/cg38734

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3940-None]

Paralympic Sports

Session Chair
Potthast, Wolfgang (Köln DE) | Dr.
Deutsche Sporthochschule Köln - Institut für Biomechanik und Orthopädie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg997394

Symposium: Paralympic Sports
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3997-901]

Technology and Sports: The Future of Paralympic Sports

Author
Dyer, Bryce (Bournemouth GB)
Bournemouth University - School of Design, Engineering & Computing

Introduction
Sports technology, an in particular sports equipment, refers to all the implements an apparatus used by athletes during competition on the field of play to facilitate participation and/or to achieve results. The International Paralympic Committee recognizes the important role of sport equipment in enabling Paralympic competition, and is committed to a
sport environment where there are fair and clear rules governing the use of sport equipment for each sport. The fundamental principles that IPC is promoting regarding the evolution of equipment used during IPC Competitions are:
- Safety (i.e. to the user, other competitors, officials, spectators and the environment)
- Fairness (i.e. the athlete does not receive an unfair advantage that is not within the “spirit” of the event they are contesting)
- Universality (e.g. commercially available to all not just selected athletes or countries)
- Physical Prowess (i.e. human performance is the critical endeavor not the impact of technology and equipment)

Methods
The use of the following technology is prohibited at IPC Competitions. This applies e.g. to:
- Equipment that results in athletic performance being generated by machines, engines or robotic mechanisms; and
- Osteo-integrated prosthesis.
The development of technology drives the sports governance into a debate on ergonomics (safety, fairness and prowess), economics (universality) and ethics (fairness). This debate should be held with representatives of the industry, and guided by short-term and long-term objectives.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg997394/cg1887956

Symposium: Paralympic Sports
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3998-922]

Biomechanical Analysis in Amputee Running

Author
Potthast, Wolfgang (Köln DE) | Dr.
Deutsche Sporthochschule Köln - Institut für Biomechanik und Orthopädie

Introduction

The biomechanical sprinting analysis of the double amputee sprinter Oscar Pistorius revealed evident mechanical differences between double transtibial amputee sprinting and sprinting of able-bodied athletes (Brüggemann et al., 2008). In double amputee sprinting the loading of the lower extremity is completely differently distributed than in the sound limb. Also the energetic contributions of the joints of the lower extremity show entirely different distributions. In the limb with prosthetic supply about 80-90% of the mechanical work is done in the artificial ankle (prosthesis). Knee and hip joints contribute hardly. In the sound athletes the energetic contribution of ankle, knee and hip joint is much more evenly distributed. Hip and knee joints contribute more, the ankle less. However, this relationship of energy contribution in the symmetric runners (double amputee & sound athlete) is inverted in single amputee runners (asymmetric):

Methods

When running at about 7 m/s the sound ankle does about two to three times more mechanical work than the sound knee or the sound hip joint. At the prosthetic side about 80% of the mechanical work is done at the hip joint while knee and (artificial) ankle contribute less (Buckley, 2000). Apparently the different prosthetic situations induce entirely distinct movement strategies for a given task “run as fast as possible over a given distance”. Expressed in very simplified terms double amputee sprinting can be characterized as a movement, where the athlete - once he has a certain speed (and therefore a certain kinetic energy) - has to transmit his kinetic energy partly into the prosthesis with every footstrike. This movement strategy of stiffening the lower extremity and using the capacity of energy storage and return of the prosthesis is entirely different from able-bodied sprinting and it is apparently not feasible for the single amputee sprinter.

Results

The single amputee runner is not able to store a substantial amount of energy in the prosthesis and therefore has to use the hip for additional energy generation. These described phenomena might have drastic consequences in different fields of athletics. Questions of (A) safety and health of the athlete are directly linked to the described effects as well as (B) issues of limitations/regulations of technical development. Of course intensive and more comprehensive research has to be done before those ideas can be translated into practice.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg997394/cg1889216

Symposium: Paralympic Sports
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [3999-903]

Biomechanical Aspects of Sprinting with Lower Limb Prostheses

Author
Schmalz, Thomas (Göttingen DE) | Dr.
Otto Bock HealthCare GmbH - Research

Abstract
The presentation starts with describing general essential biomechanical parameters of sprinting. This biomechanical view allows to define the specific handicap of sprinters provided with transfemoral and transtibial prostheses.

Introduction
For athletes with transtibial amputation it is crucial that the most important muscles responsible for generating propulsion - the ischiocrural muscles - are functionally intact. The missing function of plantar flexors can be well compensated by modern prosthetic feet designed for sprinting. Therefore sprinters with transtibial amputation must not completely change their motion pattern compared to non-amputees.

Methods
Sprinters with transfemoral amputation, however, can neither use transtibial muscles nor knee extensors and ischiocrural muscles. In addition to limited possibilities of increasing the sprint velocity, this leads to stability problems during the support phase. Compensation is required by using suitable components, by biomechanically optimized prosthetic alignment and by changing the motion pattern. The latter becomes obvious by compensation movements of the trunk to avoid external flexion moments acting on the knee during the support phase.

Results
In the second part of the presentation, the sprint characteristics of non-amputees, transtibial and transfemoral amputees are compared based on exemplarily determined measuring data.

Conclusion
This analysis provides valuable information for further improvement of specific components as well as for optimization of movement techniques.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg997394/cg1890205

Symposium: Paralympic Sports
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Sports

Congress Lecture [4000-884]

An Argument for Assessing Lower-Limb Sprinting Prostheses Technology

Author
Dyer, Bryce (Bournemouth GB)
Bournemouth University - School of Design, Engineering & Computing

Coauthors
Sewell, P., Noroozi, S., Redwood, S.

Introduction
The premise of Disability Sport is to provide an environment within which an athlete can have a fair and competitive chance of success.
This presentation focuses on an exploration into the role and use of lower-limb prostheses in sprinting. However uniquely for disability sport, any solution should remain sensitive to any future innovations of this enabling technology. This research project explores these often conflicting themes.

Methods
Literature Review
Delphi Technique

Results
A literature review has indicated that fairness is a concern with respect to current lower-limb prostheses technology.
A qualitative exercise using an expert stakeholder panel raised and obtained consensus with several key themes. These themes relate to the role, perception and use of lower-limb prostheses in sprinting with a disability.

Conclusion
The results have revealed a greater understanding of the sprinting lower-limb prostheses in disability sport. From this, a need has been identified to monitor prostheses performance but not as an evaluation which focuses exclusively on physiological performance or one centred solely as a philosophical debate. Instead, a functional, equipment centred approach is recommended to monitor restorative based sports prostheses technology.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Symposium [3754-None]

Orthopaedic Footwear Manufacturing

Session Chair
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Session Chair
Schievink, Frank (Hannover DE)
ISPO Deutschland

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg390460

Symposium: Orthopaedic Footwear Manufacturing
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Foot and Shoe

Congress Lecture [3755-746]

Orthopaedic Shoe Fabrication - an Overview of Classical Measuring and Fabrication Techniques

Author
Schievink, Frank (Hannover DE)
ISPO Deutschland

Introduction
The diabetic foot is a complication for patients with diabetes mellitus and one of the main reasons for amputations in the lower extremity. The causes are neuropatic and angiopatic changes with effects on the fitness of the loaded foot.

Methods
Apart from the medical treatment, the education of the patient, podiatry as well as orthotics and special shoes are necessary for the prevention and therapy of foot-problems, e.g. ulcers. A well organized life-long treatment program by a team of different specialists will help the patient change his behavior and support the team in its efforts.
The treatment depends on how seroius the problem is. According to their state of health and their risk-factors, the patients are being classified in different groups. For each group, the German Association of Orthopedic Surgeons has developed guidelines for treatment.
The main technical measures of orthopedic shoemakers are the reduction of peak pressures through specially adapted orthopedic insoles, orthopedic alteration of factory made footwear, innershoes (functional orthopaedic components) and custom made footwear.

Results
The aims are: preservation of mobility, avoidence of ulceration and recidives and reduction of amputations. Several examples of treatment will be shown.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg390460/cg390906

Symposium: Orthopaedic Footwear Manufacturing
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Foot and Shoe

Congress Lecture [3756-None]

Hybrid Process During Fabrication

Author
Möller, Michael (Münster DE)
Möller Orthopädie Schuh Technik Münster

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg390460/cg391085

Symposium: Orthopaedic Footwear Manufacturing
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Foot and Shoe

Congress Lecture [3005-203]

Time-saving and Increased Quality for Orthopaedic Last Design with CAD-CAM Technology for Individual Shape Designed Lasts and Mass Customized Footwear

Author
Winkler, Patrick (Basel CH)
Winkler ORTHO SCHUH TECHNIK - CEO

Abstract
To an orthopaedic shoemaker the main advantage of CAD-CAM technology is its time-saving, coupled with high quality results. An objective criterion for patients´ satisfaction with the said technology is when the patient orders a second pair of shoes using the same last.

Introduction
The last is the basis of all orthopaedic mass customized shoes. Its design is of crucial importance for the shoe's quality, i.e. functionality and fit. The lasts are usually produced in several steps:
1. Measuring of the surface of the foot by means of cast copy, circumference-measurements, footprint, body scan or other methods.
2. Shaping of an initial last using a standard-, a foamed-resin- or a CNC-milled last.
3. The shape and settings of the last are tried on the patient by foil- or test shoe.
4. Corrections and finishing, final release for shoe production.
The routine of this procedure is nearly the same for each technique. The foamed-resin technique made from a cast copy is the most frequently used method in Western Europe.
This is an evaluation of a new way to produce lasts using 3D body scanning- and CAD-CAM technology.

Methods
74 last CAD-CAM fittings for primary supplies were evaluated between 1 March and 31 December 2008. Exclusion: Regular patients, former mass-customized shoe wearers, second last productions (last-copies). The feet were scanned using a 3D body scan in the Easy-Foot-Scan®. The scan- and setting data were submitted by an internet based CRM interface. The design work was provided by the manufacturer according to the submitted requirements. Each last was revised by a test-foil shoe on the patient's foot. It was then manually adjusted and fine-tuned, which took 1h30 on average. After that, a mass customized shoe was made using the finished last.
To find out if the CAD-CAM design and production is a practical way to produce orthopaedic mass customized footwear, it was checked if the patient ordered a second pair of shoes. The decision to re-order mass customized shoes, using the same last, was taken as objective confirmation by the patient that the made to measure shoe met his needs.

Results
The majority of cases, i.e. 54% (42), resulted in second orders.
41% (30) did not result in a second order. 3 % (2) have not been used to produce shoes to date.
The main reasons why 41% of cases did not result in second orders were:
• the patient moved out of the region,
• death,

• there was no insurance claim possible within the evaluated time period,
• old patients are immobile and have no wear-out and, consequently, use the same shoe for many years,
• the patient preferred to wear semi-orthopaedic shoes,
• the patient chose another supplier,
• other reasons.
With this 41% of cases which did not result in second orders, we regarded 70% (21) of the supplied shoes as still successful or quite successful. With 13.3% (4) of shoes we were not satisfied with the result. In 10% (3) of cases an appraisal was impossible.

Conclusion
The main conclusion of our evaluation is that 3D body scan and the outsourced CAD-CAM production of individual lasts is a practical way of producing mass customized footwear and an alternative to the foamed resin technique.
Other advantages of the CAD-CAM technology versus the foamed-resin technique are:
- time-saving, i.e. cost-efficiency,
- accurate implementation of settings and corrections in alignment with the last body
- digital data storage,
- less synthetic material and chemical reactions needed, i.e. this process is more environmentally friendly.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg390460/cg35189

Symposium: Orthopaedic Footwear Manufacturing
Saturday 2010/05/15 | 10:30 - 12:00 | Subtopic/Track: Foot and Shoe

Congress Lecture [3820-852]

Clinical Comparison of Scanner-made and Handcraftet Orthopaedic Shoes (First Results)

Author
Illgner, Ulrich (Münster DE) | Dr. med.
Uniklinikum Münster - Technische Orthopädie

Introduction

Customized orthopaedic shoes are the gold standard to treat malformed feet, if diabetes adapted shoes and insoles are no longer effective. Since few years an alternative method to the traditional manufacturing exists which relies on a 3-D scan of the feet instead of a plaster cast. Up to now no clinical trials have been conducted to evaluate and compare these two techniques in their clinical efficiency.

Methods

In a prospective blinded trial six patients received one pair of traditionally handcrafted as well as of scanner-made orthopaedic shoes. Criteria for exclusion were: Major amputations, walking aids and severe problems of balance. Time delay between the two provisions was 6 weeks. Clinical examination and biomechanical measurements were carried out one and 6 weeks after each provision. Clinical examination and biomechanical measurement included X-ray control of the correction in the shoe, analysis of posture (Lasar Posture), gaitanalysis (GaitRite®, Fa. CIR Systems), pedography (Pedar®, Fa. Novel) and questioning of the patients. The questionnaire has been compiled specificially for this investigation and includes 13 items on pain, mobility, disabilities of activities of daily life and work and satisfaction.

Results

By January 2010 two patients fulfilled all controls. An overview and analysis of the results from all 6 patients will be given in the presentation.

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg390460/cg535795

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Poster Session [3703-None]

Open Topics

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg244240

Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [2884-82]

Polio Eradication in India: Failure or Success

Author
Bisht, Vivek (DELHI IN)
ST STEPHENS HOSPITAL - DEPPT OF REHABILITATION MEDICINE

Coauthors
Sunil,Tyagi S,Verma P

Abstract
Poliomyelitis has been eradicated from large parts of the world. Still in India the active transmission of disease persist
WHO programme for eradication of polio as currently practiced in India was launched in 1994 The result has been encouraging with fresh polio case decreasing

Introduction
Polio is caused by the wild virus The virus spread by faceo-oral route. It invades nervous system and can cause paralysis depending upon the nerve involved Poliomyelitis has been the focus for prevention and control right from the inception of the Expanded Program for Immunization (EPI), adopted by the World Health Assembly in 1974. The availability of both the live attenuated Oral Polio Vaccine (OPV) and injectable Inactivated Polio Vaccine (IPV) and their effective usage in various countries raised hopes of eradicating this scourge. OPV was incorporated by India into the Universal Immunisation Programme (UIP) for children in 1980. Intensive Pulse Polio Immunisation (IPPI) was started in 1995, when all children under five years of age, irrespective of their immunisation status, were given additional doses of Oral Polio Vaccine (OPV) on National Immunisation Days (NIDs) and Sub National Immunisation Days (SNIDs). After a decade of intensive effort, are we any closer to eradication

Methods
2The Pulse Polio Immunization, in addition to routine polio immunization, was first started in the year 1995. Every child below 5 years of age was given two doses of oral polio drops with one month apart
The modified Intensified Pulse Polio Immunization strategy included vaccination of children through fixed booth approach on first day, followed by extensive house-to-house search of missed children for vaccination. During these years new strategies were introduced to cover endemic states and the results were good. All out efforts are being done to eradicate polio from these high risk areas Administering supplemental doses of OPV to all children aged<5 years during national immunization days to rapidly interrupt transmission: National Immunization Days (NIDs) in which a dose of OPV id administered to all children in the target age group, regardless of previous vaccination history. Subsequent doses are administered in the same way after an interval of 4-6 weeks from the previous round.

Results
Since 1994-when India initiated Pulse Polio Programme and set the ball rolling for the Eradication of Polio from our country. In 1994 and 1995 children up to 3 yrs of age were covered. From 1996-97 onwards all children up to 5 years of age are being covered under this programme. Since the year 2000-01, house to house component has been added on a full scale in the State as a part of intensification of Pulse Polio Programme with the aim of reaching each and every child in addition to booth strategy of Polio vaccination

alone which existed in earlier year. .At national level there has been decrease in the number of polio cases from 874 polio cases in the year 2007 to 559 polio cases in the year 2008 and 136 cases in 2009 till 17th July 2009, from about more than 50000 cases annually till about 1995-
1996
Number of Polio Cases :
YEAR INDIA
1998 1934
1999 1126
2000 265
2001 268
2002 1600
2003 225
2004 134
2005 66
2006 676
2007 874
2008 559
2009 136 (TILL MARCH)

Conclusion

The effort to eradicate polio in India has successfully increased the number of immunizations while reducing the number of polio cases. The focused and collaborative efforts of the Indian Government, the spearheading partners and community organizations are largely responsible for the impressive results. 33 out of India's 35 states are now polio free. In January 2009, the government committed to eliminating polio in the final two.
However, eliminating polio in two states Uttar Pradesh and Bihar will not be easy. Remote locations, diverse and migrating populations and frequent environmental impediments present immense challenges. Over the past two years, India has focused on underserved communities, increased social mobilization efforts and stepped up communication and tracking capabilities. The increased delivery and reporting infrastructure has produced positive results but the job is not done. Communication will continue to play a vital role in raising awareness of the disease, bel

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With proposed newer initiatives-an appraisal

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3613-678]

FE Modelling and Simulation of the Biomechanical Behaviour of Sensomotoric Insoles on the Foot to Enhance Digital Development and Adaptation

Author
Subke, Jörg (Gießen DE) | Prof. Dr.rer.nat. Dipl.-Phys.
University of Applied Sciences Giessen-Friedberg - Hospital and Medical Engineering, Environmental and Biotechnology

Coauthors
Kolling S, Kleinau P, Griesemann J, Neubert M, Staudt M

Abstract
The concept of sensomotoric insoles by Jahrling allows an improvement of the gait but the scientific substantiation of the method was yet to be accomplished. The aim is to develop a routine for the digital construction and adaptation of individual insoles.

Introduction
The individual adaptation of orthopaedic insoles for patients with disorders of the nervous system is a complex task. The concept of sensomotoric insoles by Jahrling [1, 2] allows an improvement of the gait without surgery. This concept of sensomotoric insoles is based on a vast practical experience in developing orthopaedic devices and a profound knowledge of the
cause and effect relation of the stimulation of crucial areas of the foot. So far the practical applications have been thoroughly successful but the scientific substantiation of the method and the development of a routine have yet to be accomplished.

Methods
To this end the mechanical properties of the insoles and their effect on the foot are investigated with the help of a FE-model combining a CT-scan of the foot and a one component FE-model of the insole. [4-6] In the first step the influence of different numerical parameters and the material description are investigated. The applied forces are determined by pressure measurement using the standard measurement systems of Novel and Zebris. Hereby two different conditions are taken into account for validation: barefoot on the floor and barefoot on the insole.
In the second step we investigate the deformation of the soft tissue in comparison with the insole which has a special surface geometry adapted to the individual foot. In this step the surface geometry and the material stiffness of the insole are changed. The viscoelastic behaviour of the insole material is determined by means of the impact test machine Impetus II [7].

Results
The result of the present work is the development of the routine for the digital construction and adaptation of individual insoles. This will enhance the practical application of the sensomotoric insole concept in order to avoid surgery. The digital construction of the insoles will also optimize the production and therefore add to the cost effectiveness of the medical treatment.

Conclusion

First steps towards an optimization scheme for sensomotoric insoles under load conditions are presented. A new modelling technique is shown using individual 3D-scans of the foot, pressure data of the gait analysis and test data of the material behaviour. With these “ingredients” all required data are available for a proper validation and verification process of the foot-insole-interaction via numerical analysis.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3381-556]

A Skill Test for a Novel Sliding Control Device of Indoor Driving for Elders

Author
Ng, How Hing (TW) | A skill test for a novel sliding control device of indoor drivin
Chang Gung University - Graduate Institute of Rehabilitation Science

Coauthors
Yang-Hua Lin, Chung-Hsien Kuo, Kuo-Wei Chiu, Yi-Chang Chan

Abstract
To compare the ability to accomplish the driving test by a sliding device mechanism with the one by a conventional joystick controlled by two elders and to analyze muscle activations during the test. At meanwhile, to calculate and compare the complete time, root mean square error(RMSE) of the tests.

Introduction
Elders have declined functional status associated with aging, medical problems, and inactivity. Old people often need wheelchairs as an assistive device for improving their mobility. There are more than half of wheelchair users lived in home environment or long-term care center. Driving wheelchair in daily activities has characteristics with shorter distance, lower speed and more bouts the indoor environment than that in the outdoor environment. Aging affects muscle strength, leading to impaired mobility and lack of independence in activities of daily living impact the motor function. After 65 years old wrist muscle strength average decrease 14%, declines hand and finger muscle strength effect hand control function. The purpose of this preliminary study is to compare the ability to accomplish the driving test by a sliding device mechanism with the one by a conventional joystick controlled by two volunteers elders and to analyze muscle activations of the forearms during the test.

Methods
The concept of the slide control mechanism (was installed on the tops of the two armrests of a standard wheelchair) was to drive power wheelchair through controlling direction with bilateral hands. The direction and speed are determined by the distance detected through the infrared installed into the armrest. Two elders with right dominant hand (1 male, 1 female aged 83±years) to participate in this test. Electromyography (EMG) of biceps, triceps, wrist, fingers flexor and extensor of bilateral arm and forearm was recorded by BIOPAC MP150 System and analyzed with Biopac's Acknowledge. Maximum voluntary contraction (MVC) was used to normalize the EMG data for each muscle group, monitored BP. Subjects took 15-minute driving practice before wheelchair driving test. The tests was executed in an indoor space and completed by following a square and S-path. Time to complete, and deviations from line shown as RMSE, and analyzing the muscle activation shown as the ratio to MVC were calculated.

Results
The participants completed the tasks and able to control the testing wheelchair without any discomfort. In, two subjects report the FEW score on the operation item, were 60% agree as independently to control the slide control wheelchair and the power wheelchair. Shown as table 1. The average time to complete the task was longer by driving wheelchair with the slide control and more root mean square error than

that completed by driving the power wheelchair in the square, S-curve test and indoor skills task. In both subjects there was not consistent achievement. We found that there was greater muscle activation of the triceps and the finger flexors and extensors at the non-dominat side with driving power wheelchair. With the slide control, the mean muscle activation showed the co-activation in the arm and forearm, and that had more muscle activation at the wrist and finger extensors at the right side. When doing left turn with sliding control , there were more activation of the biceps and the wrist and finger extensors. Although the joystick control is on the right hand side, subjects had muscle activation in the forearm muscle at the left side. S-curve by the slide control wheelchair, were left biceps brachii, bilateral wrist and fingers flexor and right wrist and fingers extensor muscle activation were greater than drove the power wheelchair. Forearm muscles were more activate than the arm in the left turn test, except biceps brachii of the left hand.

Conclusion

The slide control mechanism for driving wheelchairs is a novel design of the assistive technology. The preliminary study demonstrated that old people were able to driving with the power wheelchair with sliding control mechanism through the skill test in an indoor environment. The EMG indicated that the novel device co-activated the main muscles of arm and forearm to control it, the power wheelchair was adverse to use forearm muscle to control. The speed of power wheelchair with sliding control mechanism was driven slower than that one controlled by joystick which might be safer in the indoor environment.

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Image: Poster(fig.)_None.jpg (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3290-465]

Wheelchair Obstacle Simulator and Instrumentation for Assessing Wheelchair Rider Comfort

Author
Bryant, Tim (Kingston, ON CA) | Dr.
Queens University - Human Mobility Research Centre

Coauthors
Bryant JT, Anderson RJ, UP Wyss

Abstract
A wheelchair obstacle simulator and an accelerometer instrumented dummy were designed to study accelerations experienced by wheelchair users over rough terrain. The methodology was sensitive to the accelerations experienced and precise enough to aid in wheelchair design for rider comfort.

Introduction
Muscle fatigue, back injury and neck pain have been tied to exposure of high loads and repeated low loads. Thus, shocks and vibrations experienced during manual wheelchair propulsion can decrease an individual's comfort, increase the rate of fatigue, and limit activity (1). To improve ride quality, frame, seat, and suspension systems are designed to reduce the effects of shocks and vibration. Current wheelchair systems minimize the roughness of a ride to reduce the external reaction forces transmitted to the rider when going over bumps and curbs. To date, the magnitude and direction of these forces and the dynamic response of wheelchair riders have not been widely evaluated (1). The objective of this study was to design a methodology to aid in the design of wheelchairs for rough terrain majority world countries, by improving rider comfort through evaluation of the magnitude and direction of dynamic responses wheelchair rider's experience while descending curbs.

Methods
Testing was performed on a treadmill like apparatus. It consisted of a frame that was secured to the floor and was instrumented with a 1 hp motor. A central chain drove two 20.32 cm diameter drums - each with a 5 cm curb symmetrically attached. The wheelchair's rear wheels each sat on a drum. The frame also held the front caster of the wheelchair in place, restricting yaw but allowing for roll and pitch motion of the wheelchair. The wheelchair ground speed was set to an equivalent of 0.39 m/s. A 40 kg dummy, the mass of the 5th percentile Indian population (2), was secured to the wheelchair. The dummy's buttock was instrumented with three piezoelectric accelerometers oriented in the Headward/Footward (z), Forward/Backward (x), and Right/Left (y) directions. Data were collected at a rate of 1000 Hz in which the wheelchair went over 10 curbs. Six tests were done in total -three were done on one day and three on a separate day. Peak acceleration analysis was performed on the data.

Results
Acceleration vs. time graphs revealed distinct acceleration peaks corresponding to the wheelchair system passing over the curbs on the testing apparatus multiple times during data collection. These peaks were averaged over the 10 curb drops occurring in each test. These mean values were then averaged over

the six test conditions to provide a Mean Peak Acceleration and a corresponding standard deviation - summarized in Table 1.
The z-axis positive peak represents the acceleration felt by the dummy as the wheels impacted the drums of the testing apparatus after the wheels had rolled off of the curb, creating headward acceleration of approximately 0.5 g. The negative peak in the z-axis represents the acceleration the dummy experienced when falling off the curb towards the drums, giving a downward acceleration in the footward direction of approximately 1 g. Interestingly, the accelerations in the forward direction are of similar magnitudes. In the x-axis the positive peaks show acceleration in the dummy's forward (+Gx) direction and the negative peaks show acceleration in the dummy's backward (-Gx) direction -both are caused by the wheelchair's frame position that is rotated around the caster holder. In the y-axis, positive peaks illustrate the acceleration the dummy motion to the right side while the negative peaks illustrate the acceleration the dummy motion to the left. Both accelerations were likely caused due to lack of lateral stabilization in the spring suspension system.

Conclusion
No direction experienced acceleration greater than approximately 1 g, with the forward direction being the largest. The accelerations to the left were the smallest and differed in magnitude from the right due to the design of the wheelchair tested, but these accelerations should be of equal magnitudes with symmetrically built wheelchairs.
The apparatus and testing method was designed to simulate rough terrain and was sensitive to the acceleration experienced. The precision of this methodology is generally able to detect acceleration differences of 10% with a power of 0.8. This methodology thus can be used to aid in the design of wheelchair rider comfort due to its ability to demonstrate how much acceleration, hence force, as well as when and in what directions these occur. A wheelchair system that reduces the acceleration and force felt by manual wheelchair users makes it possible to improve a manual wheelchair users' comfort, reduce the rate of fatigue, and increase activity.

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Image: Table 1_465.jpg (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3223-405]

Improving Stock Management and Procurement at ICRC-supported Physical Rehabilitation Centres with the Help of a Tailor-made Computer Program

Author
Nininger, Joel (Geneva CH)
ICRC - Physical Rehabilitation Departement

Coauthors
Alexandra Schreck
Steve Mellor: smellor@ozemail.com.au

Abstract
To improve overall management of physical rehabilitation centres and ensure a high level of service for persons with disabilities, the International Committee of the Red Cross (ICRC) developed a specific computer program

Introduction
The ICRC has been supporting physical rehabilitation in Cambodia since 1992 in cooperation with the Ministry of Social Affairs, Veterans and Youth Rehabilitation. Today, the ICRC still supports two of the seven centres (Battambang and Kompong Speu) operating nationwide, as well the factory producing prosthetic/orthotic components and walking aids that are delivered free of charge to all centres in Cambodia. ICRC aid consists of financial contributions and mentoring of the technical and management staff. The material used in these facilities is purchased on the local market when possible, but goods not available locally are ordered overseas with help from the ICRCs central purchasing unit. Although the storage units were already reasonably well managed using a combination of manual and computerized recording of stock movement, the organization decided in 2007 to design a special computer program to optimize store operations

Methods
The project was budgeted in 2007 and launched in April 2008. It started with the preparation of a detailed set of specifications. Once that was complete, the ICRC contracted Steve Mellor, a software designer based in Cambodia, who did the work. From the beginning, the ICRC suggested designing a multilingual, multicurrency tool that could be used by any rehabilitation centre at no cost. For that reason, the software was developed in Microsoft Access, which offers the possibility of distributing a "runtime", thereby obviating the need for the final user to buy additional software in order to use the system. The program is also compatible with "Open Office", another free software package that includes a spreadsheet and word processor. ICRC staff felt that it would be useful to allow a degree of flexibility since the user might employ all features or only some

Results
Besides recording basic information on each item (supplier, item code, description, price, unit, currency, picture, category), the user can enter additional data such as average time for delivery, minimum stock and packing quantity. This allows the software to warn of low stock and, provided that the user records

stock movement (In/Out), to generate an "ideal" order. It includes an opportunity to manually change items and quantities in orders generated by the software.
To facilitate the recording of items received, the user can call up pending orders and account for the quantity actually received if this is different from the quantity ordered. Stock adjustment can be carried out by means of a partial or complete inventory (a recommended annual operation) and the difference attributed to gain/loss or disposal.
In the parameters, the user can set some features such as automatic backup and an alert to notify him when the quantity that has to be ordered differs from the calculated value. He can also enter general information about the rehabilitation centre and preset some values used in various parts of the program such as currencies, units of measure, beneficiaries, and item categories. Some of these values are pre-set, but items can be ticked so as to be displayed or not in the different windows.
The program also offers a wide range of reports that can be printed on screen or exported to other software

Conclusion
This program has proved an excellent tool for accurate daily management of warehousing. It is routinely used in the three ICRC-supported facilities in Cambodia and four other projects in different countries are currently testing it.
Language options and a user manual are being developed. In due course a training package will be implemented in all ICRC-assisted projects. The software will then be available at no cost to all centres, as is the case with the ICRC-developed patient-management system

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3201-388]

Psychological Distress, Body Image Disturbance, and Adjustment in Persons with Lower Limb Amputations Related to Diabetes

Author
Coffey, Laura (IE) | Miss
Dublin City University - School of Nursing

Coauthors
Gallagher P, Horgan O, Desmond D, MacLachlan D

Abstract
This study examined the relationship between depression, anxiety, body image disturbance, and adjustment in 38 persons with diabetes-related lower limb amputations. It was found that such individuals may be at elevated risk for psychological distress.

Introduction
Amputation affects psychological as well as physical well-being, and is significantly associated with depression, anxiety, social discomfort and body image anxiety1. Approximately half of all lower limb amputations occur in persons with diabetes.
In contrast to amputations arising from trauma, individuals who have undergone amputations due to diabetic complications must continue to cope with their comorbid medical condition as well as adjust to the amputation itself. The impact of amputation on psychosocial variables may therefore be even greater in persons with concurrent diabetes. Few studies to date have looked at adjustment to amputation in this population specifically, however. The aim of the present study was to examine psychosocial adjustment in persons with diabetes-related lower limb amputations.

Methods
Potential study participants were identified from the patient records of two national limb-fitting centres in Ireland. Individuals aged 18 years or over who had lost a limb and were currently using a prosthesis were considered eligible for participation. A study questionnaire was sent to all potential participants, containing the following self-report measures:
Trinity Amputation and Prosthesis Experience Scales (TAPES)
• 37-item measure of adjustment to amputation, consisting of three sections related to psychosocial adjustment, activity restriction, and satisfaction with the prosthesis
Hospital Anxiety and Depression Scales (HADS)
• 14-item measure of anxiety and depression symptoms
Amputee Body Image Scale-Revised (ABIS-R)
• 14-item measure assessing how an individual with an amputation perceives or feels about his or her body experiences

Results
Thirty-eight individuals with lower limb amputations related to diabetes participated in the study, with ages ranging from 43 to 85 years (median = 68, mean = 66.4, SD = 10.96). Length of time since amputation

ranged from 6-180 months (median = 36, mean = 40.31, SD = 28.66). Participants reported rates of prosthesis use ranging from 0-16 hours per day (median = 12, mean = 11.1, SD = 4.49).
Over 18% of participants scored above the normal range (>8) for anxiety and depression, as measured using the HADS. This compares with rates of 12.6% for anxiety and 3.6% for depression in the general adult population. Both depression (# = 0.75, p < .01) and anxiety (# = 0.62, p < .01) scores were significantly associated with body image disturbance, as measured using the ABIS-R. Significant relationships were also observed between body image disturbance and three TAPES subscales measuring psychosocial adjustment [general adjustment (# = -0.48, p < .01), social adjustment (# = -0.51, p < .01), adjustment to limitations (# = -0.45, p < .05)].

Conclusion

Individuals with amputations related to diabetes may be at elevated risk for psychological distress due to their comorbid medical condition. Regular screening for anxiety and depression in this population and the provision of appropriate follow-up care may therefore be advisable. Body image disturbance was found to have a significant relationship with psychosocial adjustment in the present sample, and may thus play an important role in how people adapt to diabetes-related amputation. Prospective, longitudinal studies with appropriate control groups are required in order to further elucidate the process of psychosocial adjustment in persons with diabetes-related amputations and inform interventions to promote positive outcomes in this population.
This work is based on the following publication: Coffey L, Gallagher P, Horgan O, Desmond D, MacLachlan D. Psychosocial adjustment to diabetes-related lower limb amputation. Diabet Med 2009;26:1063-7.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [2972-170]

Outcomes Studies in Advanced Prosthetics, Amputee, and Human Performance Research

Author
Fisher, Ashley (Fort Detrick US)
Telemedicine and Advanced Technology Research Center - Advanced Prosthetics and Human Performance Portfolio

Coauthors
Mackenzie E, Bodenhamer D

Abstract
This paper/poster will highlight the efforts underway in the U.S. Department of Defense at addressing the unique psychosocial needs of veterans returning from war with combat-related amputations.

Introduction
The Telemedicine and Advanced Technology Research Center (TATRC) is a division of the U.S. Army Medical Research and Material Command (USAMRMC) with a mission to explore science and engineering technologies ahead of programmed research. The Advanced Prosthetics and Human Performance portfolio within TATRC aims to help our warfighters achieve the highest possible quality of life through the advancement of revolutionary amputee and human performance research. Within that portfolio, the Outcomes and Program Assessment (OPA) program consists of several established and continuing research projects of which the goal is to assess the quality of life of returning veterans with traumatic amputation, both short and long term. This paper/poster will highlight two projects within the OPA program.

Methods
Indiana University and Ohio State University have combined efforts to develop the Indiana-Ohio Center for Traumatic Amputation Rehabilitation Research. During Phase I of the research, the team established a national registry of Vietnam War amputees (approximately 450 registered) and an 18 item survey of baseline information and consent for contact about future studies. Phases II and III, which are currently underway, include a qualitative investigation to inform selection of follow-up survey items and to administer the surveys to a national sample. Preliminary qualitative findings indicate higher rates of depression and PTSD as compared to the general population or Vietnam Veteran Cohort. Specifically, 42% of study veterans with traumatic amputations claim PTSD while only 9.1% of their Vietnam Veteran cohort claims PTSD. Other preliminary data indicates unique health concerns, including higher rates of arthritis and back pain among prosthetic device users compared to non-users.

Results
One major goal of this study is to apply the findings to standards of care for current veterans returning with amputations from OEF/OIF.
Dr. Ellen Mackenzie and her team at Johns Hopkins University are addressing the long-term consequences of major limb trauma sustained by service members in GWOT. The two principal sources of data for this study includes demographic clinical data abstracted from the medical record and entered into a clinical database and telephone interviews 1-5 years following the injury. Preliminary findings indicate that 23%

of Military Extremity Trauma and Limb Salvage Study participants have a positive screen for PTSD, 33% with mild TBI, and 16% with concomitant injuries. The study intends to further investigate how to improve outcomes in these patients despite these comorbidities, which may include greater emphasis on non-clinical psychosocial interventions.

Conclusion

As advances are being made in prosthetic device technology, an increasing number of researchers are focused on assessing the quality of life of returning veterans with traumatic injuries/amputations. Instead of researchers assuming they know the needs of the amputee population, they are determined to understand these issues from the veterans themselves. This paper/poster addressed the DoD's goal to address the unique needs of the amputee population from both the Vietnam War and OEF/OIF by highlighting two funded efforts.

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None.

Image: OPA_Brochure_Seite_2_170.jpg (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3132-330]

Variability of Trajectory of Center of Force during Standing and Walking in Local School Children

Author
Wong, Chi Wai (HK) | Variability of Trajectory of Center of Force during Standing and
The Duchess of Kent Children Hospital - Prosthetics and Orthotics Department

Coauthors
Aaron KLL

Abstract
The aim of this study was to investigate the trajectory of COF in children to provide a reference for further study. Influence of balance strategy by age and the correlation between static and dynamic stability were also studied.

Introduction
From the foot- pressure measurements, clinicians can diagnose foot deformities and critize the effectiveness of treatment (1).The methods of analysis can be classified into specific anatomical features approach or regional approach. However, either of the methods has its limitations such as the difficulties in distinguishing the anatomical features or dividing a foot of people with foot deformities (2).
With the advantage of not requiring any anatomical landmarks or segment divisions, the study of the COF movement under the feet is a rather convenient and important parameter generated from plantar pressure information for the study of foot function.
The COF trajectory can also be used as a stabiliometric parameter. By comparing the stability with normal subjects or comparing the results before and after treatment, the existence of balance problem which may increase the risk of a fall or the effectiveness of the treatment intervention can be determine (3).

Methods
A total of 127 subjects with either sex, aged 6 to 10 were recruited. Tekscan Walkway System was used for data collection. The displacement and velocity in anterior- posterior and medial- lateral direction were computed for setting an initial reference for further study. One static trial of 5s quiet standing and three walking trials were taken.
For static condition, the parameters for analysis included AP and ML COF excursion range and velocity of COF between both feet. These parameters are used for the investigation of postural stability.
For walking state, it is divided into single support and double support. During single support, the net COF lies within that foot is studied. While during double support, there would be a net COF lies between the two feet. The excursion and velocity of COF in AP and ML direction were calculated for dynamic analysis. And only a pair of footprints starting from right to left was selected for analysis in each trial for the reason of standardization.

Results
1) Static measurements
Similar trends can be seen among the two AP/ML parameters (excursion range and velocity) respectively. For the AP COF measures, there was fluctuation in the mean values from 6 to 10. For the ML COF

parameters, both of them reached their maximum at the age of 7. And then follow by a decrease in the values with increasing age.
Significant different of AP COF velocity occur between the age of 6 and 9 (p=0.01) and also between the age of 8 and 9 (p=0.04). Both the ML COF excursion range and velocity shows significant differences between subjects from age of 6 and 7 with age of 8, 9, and 10.
2) Dynamic measurements
All the results obtained during walking show no significant difference among all age groups except the ML COF excursion of left foot during double support with p=0.049.
This would suggest there is not much effect on the COF movement under the foot by growth.
Significance difference were shown for both AP (p=0.001) and ML body sway (p=0.04) among age groups. Significant difference of mean AP body progression is found between the age of 6, 7, and 8 versus 9 and10. This implies that the AP body progression change at the age of 8 to 9. However, the change in ML body sway is found to occur gradually from the age of 7 to 10.
Pearson's correlation coefficient (r) between AP excursion range and body progression is r = -0.254 which suggested there was a very weak correlation between these two parameters.

Conclusion

A total of 127 children aged 6 to 10 participated in this cross- sectional study. The COF was used as the measure to reflect foot function and stability.
Reference data are listed in tables and figures to describe the normal trajectory of COF across the foot during standing and walking. These tables and figures can be used as a reference by researchers. Further study on COF trajectories may enhance its usefulness as a diagnostic measure of foot deformities and may increase the clinicians ability to measure changes in foot deformity or balance problem.
The static balance, which was reflected by ML excursion range, was found to develop until the age of 7 to 8 and became mature. On the other hand, the dynamic balance which can somehow be reflected by the body sway was shown to develop at around the age after 7.
No correlation was found between static and dynamic stability. Therefore, it was suggested that balance studies on static and dynamic condition to be separated.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3203-390]

Cognitive Functioning in Persons with Lower Limb Amputations: a Review

Author
Coffey, Laura (IE) | Miss
Dublin City University - School of Nursing

Coauthors
Gallagher P, Desmond D

Abstract
The present study offers a review of the published literature on cognitive functioning in persons with lower limb amputations, with a particular focus on the ways in which this variable has been defined and measured, and examines its relationship with functional outcomes in this population.

Introduction
Improved healthcare and a steady growth in the number of elderly in the population has led to a rise in the average age at which amputation occurs, with over half of new cases involving persons aged over 65. Certain aspects of cognition such as information processing speed and abstract thinking tend to decline with age, even though intellectual performance may remain intact. Older persons with such deficits may struggle to regain mobility and independence following amputation, as complex new behaviours and skills must be learned in order to achieve these goals.
Cognitive functioning has rarely been examined in studies of individuals with amputations, despite its apparent importance in the recovery process. The present study provides a review of the published literature to date on cognitive functioning in persons with lower limb amputations and examines its relationship with health- and rehabilitation-related outcomes in this population.

Methods
A computer-aided literature search was carried out to identify studies in which the cognitive functioning of persons with lower limb amputations was assessed. The following keywords were used: amput*, cognit*, neuropsych*, intellect*, mental, dementia, memory, executive, visuospatial, and psychomotor. Studies were selected if (a) they involved participants aged 18 years and over with major lower limb amputation and (b) cognitive functioning was assessed, either for screening purposes or for inclusion as a study variable.

Results
A total of 32 studies were identified that met the inclusion criteria. Cognitive functioning was operationalised and measured in a variety of ways across studies. In seven papers, presence of dementia was ascertained from medical chart data, with prevalence rates of between 5% and 27.5% reported. Ten studies involved the administration of brief cognitive assessment inventories, three of which used these measures as screening devices for cognitive and communication problems. A further six studies used a selection of neuropsychological measures to assess cognition in this population.
Cognitive functioning was linked with a number of different health and rehabilitation outcomes, including perceived health, functional independence, activity restriction, prosthesis use, and mobility. Memory was the cognitive domain most frequently associated with rehabilitation outcome.

Conclusion

The incidence of cognitive impairment is quite high among individuals with lower limb amputations, and is associated with significant difficulty in the preservation of mobility and independence. Cognitive dysfunction often goes unnoticed until well into the rehabilitation process. This can lead to wasted time, effort and medical resources, and may represent a missed opportunity for such patients to achieve mobility through other means, such as wheelchair use.

Assessing the cognitive abilities of patients either before or after amputation would enable medical staff to determine their suitability for prosthetic or wheelchair rehabilitation, to ascertain appropriate and realistic goals for rehabilitation, and to tailor the rehabilitation programme to patients' strengths so that maximal mobility and independence is achieved. The timing of such an assessment is important, as patients may suffer from temporary confusion following amputation surgery.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3346-521]

The ICF Model as Instrument for Education in Rehabilitation Medicine and Prosthetics and Orthotics

Author
Rommers, Gerardus M (Clemens) (Groningen NL) | MD, PhD
University Medical Center Groningen, University of Groningen - Center for Rehabilitation

Coauthors
Tepper M, Bakx WGM

Abstract
The ICF model is an educational instrument for functioning with different diseases. For medico-technical students it gives relation between disease and functioning. Is gives tools for education of healthcare professionals in a team approach with medical and technical interventions towards patients.

Introduction
The ICF model (International Classification of Function, Disability and Health) is presented by the World Health Organisation (WHO) as instrument for analysis of functioning of the patient. Several parts of the model are used for the training programme of medical students and specialist registrars in rehabilitation medicine..
In rehabilitation medicine this model is used as standard for analysis of function. Is it a useful instrument in education of doctors and prothetists?

Methods
During training in rehabilitation medicine the model is used during education of students in teaching groups; on the wards as interns. The ICF model is used in patients with diabetes, stroke, amputation or spinal cord lesions. The prosthetist / orthetist is also involved in functioning of the patients before and after introducing prosthetics or orthotics. The ICF model gives possibilities toward an adequate prescription of the assistive devices related towards function. By varying the different factors a patient case can be made easy or more difficult for the students.

Results
In medical notes of the doctor and worksheets of the prosthetist a pre-printed ICF scheme helps the to formulate the medical problems and prosthetic / orthotics solutions. Medical letters and prescription forms for prostheses and orthoses give an adequate overview of functioning and the participation issues to be addressed. The model gives clear information to insurance companies why components are used and are related to functioning of the patient. The ICF model gives tools for students, doctors and prosthetist and orthetists in training. It is therefore an instrument for every doctor and technician to see the medical aspects related to functioning and participation.
A quick change can be made from the disease model (diabetes; amputation) towards functioning (walking, ADL activities) and participation (work hobby and wellbeing). It is informative for students and professionals in a multidisciplinary approach.

Conclusion
Students can use the model quite easily to have a quick an comprehensive overview of the patient involved. The model can be used in a wide variety of diseases and by different healthcare professionals. The model should be implemented in all training modules for doctors, therapists and technicians. Education for all healthcare professionals should include the use of the ICF model for education and evaluation.

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Image: ICF scheme_None.JPG (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3082-280]

Enhancing Quality of Prosthetic Services with Process and Outcome Information

Author
Heinemann, Allen (Chicago US) | Prof
Northwestern University - Physical Medicine and Rehabilitation

Coauthors
Ehrlich-Jones L, Williams D

Abstract
Five clinics providing lower limb prosthetic services are collecting outcome data using the Orthotics Prosthetics Users Survey. Project staff reviews data with the facilities and consults on ways to improve service quality. This presentation highlights issues identified during outcome monitoring.

Introduction
Despite the availability of standard measures to assess patient outcomes, provider enthusiasm for outcomes monitoring is diminished by the burden. While providers acknowledge the value of data collection, they do not have access to information systems that allow them to compare their outcomes with other providers. We are conducting a study in collaboration with the American Board for Certification in Prosthetics and Orthotics, Focus on Therapeutic Outcomes and the American Orthotics and Prosthetics Association to develop an outcomes monitoring program that allows providers to improve patient care. We are evaluating this system and a quality improvement curriculum to assess the actions providers take to enhance the quality of patient outcomes. Accreditation standards are designed to enhance quality healthcare and to increase efficiency and improve patient outcomes. We have learned from providers that they perceive outcomes data collection and monitoring as time consuming and expensive.

Methods
We have recruited 5 prosthetic facilities to collect data from 100 lower limb prosthetic patients in the Midwestern United States. Participating facilities include free-standing clinics and clinics within hospitals. Facilities are using either paper forms or a PC-based application that uploads data to a central repository. Patients complete the Orthotics Prosthetics Users Survey at admission, discharge and 2-month follow-up; clinicians report patient characteristics and services at admission and discharge. Focus on Therapeutic Outcomes manages the data. Project staff prepares comparative reports and provides consultation on quality improvement opportunities.

Results
We expect that process and outcome indicators will demonstrate improved compliance with ABC's Performance Management and Improvement Standards. Facilities will collect more detailed and specific quality-related information and they will implement a number of procedural changes to improve patient care quality. We will use accreditation survey results to identify common problems facilities have complying with American Board for Certification in Prosthetics and Orthotics standards and develop an on-line curriculum that addresses these deficiencies. We expect survey results 12 months after the educational intervention to show increased compliance with standards and increased patient satisfaction with services and devices.

This project has the potential to improve clinical practice favorably. The Centers of Medicare and Medicaid Services require facilities to achieve accreditation in order to be eligible for Medicare reimbursement. Still, wide variations in performance management exist, in part because facilities have few examples on how to monitor and improve their services. This project will develop and promote “best practices” to a wide audience.

Conclusion

Prosthetic providers do not compete on the basis of valid measures of clinical quality. Quality improvement should be undertaken by health care facilities on behalf of their patients and communities, not solely as an accreditation exercise. Health care quality instruments are rarely developed with the care and precision taken for granted in other industries; thus, we do not know what we are measuring. Orthotics and prosthetics providers urgently need a means of measuring and enhancing healthcare quality given the fragmented nature of the industry. No industry-wide instrument is accepted for quality improvement. The Orthotics and Prosthetics Survey allows facilities to monitor patients’ outcomes and the typical goals of prosthetic services: reduction of activity limitations, enhancing quality of life, and assuring patient satisfaction with services and devices. Routine collection of outcome data will allow facilities to monitor their services and take steps to improve service quality.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3248-429]

Case Study of Relation between Prostheses and Extended Haptic Perception in Left Forearm Amputee

Author
Hara, Kazuko (Hamamatsu JP) | Case study of relation between prostheses and extended haptic pe
Seirei Christopher University - Rehabilitation Sciences

Coauthors
Miyamoto E,Koike T,Soga T,Okumura S

Abstract
We evaluated the haptic perception of a subject who underwent below elbow amputation of his left forearm 23 years previously as the result of an industrial accident.
Our results suggested that the haptic capabilities with the upper prosthetic extremities was not disappeared but conserved some degree

Introduction
For the reason of the absence of neural supply and connections, it seems to be difficult to perceive both the objects grasped with prosthetic hands and the prosthesis itself without other sensory modalities or conscious efforts.
However, note that people can use the non-neural implements to perceive their surrounds. It is well recognized but poorly understood that a person can feel the end of the implement, the surface of it, and the implement as an extension of the body rather than another part of the environment, when one uses a hand-held tool to act upon or to explore the environment. Moreover, the distal layouts of surfaces are also perceived by striking them with an implement, such as blind people who can detect a curb with a long cane. This haptic capability implies that the non-neural prostheses provide a means for obtaining information at a distance from tissues with mechanoreceptive neurons.
Our goal was to investigate whether an amputee can perceive the properties.

Methods
Participant
A 48-year-old male who was amputated below elbow, 25 years post-amputation was participated. He has used three kinds of prosthetic arms for his daily activity: a myoelectric arm (Otto-Bock, VC hook), a body-powered Arbeitsarm (TRS, Grip 2SS VC hook with locking devices), and a cosmetic arm.
Procedure
We evaluated the haptic sensitivity of his right arm and the three kinds of prostheses by the standardized sensory tests which are often used in clinic. They included the tests for vibratory sensation with 128cps/256cps tuning forks, two-point discrimination (static/moving), cutaneous sensation with Semmes-Weinstein monofilament, sensation of weight, texture discrimination (static/moving), and a sensation of position of thumbs.

Results
The sensation of his right arm was normal. On the left arms, the scores of vibratory sensation test showed that the myoelectric arm was in hypesthesia class and Arbeitsarm was in normal class. The scores of two-

point discrimination test were low in all arms, though he reported that he felt the touch. The scores of Semmes-Weinstein monofilament test showed that the cosmetic arm was most sensitive, the Arbeitsarm was second, and the myoelectric arm was third. The scores of texture discrimination test and position sensation of thumb test showed that the cosmetic arm was in severely disabled class, while the Arbeitsarm and the myoelectric arm were in mild disabled class.

Conclusion

Our results suggested that although the performances of touch tests by means of the prostheses were under his intact arm, the haptic capabilities with the upper prosthetic extremities was not disappeared but conserved in some degree. The additional fact that these different three prosthetic arms showed different sensitivities implies that they are not completely equivalent and transparent media which do not depend on any relevant parameters of themselves. It is possible that certain physical quantities and material compositions of the prostheses might be functional as haptic extensions. For example, the lighter prosthesis might better facilitate to transfer the momentum from prosthesis to an adjacent body segment and detect a little displacements of target objects. The future direction of this study will be to identify some mechanical (not anatomical) parameters of prostheses to increase the sensitivity of haptic system.

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Image: Extended_haptic_None.doc (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3385-560]

The Important of Clinical Experience for Assistant Lecturer in Sirindhorn School of Prosthetic and Orthotic

Author
Sukthomya, Sasithon (Bangkok TH) | The important of clinical experience for assistant lecturer in S Sirindhorn School of Prosthetic and Orthotic - Rehabilitation medicine, Faculty of Medicine Siriraj Hospital, Mahidol University

Coauthors
Thanyaporn Rakbangboon

Abstract
Clinical experience always has been an integral part of P&O education. The importance of preparing prosthetist and orthotist capable of “doing,” as well as “knowing,” has meant that clinical education has remained a significant component of teaching

Introduction
In 2009, four promotions from the school have been graduated. Most of the graduates are work in P&O field as CPOs in clinic both government hospital and private companies. The less are continuing in education and working in different field.
Currently, ten graduate working as assistant lecturers for the Sirindhorn School of Prosthetic and Orthotic were divided into 2 group ,working as lecture with students and the other are in the clinic for clinical experience. Aiming to treat real patients with real problems under supervise of clinical mentor in order to gain valuable knowledge from working in clinic with other P&Os, physician, and P&O Technicians. As we have a close relationship with the hospital so that their patients can be referred to SSPO.

Methods
Assistant lecturer responsible in the clinic by assessing the patient, take measurements and casts of the patient utilizing the knowledge, fabricate the device according to the knowledge, Fit the patient carefully and be self-critical, correcting all problems and ensuring the safety and satisfaction of the patient. Provide a well-finished and strong device to the patient Keep records of the patient and the treatment given, make entries into the patient notes in data collection form.

Results
Clinical experience allows assistant lecture to reinforce both theoretical and clinical knowledge to gain valuable clinical experience in real clinical setting. Although these experiences are supervised by expatriate CPO clinical mentors, the patients’ evaluation, impression, fabrication and device fitting are all done by assistant lecturer with some supported from clinical mentors.
Assistants lecture responsible in Siriraj clinic consist of clinical work , research developing related to P&O, as well as represent in seminars relating.
From the experience of clinic allow assistant lecturer to be more confident in teaching in front of the students

Conclusion

The clinical experience is a wonderful opportunity to gain valuable experience in P&O while remaining in a familiar, safe and controlled environment. The assistant lecturer will get to treat real patients with real problems under supervise of clinical mentor. The assistant lecturer can gain valuable knowledge from working with other P&Os, physician, and Technicians.
However, the clinical experience is a critical piece in the development of becoming a teacher. It should be given first priority over personal obligations and commitments

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www.sspo.ac.th
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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3364-539]

Effects of a Custom Made Cervical Pillow (Night Cervical Support) for the Patient With Neck Pain

Author
Verma, Pravin (Delhi IN) | Prosthetist & orthotist
ST STEPHENS HOSPITAL - REHABILITATION MEDICINE

Coauthors
1.Ravi Verma (Physiotherapist, Krishna Mohan Memorial Rehabilitation Centre, Delhi, India
2.Dr. Mathew Varghese (Head, Orthopedics Department, St Stphen's Hospital, Delhi, India
3.Dr. V.S.Gogia (Head, Rehabilitation Medicine Department, St Stpen's hospital, Delhi, India

Abstract
There are various types of cervical pillows available in the market, generally rectangular shape, the base of the rectangle adjacent to the user's shoulder being formed with a concave curvature. This type of pillow forces the user to lay in supine position only and dose not allow freedom of movement

Introduction
The objective of this intervention is to provide a pillow for providing proper support and maintain the posture of the cervical spine. Patient is to lay on supine and as well as on his side position and to provide continuous support for head and neck throughout the sleep.

Methods
Due to the variability in human neck thickness and shoulder width, a different height of pillow may be required when someone is lying on his/her back as opposed to side. This potential problem is to be solving by this customized pillow in that a shorter height throughout the middle curved area for supine sleeping, and a higher height on the either sides of the curved area for lateral recumbent sleep posture is provided. The special "C" shape in the cervical pillow, cradles your head and neck and gently lifts the head away from the shoulders at the same time the neck roll underneath supports the neck. While sleeping on side, the soft wings keep head at the right height from the mattress, to relieve strain on the neck and shoulders. The pressure releases, neck muscles relax and pain goes away. This cervical pillow is designed to work for back and side sleepers.
The pillow is hand stuffed with the locally available cotton fibers, non allergic and most accepted in the Indian condition.

Results
A sample 8 participant was recruited for this trial. This sample was randomly allocated to the experimental and controls groups, age group of the patients – 34 to 45 years, 6 males and 2 females.
One failed to complete all the required questionnaires and found the pillow uncomfortable and withdrew from the study during the second week.
Most of them fully satisfied with the experimental customized pillow.

Conclusion
An ideal pillow should be soft and with good support for the neck lordosis. A specially

selected and individually tested pillow with good shape, comfort and support to the neck lordosis can reduce neck pain and give a better sleep quality.
The study results show that compared to conventional pillows, this experimental customized cervical pillow for individual patients was effective in reducing low-level neck pain intensity, especially in the morning following its use in a 4 week long study.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3342-517]

An Educational Tool to Support the Team Approach to Amputee Pain Management

Author
Sooriakumaranan , S. (London GB) | Dr.
Douglas Bader Centre, Queen Marys Hospital

Coauthors
Dr E. McGilloway and Dr S. Sooriakumaran

Abstract
A poster has been designed to assist clinicians provide effective pain management in amputees experiencing residual and/ or phantom limb pain.

Introduction
Commonly, amputees can present with pain – residual limb and/ or phantom limb (Ehde et al 2000) – which may influence the ability to walk or participate in activities of daily living, and can affect overall health, well being and quality of life (Hanley et al 2006)
At the rehab centre at Roehampton, London, United Kingdom there are considerable resources of clinical expertise available to treat these types of pain effectively. Through team discussions and in-service training it was agreed that a systematic approach to pain management which includes assessment, selection of treatment option/s based on sound clinical reasoning and thorough evaluation of treatment choice, contributes to quality care.

Methods
A poster based on a pain algorithm (Meier and Atkins 2004) was designed to graphically inform and guide clinicians with this process.
The aim of the poster is to act as an aide-memoire, prompting clinicians to reflect on causes of pain and consider the most appropriate pain management approach.
The poster illustrates an overview for pain management for both residual limb pain and phantom limb pain via pathways. The pathways present facts, findings or questions which lead by way of arrows to further assessment strategies or treatment recommendations and resources e.g. physical modalities, medications.
Posters – in A2 format – are now displayed in specific areas in the centre for easy reference for clinicians – on the ward, in a clinic room, in the rehabilitation gym (therapy) and in the prosthetists' office for example.

Results
Now that the posters are in place their usefulness as an educational tool for clinicians will be evaluated after a year via a questionnaire survey. Findings will identify if changes are required to the poster and/ or to clinical practice in relation to the evidence base.

Conclusion

Now that the posters are in place their usefulness as an educational tool for clinicians will be evaluated after a year via a questionnaire survey. Findings will identify if changes are required to the poster and/ or to clinical practice in relation to the evidence base.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3055-253]

An Unusual Sports Injury of the Hand. A case Report

Author
van Loenen, John (Groningen NL) | MD
University Medical Hospital Groningen - Rehabilitation

Coauthors
van Loenen JTW, Eissens MH, van der Sluis CK

Abstract
An unusual severe sports injury of the hand was presented in a 25 year old male. The hand was completely perforated due to a weight lifting injury. Osseous, tendon, nerve and vascular injuries were diagnosed. Despite the severity of the injury, excellent outcomes were attained.

Introduction
Severe hand injuries are frequently sustained at work or at home, where patients can be seized by apparatus or machinery (Opsteegh, 2009). Injuries to the hand can also be caused by sports activities, but these are mostly of minor or moderate severity (Aitken, 2008). In this case report we present a very unusual and also severe sport injury of the hand. It is known that injuries of the upper extremity ask for maximal attention to prevent disturbance of its unique and refined coordination and grasp function, which can lead to severe disability (Van Kampen, 2003). To obtain maximum outcomes, treatment of severe hand injuries should cover all functional levels of the International Classification of Functioning and Health (ICF) (WHO, 2001).

Methods
In February 2009, a 25 year old man sustained a severe injury of the left, non-dominant hand during weight lifting exercises at a sport school. When lifting the weight and trying to get rid of the dumb-bell, he got stuck with his hand between the dumb-bell and the rack. His hand was completely penetrated by part of the rack (see Figure 1), which caused an instable fracture of the third metacarpal bone, a rupture of the deep and superficial flexor tendons (FDP III and FDS III) and the tendon of the extensor digitorum communis (EDC III). Furthermore, a rupture of the digital nerve and an arterial bleeding were found. The instable fracture was repositioned and stabilized by a mini external fixator. Besides, tenorraphy was performed on flexor and extensor injuries. To repair the damaged nerve, a nerve transplant of approximately 4 cm was necessary.

Results
After surgery, an intensive and complex hand therapy regime was started. A static splint was applied, with the hand positioned in an intrinsic plus position. Edema was controlled using elastic wrappings. Scars were treated with silicon dressings and massage. All joints were mobilized passively within certain limits because of the tendon lesions. Exercises at home were instructed. Place-hold exercises were added after four weeks. One month post-operatively, the mini-fixator was removed, although there was no sign of consolidation, clinically nor radiographically. Despite the application of dynamic splints, three months after the injury a tenolysis was necessary, because of tendon adhesions in the third ray. An intensive treatment with active exercises was started after this second operative procedure.
Outcomes: Looking at ICF-body functions level, only a few restrictions were found six months post-injury. Full active and passive range of motion was achieved. Grip strength was still increasing: 31 kg (left) and

52 kg (right). Diminished sensation was found only in a small area on the top of the third ray. On the ICF-activities and participation level, no restrictions were found. The patient was able to resume his job as a manager in an outdoor sport shop four months after the injury. He also continued his weight lifting activities. Personal factors were important with regard to recovery: the patient remained optimistic and highly motivated throughout the rehabilitation process

Conclusion

In this unusual severe sport injury of the hand excellent outcomes on all functional levels of the ICF were achieved. Immediate reconstruction, specialized hand therapy and a well motivated patient were the factors that contributed to this result.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3358-533]

Scientific Research Skills Training Course for Integration Into P&O Professional Courses

Author
Bryant, Tim (Kingston, ON CA) | Dr.
Queens University - Human Mobility Research Centre

Coauthors
Trebbin H, Lemus G, Martinez Panamana, R

Abstract
A newly developed Integrated Research Team model has been developed for training Category 1 students in research skills. Faculty members at Univerisdad Don Bosco (UDB) will be mentored by researchers from Queen's to facilitate supervision and to assist in technical aspects of research projects.

Introduction
There is a requirement for research content in current ISPO-certified programmes and a growing trend to integrate research into Prosthetics and Orthotics professional practice. These goals are achieved at academic centres associated with institutions with highly developed post graduate programmes in related disciplines. However, there are challenges for other training programmes in which research is not a major activity at the host institution.
As part of Project Acceso (2007) capacity was developed for scientific research including a small research laboratory at UDB and technical training for its use. A training model has since been developed that integrates clinical and a research activity that is intended to meet research requirements for both the UDB degree and ISPO certification. The outcome is intended to be a course that can be modified for use in centres that do not have accessible post graduate institutional resources to support this training.

Methods
A key objective of the Integrated Research Team model (Figure 1) is to facilitate research while recognizing the real limitations in available time for these activities by clinical professionals and trainees.
The Assessor is a local clinician/teacher and the Sponsor is a basic scientist or engineer with a professional research background from partner research-intensive institutions. The Sponsor and Assessor collaborate closely through electronic communication and the research team meets as a whole using distance learning tools available through the UDB programme; iIt is occasionally necessary for the Sponsor to visit the team in UDB.
A study is organized by senior researchers (Sponsor and Assessor) into a series of smaller projects that are undertaken by trainees (Students). Each project results in a technical note that may be suitable for presentation at a suitable conference. A study is intended to produce an article for a journal or international conference.

Results
The initial course design is shown is comprised of seven phases, organized in a series of activities over a 24 week period. These also include a number of evaluation steps for formative and summative feedback.

Time estimates for the students are based on eight hours per week dedicated to the project. The design has been developed in collaboration with the teaching staff and administration of UDB.
1. Clinical Needs Identification (16 hours). Clinical problem is identified in terms of patient need. Relevant literature is reviewed. Expected clinical outcome is defined.
2. Research Questions (16 hours). Research questions posed in terms of identified clinical need.
3. Research Objectives (32 hours). Thorough clinical, scientific, and technical review of literature. Description of research objectives in terms of new knowledge or technology requirements.
4. Work Plan (16 hours). Experimental design described in terms of objectives. Measured variables defined and justified. Experimental protocol detailed.
5. Feasibility Assessment (32 hours). Proof of principle study demonstrates feasibility of work plan or technology.
6. Project Completion (48 hours). Completed research study described in formal structure suitable for conference presentation.
7. Final Report (24 hours). Completed research study written in technical report format.

Conclusion
sessions were used to evaluate students' background and to establish curriculum mapping for the project. Learning outcomes have been established as:
Core Competencies
Communication
Concept of knowledge versus information and opinion
Skills in finding knowledge
Understanding of the research process
Ability to participate in the research process
Attitudes
Lifelong learning
Incorporation of evidence based practice
Understanding the importance of research to the profession
Responsibility to patient, profession and society
It was concluded that there is a need for an early introduction of core concepts in the curriculum, before the research skills course is offered. A research axis is recommended by which these competencies and attitudes are introduced in each cycle of the programme and that methods be established to ensure a continuum of skill development.

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Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg244240/cg43931

Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3345-520]

On the Engineering and Design of a Complete Below-Elbow Prosthesis for Lower Income Amputees

Author
Johnson, Alwyn (Littleton US)
PhysioNetics - Assitive Technology

Coauthors
Veatch, Bradley D.

Abstract
Increasing global demand and awareness have given rise to a number of initiatives focused on developing affordable and biomechanically-appropriate prosthetic technologies. This paper presents the engineering and design of a new body-powered (BP) prosthesis for lower income below-elbow amputees.

Introduction
With increasing global connectivity, worldwide health and economic needs are becoming more evident. The World Health Organization estimates 0.5% of the world's population (»34,000,000) needs orthotic and prosthetic devices (1), most of whom survive through manual labor and earn less than US$2.50 per day (2). Meeting the developing world's needs would, by some estimates, require close to 100,000 new prosthetists (3). Factors such as the availability of resources for maintenance and repair, technical support, technology costs, access to electricity, running water, and transportation render many devices impractical or limit their utility. Accounting for these factors from the outset enabled the project team to create a complete below-elbow (BE) prosthesis system that is functional, robust, and both technologically and economically appropriate for persons with transradial amputation. The device can be fit by trained prosthetists or technicians with limited resources.

Methods
A team of prosthetists, BE amputees, physicians, and engineers implemented the project in four standard phases: 1) Product Design Specification, 2) Ideation, 3) Evaluation and Refinement, and 4) Review. Core specifications included high grasping utility, "good comfort", low-weight, durability, ventilation, appearance, corrosion resistance and reduced reliance on special tooling. Terminal device specifications required incorporating easy pinch-force adjustment. A novel dual-ratchet mechanism was integrated within a reinforced plastic prehensor to accomplish design goals. To provide adequate suspension and minimize socket/interface costs the development of a mechanism to supplement standard hand cast interfaces was specified. A variable structure-performance, humeral suspension mechanism which creates a comfortable mechanical lock on the distal humerus was devised. Harness components which use threaded fasteners were concurrently devised to withstand high loads and be easily replaceable

Results
Over a four month period, two amputees considered expert prosthesis users (more than three years) and two new amputees evaluated the complete UE prosthesis, referred to as the International Trans-radial Adjustable Limb (I-TAL) consisting of the Vari-Pinch Prehensor™ (V2P™) and the adjustable "Johnson-Veatch Interface". Active lifestyle evaluators with larger residuums were selected to functionally validate

the large (L) size I-TAL. The interface is designed to be available in large, medium and small sizes. Fitting the I-TAL with a small set of Allen wrenches was performed within one hour. Users were immediately able to operate the system intuitively and easily. Load suspension capability of the interface was satisfied, with all users able to carry a minimum 35 lb (156 N) load. Expert users report a comparable but slightly lower comfort level compared to individually custom-fabricated interfaces, and are pleased with the easy pinch force adjustability, reporting reduced fatigue when using the V2P. New users report high satisfaction and have permanently adopted the device for daily living activities. All users were pleased with good ventilation, low-weight, appearance, and the ability to vary interface compression throughout the day to desired comfort, and some users elect to not use sock or sleeve liners. Manufacturing costs for the complete I-TAL units is sufficiently low as to be economically viable for procurement by lower income amputees.

Conclusion

The I-TAL provides a new option for transradial amputees for whom few or no options exist. The device is sufficiently robust for demanding service, and has been designed to withstand exposure to salt water, and materials common to agrarian environments. Ease of fitting with minimal training and packaging as a complete kit make the device suitable for distribution through health care providers and humanitarian agencies worldwide. Low cost makes it possible to warehouse units to facilitate timely deployment and ensure that new amputees can receive BE prostheses to maximize benefits. The V2P and Johnson-Veatch Interface when combined as the I-TAL offer a good balance of affordability and technical sophistication necessary to have an impact on improving the quality of life of transradial amputees worldwide. The success of this and similar projects demonstrates considerable opportunity to develop affordable, clinically practical, assistive technologies that are functional, and robust.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3415-590]

Optimising Workforce Organisation to Meet New Demands in the Prosthetics and Orthotics Industry

Author
Nilsson, Kjell-Åke (Jönköping SE) | M.Sc.
Team Ortopedteknik Scandinavia AB - Educational Section

Abstract
New demands placed on the different professions and companies in prosthetics and orthotics require creative solutions in company organisation. Team Ortopedteknik Scandinavia AB has successfully designed and implemented a major change to meet present and future demands.

Introduction
The prosthetics and orthotics industry is facing serious challenges in the near future. New componentry, or even new types of componentry, will increase demands on evidence based practice and continued education for employees.
We will need to prove that we provide state of the art service and componentry. Service quality has to be monitored, re-designed and implemented. Componentry is becoming more and more complicated, with an increased need for further specialisation for each individual in the workforce.
At least in regions of relative peace, there is a decreasing number of clients in need of P&O services. Some of this is due to improvements in general health care and safety, while one might also speculate whether it is also the effects of reduced funding. All of this begs the question: how can a P&O company be organised to meet a future with both a need for a higher degree of specialisation in the workforce, and at the same time a decreased number of clients and/or funds?

Methods
Attempting to make an evidence based change to the company structure, management and members of staff have formed workgroups to determine key issues that need to be covered in order to meet these new challenges. The need for development of new departments within the company has been identified. During the past five years, fourteen essential company goals have been identified and broken down into several target requirements for the ongoing work of implementing the proposed changes to the organisation. Areas of needed knowledge new to traditional work in prosthetics and orthotics have been identified.

Results
A new organisation, with several changes to production and service structure, has been implemented. New positions within the company have been manifested, such as an educational department and a new structure for the production of devices. New technology has been implemented to meet demands both from paying customers and public service contract holders. Ways to measure customer satisfaction and resulting quality of life have been put to use to facilitate future changes. We now feel that we can present this as a model for other companies who have identified the same needs for structural change to meet future demands in prosthetics and orthotics.

Conclusion

Any company needs to determine what changes need to be made to its structure to meet new demands on and from that company´s market. Our work during this transition has resulted in a somewhat untraditional approach as a service provider in prosthetics and orthotics. We hope to inspire other companies to make similar challenges and perhaps create more of future collaborations to benefit the development of new and improved prosthetics and orthotics services and products.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3426-601]

Impact of Forced Leg Length Discrepancies on Body Posture and Jaw Position

Author
Ohlendorf, Daniela (Frankfurt DE) | Dr.
Carolinum, J.W.Goethe Universität Frankfurt - Polikinik für Kieferorthopädie

Coauthors
Pusch K, Natrup J, Kopp S

Abstract
The "holistic therapy" in treatment of patients with craniomandibular disorders is in the public eye. The cooperation between orthodontics, orthopedics, osteopathy and physiotherapy increases.To achieve an successfully treatment an interdisciplinary understanding is neccessary.

Introduction
The aim of the study was the documentation and analysis of interdependencies between temporary provoked leg length discrepancies on the upper body posture as well as the position and the movements of the mandible.

Methods
All 30 testpersons (21 f / 9 m) were successively placed unilateral a 1 cm and 3 cm thick wooden panel below the left and afterwards below the right foot. Following the increases were registered with a three-dimensional back scan and an electronic registration system for the mandible. The three-dimensional back scan “MiniRotKombi” (ABW / GeBioM,Germany) based on the triangulation and fringe projection technique so that the back can be measured and documented. Following the same increases were registered with the electronic registration system Arcus Digma (KaVo,Girrbach; Germany) which is able to record the situation and the movement of the mandible on
ultrasound base. The statistical evaluations were
made by the software program SPSS version 15.0 and the one-Sample t-test and the t-test for correlated samples were used.

Results
Due to the unilateral raise of the foot a change of body posture was produced in relation to the pelvis and shoulder position ($p = 0.00$). This can be seen as a compensating movement by the increase. The range of motion correlated with the strength and the relevant side of the increase. Likewise, a deviation of the mandibular condyle position in centric occlusion ($p = 0.03$) and at the mouth movement ($p = 0.01$) can be observed, which also increased with the amount of the wooden plate. Positions related changes were observed in the ipsilateral and contralateral side of the jaw.

Conclusion
The results show a statistically reliable interdependency between the leg length, body posture and mandibular position. This also shows that the human body is a complex system where different parts of the muscle-skeleton system are interlinked and are able to influence each another.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3392-567]

Biomechanical Test of New Capacitive Pressure Sensor Stripes Under a Knee Orthosis

Author
Koch, Johannes (Münster DE)
FH Münster - Technische Orthopädie

Coauthors
Prof. Dr. habil. Peikenkamp K

Abstract
The ability of new capacitive sensor stripes from Nicol Biomechanics is analyzed by pressure distribution measurements under a knee orthosis considering different knee angles. The different parts of the orthosis could be detected clearly which is an indication for reproducibility of the stripes.

Introduction
In modern technical orthopaedy measurement systems especially systems of pressure measurement become more important. The challenge to construct a pressure distribution measurement system which develops reproducible results and which is preferably flexible, thin and light is of great relevance.
The method of pressure measurement is divided into two different techniques using either resistive sensor types or capacitive sensor types. This paper deals with capacitive sensor stripes (Nicol Biomechanics).
These sensor stripes are dimensioned 370x30x2 mm and consist of 256 sensors sized 1.2x10 mm. They are able to measure up to 500 kPa and can be bent up to a radius of 5 mm.

Methods
The purpose was to find out if the sensor strips are able to record the prevalent changes and how reproducible the results are. The sensor stripe was placed on the extended knees of 10 subjects. Afterwards the orthosis was slipped over an extended knee. Measurements were obtained for 15 seconds with a frequency of 0.2 frames/sec. Finally the measurements were repeated with a 90° knee flexion.
Measurements were obtained (A) under the distal part of the silicon ring, (B) under proximal part of the silicon ring and (C) between (A) and (B). Mean pressure was determined for the 3 parts. The mean pressure under the proximal part of the silicon ring with the extended knee was normalized to 100 %. A 2-factor repeated ANOVA was used to detect significant differences ($p<.05$).

Results
The measurements show significant higher mean pressure ratio for (A) compared to both (B) ($p<.001$) and (C) ($p=.003$) whereas mean pressure ratio is significant lower for (B) compared to (C) ($p<.001$). There are significant higher mean pressure ratio values for kneeflexion compared to extension ($p=0.029$). No significant interaction between both factors is detected. For (A) the mean pressure ratio increases from 100 ± 49 % (extended) to 224 ± 130 % (flexion) as shown in the figure. The mean pressure ratio is low (2 ± 3 %) for (B). For (C) with an extended knee mean pressure ratio is about 56 ± 38 %, and 83 ± 29 % in flexion.

Conclusion

This pilot study shows that the sensor stripes are able to measure and to compare pressures under orthoses and bandages. The results show that the different regions of the orthosis can be detected clearly, which is also an indication for reproducibility. The standard deviation is partially very high and may result from the different constitution of the subjects and may also be caused by ortheses which are not individually manufactured for each subject.

The higher increase of the pressure ratio in the proximal region is probably caused by a higher increase of the cross-section. Low mean pressure ratio values between the silicon ring are a proof for the orthosis' effectiveness. The higher mean pressure ratio in extension indicates that the knee orthosis is fitted tighter under the proximal part of the silicon ring compared to the distal one. This effect becomes even more obvious due to the larger increase of the pressure under the proximal part.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3413-588]

A Clinical Need for Objective Diagnostics of the Ditfunction - Objective Insight in Loading Characteristics when Seated in a Wheelchair

Author
De Vries, Jaap (Apeldoorn NL) | Dr.J.de Vries
ViaReva, centrum voor Revalidatie Geneeskunde - Rehabilitation

Coauthors
Grady, J.H.

Abstract
In this study hypothetical clinical "load parameters" have been established and tested for their clinical value. This was done because of the need in the clinic for objective diagnosis of the sitfunction. The study was succesfull in establishing objective load parameters.

Introduction
This paper concerns the outcome data of a study concerning objective sit loading characteristics of a population of wheelchair bound persons.
Protocolled pressure measurements formed the input data for a specially designed analysis program for clinical diagnostics of sit complaints / impairments in wheelchair bound persons. This load analysis software program (SCI-software) provides outcome data on sit load which can then be interpret in relation to the underlying pathology to determine the nature and the extent of the (wheel)chair sit problems.
Aim:
To investigate the relation of the sit-complaints / impairments pressure ulcer, pain and instability to the clinical sit-pressure / sit load parameters Recovery Debt (RD), Proportional Pressure Index (PPI), Mode Value (MV), Maximum Pressure (MP) and Contact Percentage (Contact%).
Sample
A sample of 99 wheelchair bound patients with and without sit complaints / impairmentswith no cognitive disorders and adult

Methods
In the study the following devices were used:
• Pressure measurement system to measure pressure values
• SCI-software: specially developped load analysis software for medical application.
All patients were subjected to protocolled measurements
Patients:
• Wheelchair bound persons with chronically or repetitive (wheel)chair-sit complaints / impairments.
• Wheelchair bound persons with a large risk on the occurrence of sit complaints / impairments.
• Pathology: neurological- and orthopaedic diseases: for example Poliomyelitis, Muscle Dystrophie; M.S. , Contusio cerebri, Spinal Cord laesion, Amputation (one or both sided) / Hipexarticulation/hemipelvectomy, Mutilating reumatism; Spina Bifida, etc
Only adults were part of the study.

Results
All clinical sit pressure / sit load parameters mentioned have a clinical relevant relation with sit complaints / impairments.
A difference in parameter score is shown between complaint /impairment yes and no.
RD: the pressure ulcer group showed a statistical significant difference between complaint / impairment yes and no (p=0.038).
PPI: the pain group showed a statistical significant difference (p=0.017).
MP:the pressure ulcer and the pain group showed a statistical significant difference (p=0.043 and p=0.027).
Contact%: the instability group showed a statistical significant difference for seat and back (p=0.000 and p=0.006).

Conclusion
A clinical relevant relation between sit complaints / impairments and clinical sit-pressure / sit load-parameters mentioned has been established. Results also show statistical significant differences between complaint yes and no.
The sensitivity of the applied method for analysis is therefore such that it can be used for clinical diagnostics of the sitfunction
The method can also be used for determination of the efficacy of applied seat cushions / sitorthoses.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [2850-65]

Reconstructive Surgery and Microsurgery in Rehabilitation of Children with Proximal Ectromelia of Upper Extremities

Author
Koltsov, Andrey (Saint-Petersburg RU)
Saint-Petersburg Albrecht Center for Occupational Expertise, Prosthetics and Rehabilitation - First orthopedic departement for childs

Coauthors
Schvedovchenko I. V.

Abstract
The results of rehabilitation of children with proximal ectromelia of upper limbs are presented. We used reconstructive surgery and microsurgery for restoration of anatomy and function of upper limbs, simetimes in combination with prosthesis.

Introduction
Proximal ectromelia of the upper extremity is one of the rare and severe forms of congenital malformations and is characterized by the undevelopment of all limb´s segments, and the level of this undevelopment is decreasing in the distal direction.
In the literature we found several another terms for this anomaly, for example: axial ectromelia and phocomelia.
The last term is the most common, because there is similarity of appearance of the upper limb Proximal upper-extremity ectromelia is one of rare and severe forms of congenital pathology which is characterized by hypoplasia of all limb segments with primary affection of proximal parts.
In the literature we have found some other definitions of this anomaly, for example «axial ectromelia» and «phocomelia». Latter definition is most widely used, because quite often the underdeveloped extremity looks like seal or walrus fin.
Clinical signs of the anomaly are clavicle and scapula hypoplasia, shortening of all the extremities. The humeral joint is alway

Methods
We have treated 62 patients, from 1 month old up to 46 years old, total number of extremities 82. 30 patients had left-hand, 12 patients - right-hand, 20 persons - bilateral defect.
The patients were divided into 3 groups:
Group 1 - 31 patient with typically bilateral defect, presence of all 3 segments of the extremity - rudimentary distal part of humeral bone and sometimes hypoplastic elbow joint, forearm and hand. Most patients were actively using the underdeveloped extremity for self-care.
Group 2 - 24 patients, the affected extremities were only hypoplastic bones of forearm or uncertain bone formations between the underdeveloped hand and scapula. The capability depended on the forearm bones hypoplasia degree.
Group 3 - 10 patients, the underdeveloped extremity was a faulty hand, adjacent to the scapula. Such patients had highest functional impairments.

Results

Surgical treatment was multistage. 37 operations in 13 patients, age from 11 months up to 15 years, in most cases the surgical treatment was carried out in patients of 1st group. Most operations were independent method of treatment and only 3 operations were made as a preparation to the subsequent prosthetics.
For formation of first finger and creation of an opportunity of bilateral grip, we have carried out several types of surgeries:
- pollicization of radial finger (6 patients);
- tendon and skin grafting for creation of first finger opposition (2 patients);
- reconstruction of radial finger (1 patient);
- microsurgical autografting of second toe to the position of first finger (1 patient).

In order to create a humeral bone in 6 patients we have carried out transposition of external edge of corresponding scapula with vascular pedicle to the position of absent or severely underdeveloped humeral bone.
We would like to tell about the late result of such operations - transformation of relocated flat scapula fragment to the tubular bone in 1,0-1,5 years after the operation.
In order to create a correct shape and position of the shoulder girdle in 2 patients we have carried out shoulder girdle reconstruction as a preparatory stage for prosthetics. We have carried out osteotomy of clavicle diaphysis and acromion basis, and then displaced the acromioclavicular joint and the extremity caudally up to shoulder girdle position normalization. In the resulting position we have fixed the clavicle and scapul

Conclusion

1. Even with the severe proximal ectromelia, there is a possibility to improve the outcomes of rehabilitation by reconstructive surgical and microsurgical treatment.
2. Surgical procedures are multi-stage, and should be performed at the early ages if possible.
3. The outcomes of the procedures were: increase in the amplitude of mobility of the limbs, better appearance, improvement on self-serving and better conditions for further prosthetic management.
4. Best results are achieved in patients with rudimentary humerus and hypoplastic elbow joint.

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Image: phocomelia_None.jpg (see online)

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg244240/cg33003

Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3273-448]

Examining Activity of Extrinsic Finger Muscle Compartments to Serve as Inputs to Directly Control Individual DoF of a Multifunctional Prosthetic Hand

Author
Birdwell, Jay (Alex) (Chicago US)
Northwestern University - Mechanical Engineering

Coauthors
Weir, R.F.ff.

Abstract
In order to test the viability of using extrinsic finger muscles to control individual DoFs of an artificial hand, subjects independently activated the first two compartments of EDC, FDS, and FDP. Initial work has tested EDC and FDS and found three compartments that will serve as independent inputs.

Introduction
Traditional prosthetic hands have one degree of freedom [1] (DoF) and use direct myocontrol [2] along with two user inputs to command the hand to open or close. Researchers are currently developing hands that have several DoFs and more closely mimic the capabilities of human hands [3, 4]. Obtaining a sufficient number of independent control sites from the extrinsic hand muscles to command each of these DoF is very difficult with surface electrodes because they measure the activity of many of the small muscles simultaneously. Intramuscular electrodes can measure signals from a single muscle [5] but there hasn't been extensive work quantifying how independent the extrinsic finger muscles are from one another or from compartments within each muscle [6]. This study aims to explore how well the first two compartments of EDC, FDS, and FDP will serve as control inputs to a multifunctional artificial hand by measuring their ability to independently activate.

Methods
Able-bodied subjects were recruited and six intramuscular electrodes were inserted into the first two compartments of EDC, FDS, and FDP of their dominant hand. EMG activity from each compartment was measured using a Delsys Bagnoli-16 system and recording at 3 kHz using Labview on a desktop PC. Signals were low pass filtered and scaled to each muscle's MVC. A visual bar chart provided real-time feedback of each compartment's activity. Subjects had their hands rigidly confined in a neutral position and were instructed to activate a single muscle compartment to a specified threshold, while maintaining all other non-targeted muscles below a lower threshold. Trials were repeated several times for each muscle compartment and for a range of target thresholds.

Results
Our preliminary study has tested the first two compartments of EDC and FDS for independence against one another. Each compartment was targeted to see how well it could individually contract while keeping all other nontargeted compartments as relaxed as possible. Independence was determined by having the targeted muscle's activity be larger than the non-targeted muscles' activity. Ideally this would result in a single muscle compartment able to activate its full range while all other compartments remained relaxed.

However, this task was very difficult and usually resulted in unwanted coactivations. It was found that EDC1, FDS1, and FDS2 were very capable of eliciting isolated contractions and 100% of each of their trials resulted in their activations several times larger than nontargeted activity levels. EDC2 was able to activate independently from FDS1 and FDS2 but coactivated heavily (50% of trials) with EDC1 when it was the targeted muscle. Further work will include tests of FDP.
The figure shows the results when the first compartment of EDC was the targeted muscle. The boxplots show the range of activations of the nontargeted muscles as a percentage of the targeted muscle signal. For these trials all nontargeted muscle signals were less than 15% of the targeted muscle signal, on average, meaning that EDC1 is capable of isolated activations. The bar graph shows the level of activations for each muscle relative to the targeted muscle signal, EDC1.

Conclusion

This study seeks to quantify the independence between compartments of EDC, FDS, and FDP to have them serve as commands for individual DoFs in an artificial hand. We tested the first two compartments of EDC and FDS for independence from one another and found all compartments are capable of isolated activations except EDC2. If these compartments served as the inputs to control individual digits on an artificial hand using direct myocontrol then the compartments of FDS would command independent flexion of the first two fingers. Isolated extension of the first digit would be possible using the activity of EDC1, however since EDC2 coactivates with EDC1, isolated extension of the second digit would not be possible. Further tests are being conducted to explore the independence of the first two compartments of FDP.

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Image: EDC1_ISPO_fig_None.tif (see online)

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3241-423]

Spacer Fabrics - an Optimal Basement for Medical Applications

Author
Schwabe, Danny (Greiz DE)
Textilforschungsinstitut Thüringen-Vogtland e.V. - Textile Strukturen und Materialien

Coauthors
Heide M, Möhring U

Abstract
The presentation describes the construction, the manufacturing and the application of knitted spacer fabrics. The results of research projects that are dealing with novel solutions in the field of pressure-reducing insoles, 3d- compression bandages and textile hip protectors will be presented.

Introduction
The most outstanding characteristics of functional spacer fabrics are moisture conduction, pressure compensation, thermal regulation as well as further special functions, controllable by the specific use of material. These can be bioactive effects, flame resistance, active heating functions and also a defined bi-elastic behavior. The use of different functional material components in the structure and specific construction characteristics significantly upgrade the range of the achievable physical and clothing physiological properties in comparison to classical fabrics, nonwovens or knit fabrics.

Methods
When the results of the research project are introduced, it will be shown how the requirements on novel textiles, based on knitted spacer fabrics for the application in medical purposes, can be realized with the help of special technologies. Thereby, something will be said about the development of operation-table covers, three dimensional compression bandages, heatable spacer fabrics, insoles for diabetics and textile based hip protection pads. It will be shown, how far existing technologies had to be adapted, respectively modified for the special purpose. Besides of the constructive parameters the use of the required machine technology will be discussed along with the corresponding user feed backs.

Results
The results of the research projects have shown that spacer fabrics are not only able to improve the properties of existing products. They also offer completely new application possibilities where single-surfaced textiles reach their limits. By developing operation table covers, based on knitted spacer fabrics, not only a pressure reduction of 25 percent could be achieved, but also bedsores could be prevented [1]. In another research project it could be proofed, that it is possible to integrate electric conductive yarn into knitted spacer fabrics for the realization of heating functions [2]. Within a research project [3] it also could be proofed that three dimensional compression bandages, based on knitted spacer fabrics, are conducive to waste-prevention within the complex anti-congestion therapy, they also offer -due to the clothing-physiological properties- a significantly higher patient’s compliance, compared to the standard method of treatment. Compared to standard hip protectors, based on foam and hard shell, the in [4] investigated textile based hip protection pads feature an improved flexibility and an increased wearing comfort.

Conclusion

Recapitulatory it can be said that the at the TITV Greiz developed and investigated spacer fabrics are accentuating their advantages in a high level when they are used for medical applications. Air permeability, flexibility, pressure reducing properties, a high clothing physiological comfort, a wide range of combinable yarn materials and defined adjustable special features are only just a few characteristics that allow a wide use of applications in the first place. The research projects in the TITV Greiz have shown that by using special textiles it is not only possible to avoid unnecessary stresses and strains for the patient during an operation, but also to increase the well-being and the healing process in the postoperative and ambulant field for an optimal aftertreatment. Until today, all developments in this field are not finished yet and still other applications have to be investigated.

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[4] IW 050045: „Development of protection pads based on knitted spacer fabrics for injury prevention in case of an accident”

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3571-668]

The Development and Implementation of Training of Clinical Placement Supervisors/Clinicians in P&O

Author
Figgins, Elaine (Glasgow G4 0LS UK) | BSc Honours Prosthetics and Orthotics
University of Strathclyde - National Centre for Prosthetics and Orthotics,

Coauthors
Paul Lambert

Abstract
This paper will show the work carried out to develop and implement clinical supervisors training for prosthetists and orthotists who act as clinical placement supervisors and partners with the national Centre for Prosthetics and Orthotics at the University of Strathclyde in Scotland.

Introduction
Following revision to the guidelines from the Health Professions Council called the Standards of Education and Training for all higher educational institutions for professions allied to health the department reviewed its procedures. Standard number 5 specifically had been revised to place more emphasis on Universities training and supporting its clinical supervisors in clinical practice who have to educate, train and assess undergraduate students in the real clinical environment. This paper will describe and document the NCPO at the University of Strathclyde's response and outcomes to these new standards.

Methods
Review and discussion with other health professional Universities and authorities was under including HPC consultation. Review of the relevant literature was undertaken and a decision was taken to develop and implement a training event for clinical supervisors associated and working in partnership with the university of Strathclyde prosthetic and orthotic department. This training was then offered and ran on several dates throughout 2008 and 2009. This was at the University and at specific hospital with rehabilitation departments across Scotland.

Results
At each event a feedback questionnaire has been used and the results of these will be discussed to show the positive response to these training and interactive events.

Conclusion
Feedback showed the training was felt appropriate and at the correct level to be of use.
Future work will be ongoing to develop a multi- professional training day with an addition specific session on assessment tools used in each discipline allied to Health. The review of all the professional guidelines for the training of clinical supervisors showed shared and common learning outcomes that were required for all the staff in all groups allied to health. Future Masters Levels module as clinical educators is also being developed for the group.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3423-598]

Gait Classification in Children with Cerebral Palsy: Specific Motion Patterns of the Sagittal, Frontal and Transversal Plane – Preliminary Results

Author
Nagel, Arne (Drensteinfurt-Walstedde DE) | Dr. rer. medic.
Ga:it - Bewegungsanalyse und -therapie im Haus Walstedde

Coauthors
Dercks M, Sprinz A

Abstract
This study identifies motion patterns of children with cerebral palsy. Preliminary results confirmed motion patterns in the sagittal plane and gave new inside in associations between motions in different planes. This could lead to prescription guidelines concerning orthotic treatment.

Introduction
Children with cerebral palsy often show gait deviations due to congenital brain damage. One of the first approaches of gait classification in children with spastic hemiplegia was made in 1987 by Winters, Gage and Hicks [1]. This and later approaches were mostly restricted to the motion patterns of the sagittal plane [2,3] and did not give connections to the motion patterns in the frontal and sagittal planes. However, even this is required to get full knowledge of specific motion patterns due to cerebral palsy [4,5]. 3D-Gait Analysis gives detailed information about all three planes of motion and can be a valuable tool to evaluate gait deviations in children with cerebral palsy [6].
Therefore, the first aim of this study is to identify specific motion patterns of children with bilateral spastic cerebral palsy in the sagittal, frontal and transversal plane. Furthermore, the investigation of associations between motion patterns of different planes is a second aim of this study.

Methods
This study includes 8 children with bilateral spastic cerebral palsy by now (8.5±1.3 years; 4 male, 4 female; GMFCS-Level 1-2). The study will be carried on in the next years to include a maximum of affected children to get a precise knowledge of specific motion patterns. To evaluate the three-dimensional gait patterns a motion analysis system was used (VICON, Oxford Metrics, UK). Five gait trials of every patient was recorded, normalized and averaged.
Due to few patients included by now no statistic analysis was conducted. Therefore, the preliminary results should be understood as implications that have to be confirmed when more patients will be included in the study.

Results
Preliminary results showed associated motion patterns in the sagittal plane: maximum anteversion of the pelvis was positive associated with maximum flexion of the hip and retroversion of the spine in relation to the pelvis. Furthermore, a connection between hip and knee motion could be seen: a lower range of motion in the hip joint was associated with a lower range of motion in the knee.

Moreover, associated motions could be seen in the frontal and the transversal plane. The range of motions of pelvic obliquity and spine obliquity were positive associated. In addition reduced range of motion in ankle rotation was associated with reduced range of motion in knee rotation.
Furthermore, the preliminary results revealed new insight concerning associations between motions in two different planes: the greater the inversion of the ankle, the greater the internal rotation of the ankle.

Conclusion
Preliminary results confirmed well known motion patterns in sagittal plane, e.g. the positive association between maximum anteversion of the pelvis and maximum flexion of the hip is in accordance with Berweck&Heinen [2]. Other associations in this plane and the frontal and transversal plane show that there are specific motion patterns beyond the sagittal plane that should be taken into account during decision making for further treatment of this patients. Especially the new inside in specific associations between motions in different planes can help to understand how orthotic treatment alters motion beyond the joint it is applied. This could lead to new prescription guidelines.
These preliminary results have to be confirmed in later evaluations when more patients were included in this study.

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Poster Session: Open Topics
Saturday 2010/05/15 | 12:00 - 13:30 | Topic: Open Topics (like Seating and Wheelchair, Paediatrics, Rehab Medicine and Surgery, Education, Low Income Nations) | Subtopic/Track: Miscellaneous

Poster [3398-573]

The Biomechanical Evaluation of Dynamic Cushion System with Spring Elements on Deep Tissue of Human Buttock

Author
Lin, Shih-Cherng (Taoyuan TW)
Chang Gung Memorial Hospital - Physical Medicine and Rehabilitation

Author
Tang, Simon Fuk-Tan (Taoyuan TW) | Professor
Chang Gung Memorial Hospital - Physical Medicine and Rehabilitation

Coauthors
Tang FT, Chen PC, Zhang YX, Wang JJ, Lin YC, Chen WP

Abstract
In this study, the biomechanical evaluation of newly-designed dynamic cushion system with spring element on deep tissue of human buttock was performed by finite element analysis, and the results were compared with the data from pressure measurement to verify the accuracy of computer simulation.

Introduction
Pressure sore is a common complication for wheelchair-bounded persons with spinal cord injury. The effects of pressure and time are believed to be the major factors accounted for the formation of pressure sores. Appropriate cushion are often used to reduce the possible damage that caused by excessive pressure on the weight-bearing soft tissue, and to prevent the development of pressure sores. The purpose of the current study was to develop a newly-designed dynamic cushion system, and to investigate the biomechanical response of human buttock as well as the efficacy for pressure sore prevention.

Methods
A computer aided design software (Hypermesh) was used to construct the model of the dynamic cushion system with spring elements. The magnetic resonance images of a healthy male subject were also used to reconstruct the finite element model of a human buttock. Besides, the Vicon motion analysis system and the Novel Pliance pressure measurement system were integrated to capture the kinematic and kinetic data of the same male subject in sitting posture in order to provide boundary and loading conditions for computer simulation. Finally, the results from finite element analysis were compared with the data from pressure measurement to verify the accuracy of computer simulation.

Results
In terms of shear stress at skin beneath the ischial tuberosity, the shear stress of rigid cushion system was 5.45kPa. The maximum shear stress of high stiffness and low stiffness cushion were 7.2kPa and 7.3kPa; the minimum were 5.1kPa and 5kPa respectively. Even though the maximal shear stress resulted from dynamic cushion system was higher than rigid cushion, the minimal shear stress was lower than that. According to the peak stress in the deep soft tissue beneath the ischial tuberosity, the averaged peak von Mises stress of rigid cushion system was 10.65kPa. The maximum peak von Mises stress of high stiffness and low stiffness cushion were 13.7kPa and 14.1kPa; the minimum were 8kPa and 7.7kPa respectively.

Although the maximal peak von Mises stress resulted frm dynamic cushion system was higher than rigid cushion, the minimal peak von Mises stress was lower than that.

Conclusion

Based on the results from finite element analysis, the dynamic cushion system could cyclically relief the shear stress at the skin as well as the peak stress in the deep soft tissue beneath the ischial tuberosity. Therefore, this device could reduce the probability of pressure sore formation. In conclusion, this newly-designed dynamic cushion system can provide a means for preventing pressure sores and the quantitative data of the current evaluation can provide reference for clinician and biomechanics researchers.

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Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [4121-None]

Closing Ceremony

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4122-None]

Welcoming Speech and Congress Summary

Author
Forst, Raimund (Erlangen DE) | Prof. Dr.
Orthopädische Universitätsklinik der FAU Erlangen-Nürnberg - Lehrstuhl für Orthopädie mit Orthopädischer Chirurgie

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3616746

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4123-None]

Presentation of the ISPO Forchheimer Prize

Author
Geertzen, Jan (RB Groningen NL) | Prof. Dr.
University Medical Center Groningen

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3617140

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4124-None]

The Center for International Rehabilitation Yeongchi Wu International Education Award

Author
Heim, Sepp (Öhningen DE)

Author
Wu, Yeongchi (US)
Northwestern University - Dept of Physical Medicine and Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3618856

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4125-None]

Presentation of the Best Paper Award ISPO Germany, Austria and Switzerland

Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Author
Landauer, Franz (Salzburg AT) | Dr.
Universitätsklink für Orthopädie Paracelsus Medizinische Privatuniversität

Author
Böni, Thomas (Zürich CH) | Dr. med.
Uniklinik Balgrist

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3619512

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4126-None]

Transfer of ISPO Presidency

Author
Blocka, Daniel (Brussels CA)
International Society for Prosthetics & Orthotics

Author
Geertzen, Jan (RB Groningen NL) | Prof. Dr.
University Medical Center Groningen

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3619775

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4127-None]

Presentation ISPO World Congress 2013 in India

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3620043

Session: Closing Ceremony
Saturday 2010/05/15 | 13:30 - 14:45

Congress Lecture [4128-None]

Closing Words and Acknowledgement

Author
Wetz, Hans-Henning (Münster DE) | Prof. Dr.
Klinik und Poliklinik für TO und Rehabilitation

Online version: http://www.ot-forum.de/e20622/e28728/e20623/e19584/cg3615959/cg3620306

Congress: 13th ISPO World Congress
Monday 2010/05/10 | - Saturday 2010/05/15

Session [4120-None]

Closing Ceremony

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