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**FREE PAPERS**

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**Mon, Feb 4 / 12:00 - 13.15**

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Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 1**

**Room 1.03**

Abstract Title: **Predictors Of Prosthetic Use In Individuals With Lower Limb Amputation At 6 And 12 Months After Discharge From Rehabilitation.**

Abstract number: **13**

Authors: **C. Roffman, J. Buchanan, G. Allison**

Presenter: **C. Roffman**

**Introduction** The study objective was to develop a clinical prediction rule(CPR) for individuals with lower limb amputation that identifies variables predictive of prosthetic non-use following discharge from rehabilitation.

Design: Retrospective cohort study

Setting: Royal Perth Hospital - Shenton Park Campus

Participants: 135 consecutive rehabilitation patients (103 males, age 56.1(15.1) years)

### **Method**

Medical records were audited for potential predictor variables of prosthetic use and non-use. Subjects were interviewed at 1.9 (0.7) years after discharge to record if they were users or non-users and the time they stopped using their prosthesis after discharge. Prosthetic use was determined for 6 and 12 months post-discharge. Receiver operator curves were generated to determine the thresholds for continuous variables. Univariate analysis ( $p < .1$ ) identified the association between predictor variables and non-use. A stepwise logistic regression model reduced these variables to a set of flags that were most accurate at predicting non-use. Likelihood ratios of a set of parsimonious variables were generated as CPRs for each time frame.

### **Results**

Prevalence of prosthetic non-use were 11% (15) and 19% (25) at 6 and 12 months. Significant predictors and probability of predicting prosthetic non-use for the time frames were:

6 months: Amputation level above transtibial, mobility aid use, inability to walk on concrete, having > 19 comorbidities and Type II diabetes. If 4 out of 5 of these variables were present (LR+ = 32.0, CI = 3.61 to 748) the probability of non-use increased to 80% ( $p < .0001$ ).

12 months: Amputation level above transtibial, mobility aid use and delay to interim prosthesis > 156 days. If all 3 of these variables were present (LR+ = 74.8, CI = 12.6 to 1500) the probability of non-use increased to 94% ( $p < .0001$ ).

### **Discussion and Conclusion**

These CPRs have implications for patient rehabilitation and service model development.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 1**

**Room 1.03**

Abstract Title: **Biomechanical Advantages Of A New Microprocessor-Controlled Prosthetic Knee Joint**

Abstract number: **47**

Authors: **M. Bellmann, S. Blumentritt, T. Schmalz, E. Ludwigs**

Presenter: **M. Bellmann**

### **Objective**

To investigate the immediate biomechanical effects after transition from an established microprocessor-controlled knee (C-mpk) to a new microprocessor-controlled knee (G-mpk) an interventional cross-over study with repeated measures was conducted in a motion analysis laboratory. Only prosthetic knee joints were changed. 11 men (mean age  $\pm$  SD: 36.7  $\pm$  10.2 years; Medicare functional classification level: 3 - 4) with unilateral transfemoral amputation participated in the study.

Measurement techniques: optoelectrical six camera system (VICON 460, Oxford Metrics, GB) in combination with two force plates (Typ 9287 A, Kistler, CH), L.A.S.A.R. Posture static analysis system (Otto Bock HealthCare GmbH). Main outcome measures: Static prosthetic alignment, kinematic and kinetic parameters, time-distance parameters, centre of pressure.

### **Results**

After a one-day accommodation, significantly improved biomechanical outcomes were demonstrated by the G-mpk compared to the C-mpk such as: lower ground reaction forces at weight acceptance during level walking at various velocities, increased swing phase flexion angles during walking on a ramp and level walking with small steps, nearly consistent maximum knee flexion angle during swing phase at various velocities, a more physiological load distribution between the prosthetic and contralateral side as well as a more natural gait pattern during step-over-step stair ascent, increased knee flexion moments when descending stairs and ramps, reduced loading of the prosthetic side hip joint as well as reduced postural sway during quiet stance on a decline.

### **Conclusions:**

The G-mpk demonstrated immediate biomechanical advantages during various daily ambulatory activities for people with above knee amputations. The Results showed that the use of the G-mpk facilitated more natural gait biomechanics and load distribution throughout the affected and sound musculoskeletal structure. This was observed during quiet stance on a decline, walking on level ground, and walking up and down ramps and stairs.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 1**

**Room 1.03**

Abstract Title: **Fall Prevention Training Program For Persons With Lower Extremity Amputations: Early Results**

Abstract number: **52**

Authors: **K. Kaufman, M. Wyatt, P. Sessoms, M. Grabiner**

Presenter: **K. Kaufman**

### **Introduction**

Key factors limiting patients with amputations to achieve maximum functional capabilities are falls and fear of falling. This research program focuses on rehabilitating lower extremity amputees to increase trust in their prosthesis and reduce falls using a novel training method.

### **Methods**

Three male service members with unilateral transtibial amputations (24+2 years, walking without an assistive device for 7+2 months) were recruited at the Naval Medical Center San Diego and, prior to participation, signed informed consent. The fall prevention training program utilized a microprocessor-controlled treadmill (Simbex, Lebanon, NH, USA) designed to deliver task specific training perturbations. The training consisted of six, 30 minute sessions where task difficulty increased as the patient's ability progressed. Static and dynamic perturbations were used. Training effectiveness was assessed using a perturbation test in an immersive virtual environment (MotekMedical, Amsterdam). Trunk motion was assessed, since trunk kinematics at recovery step has been shown to determine fall likelihood. Subjects also completed outcome questionnaires.

### **Results**

Mean trunk flexion angle of the subjects at recovery step improved after participating in the fall prevention training program ( $31^{\circ} \pm 9^{\circ}$  pretest vs  $15^{\circ} \pm 2^{\circ}$  posttest on prosthetic limb trip;  $27^{\circ} \pm 15^{\circ}$  pretest vs  $12^{\circ} \pm 2^{\circ}$  posttest on non-prosthetic limb trip). Subjects reported increased confidence and heightened awareness of their ability to recover from a stumble or trip.

### **Discussion**

This novel rehabilitation method increased the ability of patients with lower extremity amputations to trust their prostheses during challenging perturbations. This training has also been shown to reduce falls in older adults.

### **Conclusions**

These early Results indicate that task-specific training is an effective rehabilitation method to reduce falls in persons with lower limb amputations.

### **Funding**

DoD Grant DM090896; BUMED Wounded III & Injured Views expressed in the article are those of the authors and do not necessarily reflect the official policy of DON, DOD or the US Government.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 1**

**Room 1.03**

Abstract Title: **C-Leg Vs. Mechanical Knee: Impact On Functional Outcomes In K2 Transfemoral Dysvascular**

### **Amputees**

Abstract number: **61**

Authors: **A. Jayaraman, G. Mathur, R. Lipschultz, T. Kuiken**

Presenter: **A. Jayaraman**

### **Introduction**

Currently, dysvascular amputees are given a prosthetic knee based on the basic expectation that they will be functionally stable. This consideration does not address higher levels of function like walking at multiple speeds and over different terrains; a requirement for community ambulation and social interaction like non-injured individuals. Newer microprocessor knees enable patients with transfemoral amputations to walk on different surfaces and at multiple cadences. The jury is still out on the mechanical knee or the microprocessor knee's capabilities to help dysvascular amputees have a healthy lifestyle. The purpose of this study is to compare the functional outcomes with the traditional mechanical knee (M-knee) versus the microprocessor knee (C-leg) in transfemoral amputees.

### **Methods**

Ten individuals with K2 unilateral transfemoral amputations were randomly assigned either to the C-leg with standard foot or M-knee with standard foot. Participants were given a 3 month acclimation period and then allowed to use their knees in ever day life for 3 months. After six months, clinical and functional tests were performed to test the impact of M-knee vs. C-leg on functional outcomes and community mobility in dysvascular amputees. All participants crossed over to the other treatment group and acted as their own controls.

### **Results**

C-leg helped individuals gain significant improvements in community mobility and social interaction compared to when they were wearing the M-knee and own foot or M-knee and new standard foot.

### **Conclusions:**

Microprocessor controlled knees help transfemoral amputees improve their quality of life. The components of the prosthesis in addition to getting acclimated to device usage in real-life environments might have contributed to these functional improvements.

### **Discussion**

The regular use of the C-leg in K2 dysvascular amputees could lead to a life style with reduced co-morbidities and better quality of life with lowered health care costs.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 1**

**Room 1.03**

Abstract Title: **Socket/Liner Interface Volume And Vacuum Pressure Decay In Persons With Transfemoral Amputations**

Abstract number: **157**

Authors: **S. Fatone, S. Wood, R. Caldwell, O. Komolafe, W. Chen, C. Sun, A. Hansen**

Presenter: **S. Fatone**

### **Introduction**

Vacuum-assisted suspension (VAS) is becoming a popular system for use in lower-limb prostheses. However, little is known about socket/liner interface volume in persons with transfemoral amputations (TFA) or the rate of vacuum pressure decay during regular activity. We measured changes in vacuum pump pressures on human subjects, empirically obtaining evacuation curves and gaining insights into volume and pressure decay.

### **Methods**

Persons with unilateral TFA using VAS, sub-ischial sockets and silicone liners participated. Otto Bock Harmony® e-pulse and Ohio WillowWood LimbLogic® VS pumps were tested. Each subject donned their prosthesis and stood quietly while the space between socket and liner was evacuated to ~17 inHg (5 evacuation trials per pump). Between trials, air was allowed into the system by disconnecting the tubing attaching pump to socket. Vacuum pressure data and time were recorded during evacuation using a digital gauge. Some subjects also walked for 10 minutes with each pump at a comfortable pace on a treadmill while vacuum pressure was monitored. Interface volume was calculated from the relationship between time to evacuation in the human subjects and time to evacuate sealed canisters of known volume which were assessed for the same pumps.

### **Results**

Twelve subjects (age =  $56 \pm 14$  years; height =  $174 \pm 7$ cm; mass =  $82 \pm 25$ kg) were tested. Calculated average interface volume was  $97.8 \pm 47.4$ cm<sup>3</sup> and  $103.3 \pm 49.2$ cm<sup>3</sup> for the e-pulse and LimbLogic, respectively. During treadmill walking (4 subjects) the average rate of vacuum decay was  $0.0045 \pm 0.0021$  and  $0.0061 \pm 0.0047$  inHg/sec for the e-pulse and LimbLogic, respectively. Evacuation curves for some human subjects differed in shape from those of fixed volume canisters, resembling s-shaped curves.

### **Discussion/Conclusion**

S-shaped curves may represent a change in the initial volume for those people with “soft” tissue who are pulled into the socket by vacuum. Testing on a greater number of subjects is needed.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 1**

**Room 1.05**

Abstract Title: **Do Orthotic Walkers Affect Knee And Hip Function During Gait?**

Abstract number: **6**

Authors: **J. Richards, K. Payne, D. Myatt, A. Chohan**

Presenter: **J. Richards**

### **Introduction**

The majority of previous studies that have involved orthotic walkers have been concerned with their application in the management of specific conditions such as; higher risk diabetic patients with ulcerative or pre-ulcerative conditions, foot and ankle fractures and acute achilles tendon rupture. The focus has generally been on their ability to off load the structures in the foot and ankle, however little is known about the effects on lower limb biomechanics. The aim of this study was to determine the effects of two designs orthotic walker on the knee and hip joints compared to normal footwear.

### **Methods**

Ten subjects with no history of lower limb problems were asked to walk under three randomised conditions; Össur Rebound, Aircast FP and normal footwear. Kinematic and kinetic data were collected using a ten camera infrared Qualisys motion analysis system and four AMTI force plates and analysed using the Calibrated Anatomical System Technique.

### **Results**

Significant differences in kinematics were seen in hip extension between both walkers and normal footwear, and in knee coronal and transverse plane ranges of motion between the Össur Rebound and normal footwear. Significant differences were also seen in peak knee adduction moments between both walkers and normal footwear, and in the knee extension moments between all the conditions, with the Össur Rebound showing the greatest knee extension moment.

### **Discussion**

Both walkers show significant differences compared with normal footwear, however the Össur Rebound appears to produce the greatest deviation which includes a greater hyperextension moment at the knee which could be damaging over long term usage.

### **Conclusion**

Further research is needed into the effects of orthotic walkers on the knee and hip joint mechanics, which should help to inform future designs of walker, with a greater focus on obtaining a more normal gait pattern.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 1**

**Room 1.05**

Abstract Title: **A Microprocessor Stance And Swing Control Orthosis Improves The Walking Ability Of Traditional Kafo Users**

Abstract number: **30**

Authors: **A. Kannenberg, B. Zacharias, D. Fish, D. Lindsey**

Presenter: **A. Kannenberg**

### **Introduction**

Knee Ankle Foot Orthoses (KAFO) allow for ambulation with a stiff orthotic leg. Stance Control Orthoses (SCO) enable the user to freely swing the leg forward but are locked (stiff) during stance. A hydraulic microprocessor stance and swing control orthosis (MP-SSCO) may allow for knee flexion under weight bearing and therefore more physiologic knee movements during stance.

### **Methods**

3 KAFO and SCO users each were enrolled. For KAFO/SCO use no validated outcome measures exist. Therefore the Prosthesis Evaluation Questionnaire (PEQ) was modified creating an Orthosis Evaluation Questionnaire (OEQ) which was administered at baseline for the existing orthosis and after 3 months of use of the MP-SSCO (C-Brace®, Otto Bock HealthCare, Germany). In addition, a questionnaire rating the importance and comparative safety and difficulty to perform 45 activities of daily living (ADL) with both orthoses was filled out at this final follow-up.

### **Results**

Five males and one female, four poliomyelitis survivors, one incomplete paraplegic at T10, and one femoral nerve lesion with a mean age of  $59.2 \pm 18.0$  years were enrolled. The average rating of all OEQ questions did not differ significantly between the orthoses, however, significant benefits of the MP-SSCO were seen in the OEQ sub-scores for ambulation ( $p=.003$ ), diseased limb health ( $p=.0006$ ), sounds ( $p=.006$ ), and well-being ( $p=.01$ ). The **Results** of the ADL questionnaire showed that 69% of ADLs were rated safer and 51% less difficult with the MP-SSCO, whereas no ADL was rated safer and only one less difficult with the traditional orthoses.

### **Discussion**

Knee flexion under weight bearing is absolutely necessary for alternate stair and slope descending. Stance yielding contributes to shock absorption and appears to offer something to patients beyond a mere mechanical improvement. The Results of this pilot study indicate that the hydraulic MP-SSCO may overcome the functional limitations of the current KAFO and SCO systems.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 1**

**Room 1.05**

Abstract Title: **Immediate Biomechanical Effects Of A New Microprocessor Controlled Stance And Swing Phase Kafo System**

Abstract number: **76**

Authors: **T. Schmalz, E. Ludwigs, R. Auberger, C. Breuer**

Presenter: **T. Schmalz**

Conventional KAFOs with stance control (SCO) do not support knee flexion under load. Thus, it is impossible to walk down ramps and stairs step over step in a safe manner. A new KAFO system with microprocessor controlled stance and swing phase (MPC-SSCO) has been developed, allowing these everyday movements. Six patients [44±16 yr, 79±17 kg, 179±7 cm] using conventional KAFOs due to lower limb muscle weakness were included in the investigation. Biomechanical tests were performed in a gait lab with the patients' conventional KAFOs. Motion analysis while walking on level ground, descending ramps (10°) and descending stairs was conducted. The patients were then fitted with the MPC-SSCO, instructed in its functions and allowed to accommodate for several hours. The biomechanical testing was repeated and the data analyzed and compared.

**Results** show that 4 of 6 patients use the stance phase flexion of the MPC-SSCO during level walking. Compared to their conventional KAFO, the hip moments were reduced immediately prior to the initiation of the swing phase. With the MPC-SSCO, 5 of 6 patients could descend ramps step over step. With the conventional KAFO, only one patient was able to do so (at full knee extension in stance phase). For all 5 patients, continual knee flexion was measured in stance phase using the MPC-SSCO. Also 5 of 6 patients were able to descend stairs step over step. No patient had been able to do this with their previous orthosis.

The **Results** suggest that knee flexion under load allowed by the MPC-SSCO enables patients to perform, for the first time, demanding everyday movement patterns in an approximate physiological manner. The sensor control allowed for intuitive use of the functions after an adaptation period of a few hours.



Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 1**

**Room 1.05**

Abstract Title: **Timing Of Ankle-Foot Orthoses After Stroke: First Results Of A Randomized Longitudinal Study**

Abstract number: **101**

Authors: **C. Nikamp, J. Buurke, M. Nederhand, H. Hermens, J. Rietman**

Presenter: **C. Nikamp**

### **Introduction**

Since scientific evidence about long-term use of ankle-foot orthoses (AFOs) after stroke is lacking, no generally accepted guidelines for AFO-provision after stroke are available. Therefore, we started a longitudinal trial studying the effects of providing AFOs at different moments in time in the rehabilitation after stroke.

### **Methods**

Acute stroke patients with AFO-indication admitted to a rehabilitation centre were included and measured bi-weekly. Two groups with different randomized moments of AFO-provision were compared: "early" (provision at inclusion) and "late" (provision 8 weeks later). Among others, scores on the activity level (including Berg Balance Scale, Functional Ambulation Categories, 10-m walking test, 6-min walking test and Timed Up&Go test) were measured. Results over time of both groups were compared using a general linear model with repeated measures.

### **Results**

Fifteen subjects (9 early, 6 late AFO provision) completed the first 18 weeks of measurements so far. Both groups have shown progress over time on activity level tests, with higher scores in the early AFO-group. However, the differences between both groups at any time were not statistically significant ( $p > 0.05$ ).

### **Discussion**

The first analyses were performed with a limited number of subjects in both groups. Furthermore, not all subjects were able to perform all tests from the start of the study because of limited walking function. Therefore, future analysis will include more subjects. Besides outcomes measures at the activity level the measurement protocol also includes quality-of-life questionnaires, fall-registration and 3D gait analysis (including EMG). Further analysis of this data should elucidate if the timing of AFO-provision influences these outcome measures.

### **Conclusions**

There are no significant differences in outcome measures on activity level between subjects provided with AFOs early or late after stroke, but early AFO-provision shows a positive trend. Future analysis including more subjects should reveal whether or not early AFO-provision after stroke is beneficial.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 1**

**Room 1.05**

Abstract Title: **Mediolateral Foot Placement During Post-Stroke Ambulation With And Without An Ankle-Foot Orthosis**

Abstract number: **159**

Authors: **A. Zissimopoulos, S. Gard, R. Stine, S. Fatone**

Presenter: **A. Zissimopoulos**

### **Introduction**

Common post-stroke swing-phase gait deficits include foot drop and reduced knee flexion, resulting in a functionally longer limb. Compensatory actions, such as affected-side hip hiking and increased lateral motion of the affected-side foot are often used to create ground clearance but may negatively affect mediolateral (ML) foot placement. An ankle-foot orthosis (AFO), which reduces the need for swing-phase compensatory actions, may positively affect ML foot placement accuracy. ML foot placement has been identified as one strategy for controlling ML body center of mass motion during ambulation and affording dynamic balance (forward progression without falling). The chronic post-stroke population has a high incidence of falls that frequently occur while walking and are often attributed to intrinsic characteristics such as poor balance. ML foot placement may provide insight into impaired balance post-stroke. The purpose of this study was to investigate ML foot placement with and without an AFO to better understand dynamic balance post-stroke.

### **Methods**

Gait analysis was used to investigate ML foot placement during locomotion in a chronic post-stroke population. Target step placement (step width) was randomly varied between 0 and 45% leg length and subject's accuracy in achieving the target step placement with each foot was measured.

### **Results**

Data have been collected from 10 subjects. Foot placement accuracy was reduced on the affected side compared to the sound side, and preliminary Results suggest suggest modest improvements in affected side accuracy with AFO use. Data analysis is ongoing to determine whether reduced frontal plane compensations mediate changes in foot placement accuracy.

### **Discussion/Conclusions**

ML foot placement accuracy is impaired during post-stroke ambulation with the affected side demonstrating lower accuracy than the sound side. While AFO use reduces the need for hip hiking, this may not significantly improve foot placement accuracy given the modest improvement demonstrated in initial Results.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 1**

**Room 1.06**

Abstract Title: **Large-Scale Administration Of Shortened Versions Of The Prosthesis Evaluation Questionnaire - Mobility Subscale (Peq-Ms) And Activities Specific Balance Confidence Scale (Abc) In Persons With Lower Limb Loss**

Abstract number: **223**

Authors: **B. Hafner, D. Amtmann, D. Abrahamson, S. Morgan, A. Kajlich, R. Salem**

Presenter: **B. Hafner**

## **Introduction**

Restoration of balance and mobility are key objectives of post-amputation rehabilitation and prosthetic prescription. Self-report instruments like the Prosthesis Evaluation Questionnaire (PEQ) and Activities Specific Balance Confidence Scale (ABC) are available to assess these clinically-meaningful domains, but are not commonly used in clinical practice or research. Shortened versions of the PEQ and ABC have been proposed to address practical and psychometric limitations associated with these instruments. Although these scales show improved psychometric properties, cross-sectional data is needed to help with interpretation.

## **Methods**

Short-form versions of PEQ-MS and ABC were administered to lower limb prosthetic users via survey. Respondents were recruited via clinics, consumer magazines, list-servs, websites, and social networks. Selection criteria included 18+ years of age, ability to read English, unilateral lower limb amputation, traumatic or dysvascular etiology, and use of a prosthesis to ambulate. Population and subgroup (transtibial-trauma, transtibial-dysvascular, transfemoral-trauma, and transfemoral-dysvascular) summary scores were calculated according to developers' instructions. Differences among groups were tested with independent t-tests, corrected for multiple comparisons ( $\alpha=0.0083$ ).

## **Results**

PEQ-MS and ABC scales were administered to 650 persons with lower limb loss (age,  $M=53$ ,  $SD=14$ ). Overall, respondents scored 33.8 ( $SD=10.4$ ) on the PEQ-MS and 2.7 ( $SD=1.0$ ) on the ABC. Persons with dysvascular, transfemoral amputations reported significantly worse mobility ( $M=25.6$ ,  $SD=11.0$ ,  $p=0.001$ ) and worse balance ( $M=1.9$ ,  $SD=1.0$ ) than other subgroups. Conversely, persons with traumatic, transtibial amputations reported significantly better mobility ( $M=37.7$ ,  $SD=9.4$ ,  $p=0.000$ ) and balance ( $M=3.0$ ,  $SD=0.8$ ).

## **Discussion**

Mobility and balance are affected by level and etiology of amputation. PEQ-MS and ABC quantify this relationship and may be used to evaluate clinical interventions.

## **Conclusion**

The PEQ-MS and ABC are designed to measure constructs of interest to lower limb prosthetic users. Means and variances from this large study may aid interpretation of PEQ-MS and ABC scores and encourage their use in clinical practice and research.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 1**

**Room 1.06**

Abstract Title: **Effective Factors Influencing Evidence Based Practice In Prosthetics And Orthotics**

Abstract number: **273**

Authors: **S. Gautam, R. Mohanty, P. Lenka, M. Pathak**

Presenter: **S. Gautam**

### **Introduction**

Evidence based practice EBP refers to the process of 'integrating individual clinical expertise with the best available external clinical evidence from systematic research so as to provide the best clinical care possible.

### **Methods**

A cross-sectional email, questionnaire forms /internet survey study is conducted of Rehabilitation council of India (RCI) recognised prosthetists and orthotists providing services in India. A web-based questionnaire was prepared based on an initial review of literature and pilot testing, and the consideration of protocols outlined. An internet survey is developed and distributed to about 250-300 Prosthetists and Orthotists currently practicing in India.

### **Results**

A principal component factor analysis of the survey Results revealed ten effective primary factors affecting evidence-based practice from prosthetist and orthotist by means of Demographics data, Information sources, Barriers and beliefs. These include time constraints, workload and system demands, limited relevant evidence from research, and gaps in skills and knowledge required to perform evidence-based practice.

### **Discussion**

This study represents one of the first attempts to evaluate the multi-faceted nature of EBP as it pertains to P&O using a mass-distributed questionnaire survey. The Results indicate that while clinicians value research as a means of improving clinical practice, they are faced with a number of practical barriers in performing EBP, including time constraints, Limitations, Relevance, Presentation, Knowledge, Skills, Access, Facility, Value, Financial.

### **Conclusions**

Data about existing EBP will essential in order to inform those involved in improving existing clinical practices, including educators, professional organizations and governing bodies. This study represents one of the initial steps in acquiring empirical data to gain a better understanding of the underlying barriers and facilitators relating to EBP in P&O. Clinicians value research as a means of improving clinical practice, but they are faced with a number of practical barriers in performing evidence-based practice.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 1**

**Room 1.06**

Abstract Title: **Guidance On The Management Of Post Operative Residuuum Oedema In Lower Limb Amputees**

Abstract number: **303**

Authors: **E. Bouch, E. Geer, K. Burns, M. Fuller, A. Rose**

Presenter: **M. Cole**

### **Introduction**

As part of the 2009 Post Graduate Certificate in Amputee Rehabilitation, Bradford University, guidance for the multi disciplinary team on the management of post operative residuum oedema in lower limb amputees was developed. The literature states there are large variations in practice with the regards to the management of post operative residuum oedema with selection of modality based on clinical experience rather than current best evidence. The aim of the guidance was to identify the evidence supporting the modalities available.

### **Methods**

A literature search was completed in November 2010, 44 articles were appraised using the Scottish Intercollegiate Guidelines Network (SIGN) methodology checklists. Evidence was collated for five modalities of oedema control; rigid dressings, Pneumatic Post Amputation Mobility Aid (PPAM aid), compression socks, stump boards and elastic bandage wrapping. The guidance was developed based on the strength of the evidence for each modality.

### **Results**

Available evidence suggests rigid dressings should be used to control oedema. More commonly used modalities such as PPAM aid, compression socks and wheelchair stump boards were supported by the literature, however, methodological quality was poor with key details not addressed.

### **Discussion**

Additional benefits of rigid dressings are documented in the evidence. Early application is advised although no evidence compared timings of application. The evidence suggested the use of elastic bandage wrapping should not be used due to the possible inaccuracies in application.

### **Conclusion**

Rigid dressings should be used in clinical practice when expertise, time and clinical resources allow. Other forms of oedema control recommended by the guidance have been shown to have some evidence base and may be used in the absence of or in conjunction with rigid dressings. Further research is required to establish the optimum timing of application for each of the available modalities and to clarify the optimum design of the rigid dressing.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 1**

**Room 1.06**

Abstract Title: **The Amputee Mobility Predictor For People With Bilateral Lower-Limb Loss.**

Abstract number: **352**

Authors: **M. Raya, R. Gailey, I. Gaunaurd**

Presenter: **R. Gailey**

### **Introduction**

The Amputee Mobility Predictor (AMP) is an objective performance-based measure designed to assess the unilateral lower limb amputees' (LLA) mobility and functional capabilities prior to and following prosthetic fitting. To date there is no comparable measure for bilateral lower limb amputees. The purpose of this study was to develop and examine the utility of the AMP- Bilateral (AMP-B) to measure functional mobility in BLLA and to determine whether AMP-B scores correlated with performance on the AMP and six minute walk test (6MWT).

### **Methods**

Twenty-six male subjects, mean age 28.6 years participated, including 12 bilateral transtibial amputees (BTTA), 7 bilateral transfemoral amputees (BTFA) and 7 with combination transtibial and transfemoral (TTA/TFA) limb loss. All subjects performed the AMP, AMP-B and the 6MWT. Item analysis was performed to determine which AMP items were inappropriate for specific populations.

### **Results**

ANOVA analysis revealed significant differences between the AMP-B ( $P<.0001$ ) scores, AMP ( $P<.0001$ ) scores, and 6MWT ( $P<.05$ ) distance for those subjects with BTTA and TTA/TFA as well as those with BTTA and BTFA but not between those with BTFA and TTA/TFA.

### **Discussion**

The scoring of five items were modified to account for absence of an intact knee joint which diminishes the ability of the knee extensors to generate the necessary torque required to control knee motion during ascending and descending from a chair and stairs without upper-limb assistance. Without modifications, even an extremely high functioning BTFA would be unable to obtain the maximal AMP score.

### **Conclusion**

It was determined that minor modifications in scoring of the AMP does not alter total score and allows clinicians to determine the functional mobility of those with BTFA and TFA/TTA. No modifications are necessary for people with BTTA.

Date / Time: **Monday, Feb 4 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 1**

**Room 1.06**

Abstract Title: **Expectations Of Rehabilitation Following Lower Limb Amputation: A Qualitative Analysis**

Abstract number: **234**

Authors: **C. Ostler, C. Ellis-Hill, M. Donovan-Hall**

Presenter: **C. Ostler**

### **Introduction**

Lower limb amputation can be a traumatic and life changing event that involves adjusting to both physical and psychosocial challenges. Patient expectations can have an impact on the way that patients adjust to a new disability (Wiles et al. 2004). Positive expectations can increase a patient's motivation and serve as a coping mechanism. However, unmet expectations may result in dissatisfaction lead to increased stress levels (Holzner et al, 2001). This study aimed to investigate the expectations of lower limb amputees in relation to the rehabilitation process, the prosthesis and their final outcome.

### **Methods**

The design of the study involved a qualitative approach employing semi-structured interviews. Participants were recruited from two district general hospitals. Interviews were conducted within the first two weeks of amputation. Participants were included if they were over 18 and had been referred for prosthetic rehab. Six male and two female patients were included.

### **Results**

Data were analysed using thematic analysis and resulted in five key themes. It was found that patients' lives remained uncertain following amputation and that information is required to offer security and reduce anxiety. Participants knew little about the services and professionals they were about to encounter, especially the prosthetist. Participants were consistently expecting to return to normal, but did raise contradictions to this normal. This may be the beginnings of adapting to a new normal and should be explored as part of the adjustment process in order to promote realist expectations and satisfaction.

### **Discussion and Conclusion**

Patient Expectations may be an important part of coping following amputation and time within rehabilitation should be dedicated to shaping expectations as part of the long term adjustment process.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 2**

**Room 1.03**

Abstract Title: **Development Of A Rear-Locking Prosthetic Knee Mechanism With Improved Stability Characteristics**

Abstract number: **363**

Authors: **J. Andrysek, D. Wyss, W. Cleghorn**

Presenter: **J. Andrysek**

In regions where resources for prosthetic treatment are limited, both in terms of expertise and wealth, most high-end prosthetic knee devices are neither available nor appropriate. Furthermore, devices which are designed to withstand harsh environmental demands at appropriate costs for under-resourced regions often do not provide acceptable levels of biomechanical function. To address this need, a durable, automatic, rear-locking (RL) prosthetic knee joint was designed to meet the biomechanical requirements of physically active transfemoral amputees functioning in demanding environments. Biomechanical modeling was used to assess reliable stance-phase stability using a commercially viable, high-tech, polycentric knee joint as a benchmark for comparison.

Computer modelling and finite element analyses led to the construction of a functional prototype which was structurally tested and clinically validated in a single-subject pilot study. The 6MWT, physiological cost index (PCI), and Borg RPE scale were used to assess the energy expenditure and perceived exertion, kinetic and temporal data was collected in a 7-camera gait laboratory. The RL design uses a simplified mechanism allowing small amounts of rotation about a control axis. This rotation, caused by ground force reactions initiated at terminal stance-phase, operates the rear lock allowing the knee to safely support weight during stance-phase and flex during swing-phase. The prototype was shown to yield similarly tight zones of instability as a six-bar polycentric knee with positive locking, suggesting the prototype exhibits similar stability characteristics while being less expensive to manufacture and less sensitive to moisture. The clinical assessment shows the prototype knee operates near the same level of functionality as the benchmark compassion knee. This study represents the initial development and assessment of a technology that has potential to improve the quality of life for transfemoral amputees around the world who have previously been limited in the participation of socio-economic activities due to inadequate prosthetic function.



Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 2**

**Room 1.03**

Abstract Title: **The Effect Of Alignment On The Balance And Confidence Of Trans Femoral Prosthetic Users:**

**A Literature Review.**

Abstract number: **364**

Authors: **D. Fisher, S. Deans, A. McGarry**

Presenter: **D. Fisher**

### **Introduction**

The alignment of a trans femoral prosthesis is crucial and may affect socket pressures, stability and the function of lower limb components. Traditionally this procedure is performed using observational techniques with successful outcome reliant upon clinician experience and feedback from the individual prosthesis user. (Radcliffe 1977) Enhanced alignment techniques to improve the balance and confidence of the trans-femoral prosthesis user may promote increased mobility and level of function. The aim of this review is to establish current protocols for trans-femoral alignment and appropriate balance and confidence outcome measurements.

### **Methods**

A literature review was carried out using searches of key electronic databases. The inclusion criteria are studies relating to prosthetic alignment, balance, confidence and outcome measures for a lower limb absent population.

### **Results**

The abstracts of 227 articles located in the search were reviewed, 116 were initially excluded due to their irrelevance and a further 57 articles were excluded after further consideration. The remaining 54 articles are included in this review. The Results are divided into prosthetic alignment considerations and outcome measures. These are further sub-divided into biomechanical studies, specific interventions and technical measurements and the outcome measures are focused on balance and confidence and functional walking tests.

### **Discussion/Conclusions**

From the literature there are a number of tests to assess balance, confidence and stability in the able-bodied population. With careful consideration these tests may be used for the assessment of a lower limb absent population. (Miller, Deathe et al. 2003) It is unclear from the literature how prosthetic alignment is undertaken in day-to-day clinics and therefore if prosthetic users are gaining optimum function and stability from their prosthesis. Literature suggests a variety of Methods and tools are used to align prostheses and indicates that the principle of optimal alignment and repeatability may lead to more stable and functional gait.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 2**

**Room 1.03**

Abstract Title: **What Advantages Do Energy Return Feet Offer The Lower Limb Prosthetic User?**

Abstract number: **367**

Authors: **A. Crimin, E. Harris, A. McGarry, S. Solomonidis**

Presenter: **A. Crimin**

There is a variety of energy return feet available on the market place today, and it is commonly believed that the additional push off force they provide is of considerable benefit to the prosthetic user. However during walking, the additional power generated around the ankle at toe off may not entirely be a propulsion mechanism. The passive ability of flexible feet to adjust to the surface/terrain may be the overriding feature of preference, rather than energy return providing push off. Although prosthetic ankle joints produce significantly less power than the natural ankle, trans-tibial prostheses users can ambulate surprisingly well. The aim of this study was to analyse the gait of six trans-tibial prostheses users wearing three different designs of energy return foot while descending a ramp. The effect these feet have on mechanical work is reported. The ability of the prosthetic user to regulate the body momentum is influenced by the prosthetic foot used when descending a ramp, which in turn affects work done.

**Results** suggest that push off force is not a deciding factor on the preferred foot choice of the prosthetic user, but rather its ability to regulate the ground reaction force and body momentum, therefore stability during double support. These factors have a direct influence on the energy consumption.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 2**

**Room 1.03**

Abstract Title: **Efficacy Of Genium Versus C-Leg On Functional Level, Standing And Walking Exertion, And Heart Beats**

Abstract number: **203**

Authors: **J. Highsmith, R. Miro, D. Lura, L. Mengelkoch, J. Kahle, W. Quillen, R. Dubey**

Presenter: **J. Highsmith**

## **Introduction**

To determine if the Genium knee reduces standing and walking effort and increases gait speed and functional level compared to the C-Leg.

## **Methods**

This interim analysis presents the first 8 subjects' Results in an ongoing clinical trial of n=20. Subjects were male (age: 52y[15.1]) with non-dysvascular etiology and utilized C-Leg for >1y. Subjects randomized to either continue C-Leg use or accommodate with a Genium. C-Leg subjects acclimated 2wks with the newly fitted Trias foot. Genium subjects acclimated to knee and Trias prior to testing. Following initial testing, subjects crossed-over to the second condition and re-acclimated prior to retesting.

## **Outcomes**

Functional Level: Amputee Mobility Predictor(AMP).[1] Standing Exertion: Borgs Rating of Perceived Exertion(RPE) after standing(2min) facing downhill(7deg). Walking Exertion, Gait Speed and Total Heart Beat Index(THBI): Heart beats were counted and THBI[2] calculated. Effort was rated(Borgs RPE) in a 75m self-selected walking speed(SSWS) test. Statistical Analyses: Paired t-tests. A priori significance:  $p<0.05$ .

## **Results**

AMP scores increased 3.3points (8%;  $p<0.05$ ) with Genium use and effort required to stand facing downhill decreased 1.7points (19%;  $p<0.05$ ). Genium use decreased the 75mSSWS-test duration by 6%( $p<0.05$ ). THBI and RPE also improved (3 and 9% respectively) but were not significant.

## **Discussion and Conclusion**

Mean AMP scores placed the sample at an ambulatory level-3 with C-Leg use compared to the lower end of level-4 with the Genium. Bellmann et als[3] data are confirmed as the 8 subjects, while standing facing downhill, rated their RPE decreased 19%. This has functional relevance if patients are doing prolonged standing tasks with less perceived energy consumption. These preliminary findings also showed significantly reduced time to complete a 75mSSWS-test with Genium use.

## **References**

1. Gailey, R.S., et al. Arch Phys Med Rehabil, 2002.
2. Hood, V.L., et al. Arch Phys Med Rehabil, 2002.
3. Bellmann, M., et al. Arch Phys Med Rehabil, 2012.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 2**

**Room 1.03**

Abstract Title: **Clinical Assessment Of Two Common Suspension Systems For Transtibial Amputees**

Abstract number: **390**

Authors: **H. Gholizadeh, N. Abo Osman, A. Eshraghi, S. Ali, E. Yahyavi**

Presenter: **H. Gholizadeh**

## **Introduction**

Proper fitting of the stump inside the socket and appropriate selection of prosthetic suspension have positive effects on amputees' satisfaction and could decrease gait deviation, skin problems, and stump atrophy. The main intention of this study was to evaluate the effects of Seal-In@X5 (suction system) on pistoning within the socket and patients' satisfaction and to compare with a common pin and lock transtibial suspension system.

## **Methods**

Ten unilateral transtibial amputees participated in this work and two prostheses (with suction socket and Pin/lock) were fabricated for each of them. The vertical displacement within the socket in static positions and during the gait (dynamic) was measured using Vicon motion system. The subjects were also asked to complete a prosthesis evaluation questionnaire (PEQ) for each suspension systems.

## **Results**

This study showed that the Seal-In could decrease pistoning movement inside the socket compare to the Pin and lock system. Moreover, during gait and static position a significant difference between the two suspension systems was found ( $p < 0.05$ ). This type of liner (seal-In) provided less pistoning during the ambulation but the overall satisfaction with the locking liner was higher ( $p < 0.05$ ).

## **Discussion**

The suction sockets are commonly prescribed for transtibial amputees to have better suspension compared to the Pin and lock systems. They are said to decrease displacements inside the prosthetic socket. The current findings supported our previous studies on the Seal-In liner in terms of pistoning. Nevertheless, satisfaction with this system was lower possibly due to the relative difficulty of donning and doffing the device.

## **Conclusion**

Therefore, it is possible to conclude that less pistoning may not be the main factor that determines amputees' overall satisfaction with the prosthesis devices, and that other factors such as easy donning and doffing may also contribute to comfort and satisfaction with prosthesis.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 1**

**Room 1.05**

Abstract Title: **Moving Toward Culturally Sensitive Organization Practice: Three Cross-Cultural Perspectives**

Abstract number: **16**

Authors: **J. Odeyo, J. Osgood**

Presenter: **J. Odeyo**

Organizational leadership has been extensively examined in various practice arenas. The area of leadership in humanitarian aid organizations has been studied primarily through the westernized cultural lens of functionalist linear conceptualizations. (Burrell & Morgan, 1979) Because of issues such as colonialism, structural oppression, and widespread poverty, leadership of aid organizations in much of the developing world often follow interpretive and less linear development processes. As a result, cross cultural social work at the organizational level must overcome inherent difficulties particularly in the areas of communication, need assessment and goal setting. Utilizing two interpretively based theories of leadership development; Organizational Culture (Schein, 2004), Transformational Leadership (Bass, 1985), evolutionary perspectives of organizational leadership will be explored from three distinct cultural lenses. In order to address intrinsic paradigmatic considerations, a team of three social work/development professionals will explore their own cultural assumptions and observations within a specific practice environment. As part of cross cultural academic exploratory project, a social work pracademician from the United States will collaborate with a social development practitioner from Western Kenya to explore cultural beliefs, attitudes and practices of several aid organization directors in Western Kenya. During and after the project, a team consisting of three social work/ development professionals from different areas of the world; the United States, Western Kenya, and the Caribbean, will then explore the processes and problems of leadership development that arose during this project. The collaborative team will examine key differences of perception that may lead to a deeper understanding of leadership development and discuss these impressions together from a cross cultural practice perspective. With solid grounding in interpretive theory, the three professionals will explore areas of miscommunication, conflict or misunderstanding based on their individual cultural expectations or perceptions, and offer specific insights that will lead to more culturally humble organizational practice.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 1**

**Room 1.05**

Abstract Title: **Re-Examining Project Sustainability- Lessons Learned In Haiti**

Abstract number: **54**

Authors: **J. Batzdorff**

Presenter: **J. Batzdorff, CPO**

'Sustainability' is a term used in many applications and with a variety of implications. When used to describe an international assistance project in a developing country, it has been used to mean the the project supports and is supported by local culture and infrastructure, that it empowers local participation if not eventual ownership of the project, and that it is likely to continue well into the future.

Following the January, 2010 earthquake in Haiti, ProsthetiKa was requested to assist in developing O and P capacity in the earthquake region of Haiti. Every intention was made to assure that the project was sustainable. The goal was to create a P and O capacity for the benefit of the Haitians, that would eventually be staffed, run, and owned by the Haitians. The goal was to provide local capacity, appropriate technology, and to avoid creating dependency. The project was based on initial information and assumptions based on site visits and **Discussions**. A P and O facility was indeed built, Haitians were recruited to work as trainees, side by side with volunteers from abroad. The project has been, by many measures, a success, but at the same time, the goals were significantly re-defined based on the realities of the environment, the economy, and the culture.

This paper presents accepted definitions of sustainability. It presents an overview of the ProsthetiKa project in Haiti and the **Results**. The paper re-examines sustainability based on these experiences.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 1**

**Room 1.05**

Abstract Title: **Disability And Gender Inclusion In Prosthetics And Orthotics Profession-Challenges In Asia And The Pacific Region**

Abstract number: **88**

Authors: **S. Kheng**

Presenter: **S. Kheng**

The inclusion of PWDs and women is critical in every developmental approach, mainstreaming activities through the enforcement and practice of twin-track approach. Prosthetics and orthotics training and services are similar to those in the allied health professions. Prosthetics and Orthotics profession is thought to be a male and non-disabled profession. However, with the need of clinical service and the requirement of more understanding on disability, women and People with Disabilities (PWDs) are seen to be strong components in the profession.

The objective is to discuss importance and challenges on inclusion of PWDs in the professional and development activities in Cambodia and South East Asia.

### **Methods**

The prosthetics and orthotics students at CSPO completed a self-administered questionnaire on learning and teaching challenges. Out of 36 students, 16 are women and PWDs. In addition, other 15 prosthetists and orthotists from the Cambodia Trust also completed the questionnaires, 8 of those are women and PWD.

### **Findings:**

Challenges encountered in comparison to non-disabled peers:

1. Lack of opportunity for education, employment and training scholarship
2. Minimal social exposures and social value, particularly women with disabilities
3. Low self-confidence & self-esteem due to cultural & community attitude
4. Lack of public awareness on gender issues, disability and disability right
5. Underestimation of women and PWD's capacity and potential
6. Facility accommodation and disability accessibility
7. Lack of motivation from good role model, support mechanism and concept of self-actualization

### **Conclusion**

The index for disability inclusion through the three dimensions explained by Gahel Weigh (2012) on the development of inclusive culture, producing inclusive policies structure and evolving inclusive practices should be endorsed. The need of re-iteration for evidence of disability and gender inclusion is essential.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 1**

**Room 1.05**

Abstract Title: **Leveraged Freedom Chair Indian Trial And Partnerships For Dissemination**

Abstract number: **92**

Authors: **N. Scolnik, A. Winter, M. Bollini, D. Mehta, S. Mehta, M. Mathur, P. Mukul**

Presenter: **N. Scolnik**

The Leveraged Freedom chair (LFC) is a wheelchair-based mobility aid capable of navigating virtually any terrain by optimally utilizing upper body power for propulsion through a variable-speed lever drivetrain. The project was motivated by the 20 million people in developing countries who need a wheelchair, where existing products like western-style wheelchairs and hand-powered tricycles cannot cope with the rough terrain. A device with the LFC's capabilities is desperately needed, as these people must often travel long distances under their own power to access education, employment and community connections. These users require a device that is maneuverable within the home and that can also travel long distances on rough roads. The LFC was developed by a team from the Massachusetts Institute of Technology (MIT) and the design has evolved through four generations based on quantitative performance data and stakeholder input. The final pre-production field trial was conducted in 2011 in India with Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS), also known as Jaipur Foot. This collaboration combined MIT's engineering background with BMVSS's 34 years of experience making high-quality, low-cost mobility aids. Biomechanical data collected during our trial confirmed the advantages of the LFC lever drivetrain, enabling users to travel 75% faster on tarmac than a conventional wheelchair and off-road like no other mobility aid available. We are working with a manufacturer in Indore, India called Pinnacle Industries to prepare the LFC for global distribution. This three-party collaboration represents the intersection of the academic world (MIT), NGO world (BMVSS) and corporate world (Pinnacle), leveraging the individual strengths of each to bring the LFC to the users that need it most.



Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 1**

**Room 1.05**

Abstract Title: **Living As A Person Requiring Prosthetics In Nepal - A Qualitative Investigation In Accordance With The Convention On The Rights Of Persons With Disabilities**

Abstract number: **239**

Authors: **A. Fransson, B. Andersson**

Presenter: **A. Fransson**

### **Introduction**

Nepal is one of the poorest and least developed countries in the world and has an extreme topography. Inaccessibility in the country is a large issue for persons with disabilities and puts high demands on the prosthetic fitting. The aim with the investigation was to explore experiences of the living situation for persons requiring prosthetic service in accordance to some specific articles from the Convention on the Rights of Persons with Disabilities which consider health, mobility, work and employment, education and rehabilitation.

### **Methods**

The investigation was performed through individual interviews using a semi structured interview guide. 16 participants with lower limb amputations were included. For analysis of data latent content analysis was applied.

### **Results**

From the analysis data was divided in to eleven different categories. Those were called; Rehabilitation is encouraging and provided at a low cost, Prosthesis is essential for mobility but is not adequate for the demands required in Nepal, Prosthesis increases independence but also limiting, Living without prosthesis in Nepal is difficult, Accessibility of health care meets the demands but travelling is troublesome, Difficulties of affording health care, Education improves living situation but is lacking because of poverty, Vocational training improves independence but is not available for all, Desire for employments but unemployed due to disability, Prosthesis is essential for working but is not fulfilling requirements, Negative attitudes in society towards persons with disabilities and Living as a person requiring prosthetics in Nepal is hard.

### **Conclusion**

Healthcare and rehabilitation provided at the study site fulfills the demands from the Convention except regarding follow-up treatment. In this specific area of Nepal deficits were reported in the fields of mobility, work and employment and education. The participants requested more advanced prostheses, employment opportunities and more education. The participants also reported negative attitudes for being a person with disabilities.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Upper Limb - 1**

**Room 1.06**

Abstract Title: **Hand-And-Wrist Exoskeleton Device For The Rehabilitation Of Grasping Function.**

Abstract number: **71**

Authors: **M. Troncosi, M. Mozaffari Fomashi, C. Mazzotti, D. Zannoli, V. Parenti Castelli**

Presenter: **M. Troncosi**

In the field of robot-aided neuro-rehabilitation, the BRAVO project ('Brain computer interfaces for Robotic enhanced Action in Visuo-motOr tasks') aims at defining a new approach to the development of assistive and rehabilitative robots for motor-impaired users, in order to perform complex visuomotor tasks. The main novelty introduced by the BRAVO project is the control of a complete upper-limb exoskeleton system through the active prediction of intention/action. The system integrates the preliminary information about the movement to carry out with a prediction of the user's intended action, by interpreting the user's current gaze and brain activation (measured through an eye-tracking system and Brain-Computer Interfaces, BCIs, respectively) and by suitable force measurements.

Within this framework the authors designed and manufactured the distal part of the overall exoskeleton, i.e. the hand-and-wrist system. The hand orthosis has two degrees-of-freedom (DOFs) for (1) the flexion/extension of the thumb and (2) the flexion/extension of the group composed by the other four fingers. The functions of opening and closing is controlled by the patient's brain signals detected via a BCI system. The wrist unit has two DOFs for the actuation of the prono-supination and flexion/extension movements. The device is controlled, as the arm exoskeleton it is attached to, through a complex scheme involving trajectory planning (based on the patient's current gaze) and a hybrid position/force control.

At the time of this abstract writing, the hand orthosis prototype underwent bench tests, the manufacturing of the wrist unit prototype is at its final stage, whereas the two mentioned control systems were tested both with healthy subjects and neurological patients. A clinical pilot study involving the hand orthosis is foreseen within August 2012, whereas the integration of the whole system (robotic arm-wrist-hand and control systems) and its clinical application for a significant patients population is due within January 2013.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Upper Limb - 1**

**Room 1.06**

Abstract Title: **Patients' Perceptions On The Use Of Prefabricated Wrist-Hand Orthoses In The Management Of Rheumatoid Arthritis**

Abstract number: **401**

Authors: **K. Ross**

Presenter: **K. Ross**

### **Introduction**

Rheumatoid arthritis (RA) affects over 400,000 people in the UK. The wrist and hand are commonly affected in the early stages of RA, with most hand deformities occurring during the first year of the disease. Prefabricated functional wrist-hand orthoses (WHOs) with a volar bar are commonly prescribed to manage the functional deficit associated with the wrist as a result of rheumatoid changes. Studies have previously investigated the efficacy of these orthoses, with many reporting on the benefits and limitations of these devices but rarely on compliance. It is the aim of the present work to report on patients' perceptions on the use of these WHOs.

### **Methods**

A six month user survey was conducted in the UK to seek and evaluate the opinions of patients with RA who had been prescribed commercially available prefabricated WHOs. A questionnaire was developed and participants were invited to both rate and comment on their experience of orthosis provision and of wearing the orthosis.

### **Results and Discussion**

Analysis of the Results demonstrated that patients recognise clear benefits associated with WHO use. However many users are still dissatisfied with service provision and their orthoses, identifying many limitations to the functionality of the devices and factors which impact significantly on wear time and overall compliance.

### **Conclusion**

While there are some positive outcomes reported in the literature and recognised benefits from users in wearing these devices, if patients are to derive optimal benefit from the use of prefabricated WHOs, the factors which underpin orthotic use must be addressed. If the functionality of wrist-hand orthoses and factors affecting user compliance are both addressed, there is the potential to achieve additional gains in the outcome measures and positively impact on quality of life.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Upper Limb - 1**

**Room 1.06**

Abstract Title: **The Effect Of Prefabricated Wrist-Hand Orthoses On Grip Strength**

Abstract number: **411**

Authors: **M. O'Hare, K. Ross**

Presenter: **M. O'Hare**

Prefabricated wrist-hand orthoses (WHOs) are commonly prescribed to manage the functional deficit and compromised grip strength as a result of rheumatoid changes. It is thought that an orthosis which improves wrist extension, reduces synovitis and increases the mechanical advantage of the flexor muscles will improve hand function. Previous studies report an initial reduction in grip strength with WHO use which may increase following prolonged use.

### **Methods**

Using normal subjects, and thus in the absence of pain as a limiting factor, the impact of ten WHOs on grip strength was measured using a Jamar dynamometer. Tests were performed with and without WHOs by right-handed, female subjects, aged 20-50 years over a ten week period. During each test, a wrist goniometer and a forearm torsionmeter were used to measure wrist joint position when maximum grip strength was achieved.

### **Results and Discussion**

The majority of participants achieved maximum grip strength with no orthosis at 30° extension. All the orthoses reduced initial grip strength but surprisingly the restriction of wrist extension did not appear to contribute in a significant way to this. Reduction in grip must therefore also be attributable to WHO design characteristics or the quality of fit.

### **Conclusion**

The authors recognize the need for research into the long term effect of WHOs on grip strength. However if grip is initially adversely affected, patients may be unlikely to persevere with treatment thereby negating all therapeutic benefits. In studies investigating patient opinions on WHO use, it was a stable wrist rather than a stronger grip reported to have facilitated task performance. This may explain why orthoses that interfere with maximum grip strength can improve functional task performance. Therefore while it is important to measure grip strength, it is only one factor to be considered when evaluating the efficacy of WHOs.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Upper Limb - 1**

**Room 1.06**

Abstract Title: **The Effect Of Prefabricated Wrist-Hand Orthoses On Performing Activities Of Daily Living**

Abstract number: **483**

Authors: **M. O'Hare, K. Ross**

Presenter: **M. O'Hare**

Wrist-hand orthoses (WHOs) are commonly prescribed to manage the functional deficit associated with the wrist as a result of rheumatoid changes. The common presentation of the wrist is one of flexion and radial deviation with ulnar deviation of the fingers. This wrist position **Results** in altered biomechanics compromising hand function during activities of daily living (ADL). A paucity of evidence exists which suggests that improvements in ADL with WHO use are very task specific.

### **Methods**

Using normal subjects, and thus in the absence of pain as a limiting factor, the impact of ten WHOs on performing five ADLs tasks was investigated. The tasks were selected to represent common grip patterns and tests were performed with and without WHOs by right-handed, females, aged 20-50 years over a ten week period. The time taken to complete each task was recorded and a wrist goniometer, elbow goniometer and a forearm torsionmeter were used to measure joint motion.

### **Results and Discussion**

Results show that, although orthoses may restrict the motion required to perform a task, participants do not use the full range of motion which the orthoses permit. The altered wrist position measured may be attributable to a modified method of performing the task or to a necessary change in grip pattern, resulting in an increased time in task performance.

### **Conclusion**

The effect of WHO use on ADL is task specific and may initially impede function. This could have an effect on WHO compliance if there appears to be no immediate benefits. This orthotic effect may be related to restriction of wrist motion or an inability to achieve the necessary grip patterns due to the designs of the orthoses.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Lower Limb - 2**

**Room G.06**

Abstract Title: **Superior Efficacy Of Low-Load Prolonged Strech Dynamic Orthosis (Ultraflex) In Cerebral Palsy : Application For Knee Flexion Contractures**

Abstract number: **212**

Authors: **I. Heymann**

Presenter: **I. Heymann**

### **Introduction**

Night time static positioning braces are recommended for treatment of knee flexion contractures in cerebral palsy but often intolerated and quickly abandoned. The goal is to compare the efficacy and the tolerance of static with ratchet orthoses with Low-Load Prolonged Stretch (LLPS) dynamic orthoses (ULTRAFLEX) in the treatment of the knee flexion contracture .

### **Methods**

This randomized prospective and monocentric study included children with cerebral palsy, presenting uni or bilateral knee flexion contracture superior or equal to 10°. Main assessment criterion : the goniometric measurement of knee extension. Secondary assessment criteria : the measurement of the popliteal angle, the ankle's dorsi-flexion , the hamstrings and triceps surae spasticity level, the orthosis's tolerance . Measurements were performed by the same physiotherapist for consistency. Statistics: test of Student, using adjustment with the method of Tukey (&#945;=' &#945;/&#8730;6) Thirty patients with cerebral palsy (age 11.2 years+/-4.2, 14 ambulant; 21 boys) participated :48 legs were randomized (24 dynamic -24 static KAFO)

### **Results**

Superior efficacy of the dynamic orthosis for the reduction on: -knee flexion contracture at 6 month (9.3° vs 2.8°;  $p < 0.001$ ), at 8 month (12.5° vs 3.5°;  $p < 0.0001$ ). (for the ambulant as well as for the non-ambulant patients ( $p=0.006$  and  $p=0.041$ )).

-gastrocnemius contracture ( $p=0.0003$ )

-gastrocnemius spasticity ( $p=0.0003$ )

-hamstrings spasticity (;  $p=0.0262$ )

The analysis of the tolerance reveals that 72.5% were good or very good with dynamic vs 31.8% with static orthoses ( $p=0.009$ ).

### **Discussion**

The longitudinal follow-up would allow to know if the improvement of the extension of the knee continues beyond 8 months and in which speed .

### **Conclusion**

This first comparative study brings to light the superiority of the dynamic orthosis thanks to the LLPS. This dynamic orthosis should be in the front line in the conservative treatment of the knee flexum in cerebral palsy.

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Lower Limb - 2**

**Room G.06**

Abstract Title: **Effectiveness Of Different Configuration Of Ankle Foot Orthoses In Spastic Diplegic Cerebral**

**Palsy: Literature Review**

Abstract number: **241**

Authors: **H. Trivedi**

Presenter: **H. Trivedi**

### **Introduction**

Cerebral palsy (CP) is primarily characterized by central nervous system abnormalities, such as loss of selective motor control and abnormal muscle tone often lead to secondary deficits, including bony deformities, muscle contractures, and gait abnormalities. Diplegia is the commonest with an incidence rate of 32%. Dynamic equinus, as a result of inappropriate activity of spastic plantarflexors, is the commonest deformity for diplegic. The aim of orthotic management in spastic cerebral palsy is to produce a more normal gait pattern by positioning peripheral joints in a way that reduces pathological reflex patterns or by blocking pathological movement of the joint.

### **Methods**

The purpose of this review is to summarize the available literature related to the spastic diplegic in the respect of the different configuration of the Ankle Foot Orthosis (AFO). The literature are searched using the different keywords.

### **Results**

All orthoses solid AFO, dynamic AFO (DAFO), hinged AFO, posterior leaf spring showed increased stride length, decreased cadence, controlled plantar flexion during swing phase and increased degree of lower extremity symmetry compared with no orthoses. One Results show significantly decreased energy cost of walking with the use of AFOs compare to no orthoses. The DAFOs allowed a significantly larger total ankle range of motion than the AFOs.

### **Discussion and Conclusion**

Although the studies showed biomechanically controlled ankle motion, but no changes were found in the proximal joint motions of the trunk, pelvis, hip and knee. W.K. Lam et al Results showed an increase in hip flexion at initial contact in the DAFO group for which there was no apparent explanation. Future studies are needed that include a larger sample size of children with spastic CP and moderate to severe amounts of dynamic equinus during ambulation who receive similar physical therapy for gait training with orthoses. Keywords:- Spastic diplegic CP, dynamic equines gait

Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Lower Limb - 2**

**Room G.06**

Abstract Title: **Gait Efficiency Of Healthy Persons And Polio Survivors While Walking With Carbon Fiber-Reinforced Plastic, Weight-Added Carbon Fiber-Reinforced Plastic And Conventional Knee-Ankle-Foot Orthoses**

Abstract number: **280**

Authors: **Y. Nakanishi, F. Wada, K. Hachisuka, M. Arai**

Presenter: **Y. Nakanishi**

### **Introduction**

Although a carbon fiber-reinforced plastic knee-ankle-foot orthosis (carbon KAFO) improved gait efficiency, the main factor that improved their gait efficiency is unclear. The aim of this study was to clarify whether the lighter weight of a carbon KAFO contributes to improvement of gait efficiency.

### **Methods**

Subjects were 7 healthy persons and 8 polio survivors, for whom both conventional KAFO (1650g) and carbon KAFO (1050g) were manufactured and adjusted to get a good fit. Walking speed, step length, O<sub>2</sub> cost and heart rate at the most comfortable speed were measured during 3-minute walk on three conditions in random order: walk with a conventional KAFO (W\_CVT), walk with a carbon KAFO with additional 600g weight of leaden plate (W\_WGT), and walk with a carbon KAFO (W\_CBN).

### **Results**

In healthy persons, walking speed and step length of W\_CBN were significantly greater than those of W\_CVT, and O<sub>2</sub> cost of W\_CBN was significantly less than that of the two conditions. In polio survivors, O<sub>2</sub> cost of W\_CBN was significantly less than that of W\_CVT.

### **Discussion**

In healthy persons, the lightweight induces an increase in step length, a slight increase in number of steps, and an increase in gait speed. This process may reduce O<sub>2</sub> cost, and improve gait efficiency. Because the process is not so distinct in polio survivors as in healthy persons, both the lightweight and structural feature may be related to the O<sub>2</sub> cost reduction in polio survivors during walk with a carbon KAFO. These Results suggest that polio survivors walk somewhat differently to improve gait efficiency.

### **Conclusion**

A carbon KAFO improved gait efficiency in both healthy persons and polio survivors. The factor of gait efficiency improvement was the lightweight for healthy persons, while the lightweight and structural feature for polio survivors.



Date / Time: **Monday, Feb 4 / 14:30 - 15:45**

Session Name and Room: **Orthotics: Lower Limb - 2**

**Room G.06**

Abstract Title: **The Conservative Management Of Plantar fasciitis, A Literature Review And Clinical Trial Of Assesment Methods For Dorsiflexion Rom**

Abstract number: **403**

Authors: **E. Figgins, J. Halliday**

Presenter: **A. McGarry**

Plantar fasciitis is one of the major causes for foot pain presenting as severe pain in the heel. There are a number of risk factors, including: high-level activities; increased Body Mass Index; poor foot biomechanics; and limited range of motion. A conservative management approach is commonly utilised in the treatment of plantar fasciitis. This study undertook a critical review of the literature to evaluate the evidence for conservative management of plantar fasciitis with foot orthotics, night splints and stretching. A number of databases were searched, including: Embase, Medline, Cinahl, Cochrane library, ProQuest, Amed and RECAL legacy. A strict inclusion and exclusion criteria were applied to achieve a total of 40 studies that were critically reviewed applying SIGN guidelines. The **Results** showed that overall there was an effect for each type of conservative management. However, no individual management technique was deemed better than others.

Quality overall was low, suggesting further work was required to provide stronger evidence. From the findings a pilot study was designed to assess the dorsiflexion range of motion in plantar fasciitis compared with an asymptomatic control group. During the assessment the foot was placed in, neutral, supinated and pronated positions and a constant pressure applied. The study utilised two measurement Methods to assess for reliability. Ethcal approval was gained. A comparison between measuring using a goniometer with video analysis was done. Statistical analysis was carried out using SPSS and ANOVA.

The **Results** support goniometer measures as more reliable than the Silicon Coach, and with a position of knee extension with the foot in a neutral position. When comparing symptomatic and asymptomatic groups, there was no significant difference in ROM seen. This study outlines an effective reliable measurement method for assessing the dorsiflexion ROM in plantar fasciitis using both simple goniometer and Silicon Coach measuring systems.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 3**

**Room 1.03**

Abstract Title: **Implementation Of Combined Advanced Technologies To Assess Multiple And Different Qualities Of A Hydraulic Prosthetic Foot**

Abstract number: **426**

Authors: **I. Siev-Ner, A. Kristal, A. Gefen, U. Givon, Z. Yizhar, Z. Dvir, H. Sharon, S. Portnoy**

Presenter: **I. Siev-Ner**

### **Introduction**

The mechanism of a prosthetic foot influences the stability, gait symmetry and comfort of transtibial amputees (TTA). The Echelon® hydraulic prosthetic foot utilizes hydraulic fluid to mimic the way muscle adapts during stance phase and allows automatic self alignment to compensate for the changes of the surface.

### **Methods**

10 active unilateral traumatic TTA males were examined with their existing stored energy foot, after which it was replaced to the Hydraulic Foot and after a month they underwent the same exams. The technologies used were: the CAREN® virtual reality motion analysis system which comprises an electronically-controlled tilting platform, equipped with two force plates, the CODA Motion Analysis laboratory and an internal stress monitor that utilizes 3 thin and flexible force sensors, placed within the socket.

### **Results**

The Hydraulic foot enabled: Approximately 4° more than the subjects' own prosthetic feet, resulting a decrease in sagittal knee angle fluctuations in both legs. The COP was more centered. A dorsiflexion movement through the swing phase and less hip flexion, as measured during initial contact and swing phase. A greater ankle plantarflexor moment and power was measured while ambulating with the hydraulic foot. Peak internal stresses at the distal tibial end decreased significantly ( $p < 0.01$ ) while ambulating with the Echelon foot compared to using their own prosthetic foot

### **Conclusions**

The hydraulic prosthetic foot had an effect on the posture, expressed by both kinetic and kinematic measurements. It may assist the TTA prosthetic-user while ambulating on uneven terrain and contribute to the stabilization in standing. It enables a motion at the ankle which Results in less compensation at the hip and knee enabling a smooth and natural transition from backward to forward acceleration. Internal stresses under the truncated bones decreased, thereby lowering the risk for internal injury to the soft tissues of the residuum.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 3**

**Room 1.03**

Abstract Title: **The Outcomes Of Lower Limb Amputee Rehabilitation Are Changing**

Abstract number: **434**

Authors: **H. Batten, J. Nitz, S. Kuys, P. Varghese, S. Mcphail**

Presenter: **H. Batten**

### **Introduction**

Lower-limb amputations are a serious adverse consequence of lifestyle related conditions and an increasing concern amongst increasingly sedentary and aging populations. The health profiles of developed nations are likely to continue to be impacted by sedentary lifestyle behaviours. This study aimed to investigate the rate of prosthetic prescription at discharge from inpatient hospital rehabilitation among two cohorts of lower limb amputees.

### **Method**

Clinical outcomes of all lower limb amputees admitted to a tertiary Geriatric Assessment and Rehabilitation Unit for rehabilitation during 2005 and 2006, as well as 2010 and 2011 were collected. A range of demographic, clinical and rehabilitation outcome variables were examined using conventional descriptive statistics (median and interquartile range (IQR), mean and standard deviation (SD) and number and percentage) and conventional tests of hypothesis (t-test, Mann-Whitney-u).

### **Results**

A total of n=117 and n=102 lower-limb amputation admissions occurred in 2005-06 and 2010-11 respectively. There was no difference in median (IQR) 40 (22-73) days LOS or mean (SD) 64.8years (14.2) age for patients admitted in 2005-6 in comparison to patients admitted in 2010-11 (46 (23-79) days LOS, p=0.45; 63.6 years (12.5) age,p=0.49). Despite similar age and length of stay, a lower percentage of patients were discharged with a lower limb prosthesis in 2010-11 (n=48, 47.5%) than 2005-06 (n=74, 63.2%). The incidence of a range of lifestyle associated co-morbidities such as obesity, diabetes and stroke was higher in 2010-11 and will be presented.

### **Discussion**

The lower proportion of patients receiving prosthesis in the more recent cohort may be explained by several factors that will be discussed. These factors include the impact of stricter prosthesis prescription practice and the effect of increasing co-morbidities among amputees.

### **Conclusion**

The clinical profile and outcome of inpatient rehabilitation for lower limb amputees are changing to reflect increasingly sedentary lifestyles and budgetary pressure on health services.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 3**

**Room 1.03**

Abstract Title: **The Prosthesis And Weight-Bearing Contributions On Emg Response Latency Subsequent To Rapid Platform Perturbation In Transtibial Prosthesis Users**

Abstract number: **444**

Authors: **D. Rusaw, K. Hagberg, L. Nolan, N. Ramstrand**

Presenter: **D. Rusaw**

### **Introduction**

An individual's ability to coordinate physiological responses to postural challenges is integral in preventing falls. When subjected to sudden movements of the support surface individuals must rapidly coordinate multiple physiological systems to prevent a fall. Various disease processes contribute to pathological response to perturbations and have been identified as contributing to falls in various populations (Ting 2007; Allum, Gage, Frank et al. 2007; Carpenter et al. 2002). Transtibial prosthesis users have altered physiological responses in rapid movements when to control groups (Arui, Nicholas et al. 1997; Viton, Mouchnino et al. 2000) but little is known about their responses to unexpected rapid support surface perturbations. The aim of this study was to investigate the latency of EMG response in the intact limb and prosthetic limb of individuals with unilateral transtibial amputation following support surface rotations in the pitch plane (toes-up/toes-down). An additional aim was to investigate the role of weight-bearing and limb-position on these EMG responses.

### **Methods**

23 transtibial prosthesis users (mean age 48 years [SD 14], height 1.77 m [SD 0.08], and mass 79 kg [SD 14]) were subjected to a series of rapid, unexpected rotations of the support surface in the pitch plane. Perturbations were elicited in various weight-bearing and limb-perturbed conditions. The latency of the EMG response for muscles of the lower-extremity, both intact- and prosthetic-side, were compared to the responses of a matched control group.

### **Results**

The TTA-group had statistically significant delays of response to toes-up rotations in the gastrocnemius muscle (intact limb), and the biceps femoris muscle (prosthetic limb) compared to the control-group. Significant differences were also found in limb-position and weight-bearing on the intact side, but not the prosthetic side.

### **Conclusion**

Results suggest being a unilateral transtibial prosthesis user delays muscular response bilaterally to support surface rotations in some muscles of the lower-extremity.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 3**

**Room 1.03**

Abstract Title: **The Effects Of Transtibial Prosthesis On Correction Of Knee Flexion Contracture**

Abstract number: **454**

Authors: **F. Kazemi, M. Kamyab**

Presenter: **F. Kazemi**

### **Introduction**

Lower limb contractures are a common complication in amputees, contractures can impair future mobility. In fact after the first few days of an amputation, patients are started on an exercise programme, but some patients might refuse doing these exercises. The purpose of this study was to investigate the effects of a below knee prosthesis on the correction of knee flexion contractures.

### **Methods**

This was a case study. A 60 year old man was selected. He suffered from knee flexion contracture but he refused doing physical therapy exercises so we decided to make a prosthesis for him. At the first session we measured his knee flexion angle by means of a goniometer which was a clinically easy way to use for the patients. In fact we made 3 prostheses for this patient during a 4 months period. We measured the knee angle each time.

### **Results**

Knee flexion angle was measured 60 degrees in the first session by means of a goniometer. It decreased to 15 degrees after 4 months.

### **Discussion**

After an amputation patients should start an exercise program by a physiotherapist but there are some patients who refuse doing these exercises, they prefer to walk immediately. We decided to study the real effects of transtibial prosthesis in some patients who suffer from flexion knee contractures and are not interested in doing regular physical exercises. The results were surprising for us because after 4 months the knee flexion contracture was just 15 degrees. We are believed that the prosthesis were doing a gradual constant stretching on the knee complex.

### **Conclusion**

This study demonstrated that the transtibial prosthesis can improve gradually the knee flexion contracture. It is a good idea to prescribe an early prosthesis for patients who are suffering from knee flexion contracture with physical therapy exercises simultaneously or specially for some patients who refuse doing physical therapy exercises.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 3**

**Room 1.03**

Abstract Title: **Understanding Residual Limb Volume Loss; Utilising A Physical Model (Manikin)**

Abstract number: **461**

Authors: **A. Buis, J. Lizhang, L. Mosler**

Presenter: **A. Buis**

### **Introduction**

For individuals using lower limb prostheses, volume loss of the residual limb can cause discomfort and pain. Volume loss affects prosthetic fit and how normal and shear stresses are delivered to the weight bearing structure, the skeleton. Volume change affect suspension and how much the limb is pistoning in the socket during ambulation. In addition, the amount of volume fluctuation varies greatly among individuals as a function of comorbidities, prosthesis fit, activity level, etc. It is suggested that vacuum-assisted suspension systems retard limb volume reduction in part through improving fluid inflow into the residual limb so that it better balances with fluid outflow. This study investigated if it is physically possible to manage volume changes in a controlled environment.

### **Methods**

A physical model of a trans-tibial residual limb and matching hard socket was produced. The model was capable to reduce and gain volume by controlled fluid out- and in-flow respectively. This configuration was placed in a programmable testing machine and was exposed to various static and dynamic loading conditions the latter simulating stance and swing phase. Furthermore several sub-atmospheric pressure conditions were introduced to this configuration.

### **Results**

The following was found within the Manikin: volume loss irrespective of sub-atmospheric pressure. significant reduced pistoning with vacuum-assisted conditions.

### **Discussion**

Limited evidence exists regarding the management of limb volume, and the evidence available focuses on adults with transtibial amputation. It is essential to understand what is physically happening under controlled conditions and this study is a first attempt to do so. Furthermore, the development of a Finite-Element model informed by empirical and clinical tests created a valuable understanding what is physiological possible and what not.

### **Conclusions**

This study showed that volume loss cannot be avoided however; by applying active-vacuum a considerable stiffer coupling is created. A clinical-significant-study is recommended.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 1**

**Room 1.05**

Abstract Title: **Functional Differences Between Standard And Multigrip Myoelectric Hands In Performing Activities Of Daily Living**

Abstract number: **27**

Authors: **A. Kannenberg, B. Zacharias, L. Hermansson, S. Swanson, J. Miguelez, A. Cutti**

Presenter: **A. Kannenberg**

## **Introduction**

This study investigated whether the Michelangelo® multigrip hand (Otto Bock HealthCare, Duderstadt) offering three grip modes and seven functional hand positions improves performing activities of daily living (ADL) as compared to conventional myoelectric hands.

## **Methods**

Within-subject cross-over pilot study. The Orthotics and Prosthetics User Survey - Upper Extremity Functional Status (OPUS-UEFS) (1) was used as the primary outcome measure. As secondary outcome measure the same 28 ADLs were also rated using the scoring system of the Prosthetic Upper Extremity Functional Index (PUFI) (2) at baseline for their conventional myoelectric hand as well as after a minimum of 4 weeks of use of the multigrip hand. Statistical analysis was conducted using the Wilcoxon signed rank test.

## **Results**

15 male transradial amputees with an average age of  $40.9 \pm 14.8$  years gave informed consent to participate. Mean duration of the multigrip hand use was  $11.6 \pm 7.5$  weeks. OPUS-UEFS: Michelangelo hand use significantly improved perceived difficulty of performing the 28 ADLs from  $90.6 \pm 15.0$  to  $75.5 \pm 21.3$  ( $p=.02$ ). In addition, patients performed significantly more ADLs with "both hands together with the prosthetic hand used actively to grasp" as compared to the conventional myoelectric hands (means  $12.9 \pm 6.1$  vs.  $9.9 \pm 5.9$  ADLs;  $p=.046$ ).

## **Discussion**

Limited function of conventional myoelectric hands is an important reason to only passively use or even completely reject the prosthesis (2). The Results of this pilot study suggest that a multigrip prosthetic hand may improve prosthetic function and reduce perceived difficulty to perform many ADLs.

## **References**

1. Burger H et al.: Validation of the Orthotics and Prosthetics User Survey Upper Extremity Functional Status module in people with unilateral upper limb amputation. J Rehabil Med 2008, 40 (5): 393-399
2. Wright FV et al: Evaluation of the validity of the Prosthetic Upper Extremity Functional Index for children. Arch Phys Med Rehabil 2003, 84 (4): 518-527

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 1**

**Room 1.05**

Abstract Title: **Learning Curves Of Southampton Hand Assessment Procedure Tasks In Novice Prosthetic Users**

Abstract number: **79**

Authors: **E. Vasluian, H. Reinders-Messelink, R. Bongers, P. Dijkstra, J. Burgerhof, C. Van Der Sluis**

Presenter: **E. Vasluian**

### **Introduction**

Southampton Hand Assessment Procedure (SHAP) is a standardized procedure of 26 tasks designed to evaluate the functionality of normal, injured or prosthetic hands. Currently, improvements in functionality assessed by means of the SHAP can not be distinguished from testing effects (learning). Aim: To evaluate learning curves of the SHAP tasks in novice prosthetic users.

### **Methods**

In a repeated measurement study, 24 healthy participants (mean age 21.8, 45.8% men) completed eight measurement sessions during five consecutive days using a prosthetic simulator. The simulator is a myoelectric prosthesis that can be fixated on a normal hand, and is controlled in the same way as a myoelectric prosthesis. Participants performed one measurement session on the first and fifth day, and two sessions on the days in between. Data were analyzed using multilevel analysis.

### **Results**

Participants differed in the time needed to execute the first attempt and the time gained in consecutive attempts. More difficult tasks (e.g. pick up coins, undo buttons) varied largely and required longer time. Female or participants who performed with the left hand needed on average more time to perform the tasks, but no difference in learning curves was seen between male and female participants. Every new day participants were slower in the first session. SHAP tasks, hand, gender, sessions, interaction of the tasks and sessions, and a "new day effect" contributed significantly ( $P < 0.01$ ) to the prediction of learning curves. A clear learning effect occurred in all tasks.

### **Discussion**

This study showed a strong learning effect of SHAP in novice prosthetic users. This learning effect will influence reliability and needs to be taken into account when conducting a reliability study.

### **Conclusion**

SHAP task scores for functionality in prosthetic hands, acquired in one session, should be interpreted with caution. They may be distorted by the learning effect of the SHAP.



Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 1**

**Room 1.05**

Abstract Title: **Sensibility Of Upper Limb Stumps In Children And Adults**

Abstract number: **102**

Authors: **C. Van Der Sluis, W. Van Gils, M. Reinkingh, P. Dijkstra, F. Smit-Klajj, R. Bongers, H. Reinders-Messelink**

Presenter: **C. Van Der Sluis**

### **Introduction**

Sensible upper limb stumps may be of more functional use than non-sensitive prostheses. As such, sensibility may be important when giving patients advice whether or not to use prostheses. However, little is known about stump sensibility, neither in children with upper limb reduction deficiencies (ULRD) nor in adults with acquired upper limb amputations (AULA).

### **Aims**

To compare stump sensibility in children with ULRD with that of adults with AULA and to compare the sensibility of stumps with corresponding parts of unaffected arms and hands.

### **Methods**

A cross-sectional study. Subjects: Thirty-one children with ULRD (18 boys, 3 prosthetic users, mean age 14.6 years (sd: 5.8)) and 30 adults with AULA, at least one year after amputation (29 men, 20 prosthetic users, mean age 51.9 years (sd:13.2)). Level of amputation: from transhumeral to wrist disarticulation. Main study outcomes: touch pressure measured by Semmes Weinstein monofilaments, stereognosis measured by Shape/Texture Identification test (STI-test) and kinaesthesia.

### **Results**

Touch pressure in children was better than in adults ( $p=0.00$ ). Touch pressure of stump circumference in children was better compared to unaffected hands ( $p=0,046$ ), stump endpoints ( $p=0.02$ ) and rudimentary fingers ( $p=0.00$ ). In adults, no differences between stumps and unaffected arms/hands were found. Adults not using prostheses had better sensibility of stump and unaffected arm ( $p=0.04$ ). STI test. 25 children and 2 adults recognized shapes and textures with their stump. Kinaesthesia. No differences in shoulders or elbows were found between affected and non-affected side in children or adults.

### **Discussion/Conclusions**

Touch pressure and shape/texture identification were better in children with ULRD than in adults with AULA. Sensibility in paediatric stumps was better than in unaffected arms. This excellent stump sensibility may clarify why children with ULRD, in contrast to adults with AULA, function well without prostheses. The better stump sensibility of adults not using prostheses needs further exploration.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 1**

**Room 1.05**

Abstract Title: **An Improved Approach To Anchoring Surface-EMG Sensor For Tmr Patients**

Abstract number: **104**

Authors: **N. Kumar, J. Van Vliet**

Presenter: **J. Kalmar**

Fitting of a prosthesis on a patient with shoulder level amputation pose significant challenges. Tracking EMG signals in patients who have undergone TMR surgery and have hyper-mobile muscle contraction becomes a significant part of the challenges. This study aims at identifying the problems faced by such a user during operation of prosthesis and attempting to solve them by developing flexible sEMG sensor anchors. Furthermore, this study aims as improving the design of the said anchors and modularize the construction for other applications.

A prosthetic system consisting of the Otto Bock Dynamic Arm-TMR, sensor hand speed with rotator unit controlled by 4/5 surface-EMG (sEMG) sensors was used. The user was retro-fitted with the said anchors in such a way that it follows the movement of the skin thus tracking the signals. A preliminary lab-based user trial was conducted which revealed that the concept of anchoring electrodes has a potential to effectively control the prosthesis. Furthermore, with this design, the prosthetists don't have to decide on the accurate sensor location at the time of socket construction. It is adequate to identify the approximate area and then the flexibility of the anchor would allow the prosthetists to accurately position the sensor.

These aspects of the design seem to help prosthetists avoid errors during socket construction and, the flexibility in attaching of the anchors seems to help avoiding expensive rebuilding the sockets. It further appears that these anchors with design modifications could have other applications in UE prosthetics.

The feedback including improvement potential is being incorporated and further tests will be conducted to evaluate the feasibility of such an approach to TMR users.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 1**

**Room 1.05**

Abstract Title: **A Comparative Assessment Of The Functionality Of Multi-Function Prosthetic Hands**

Abstract number: **252**

Authors: **P. J. Kyberd**

Presenter: **P. J. Kyberd**

### **Aim**

The functional capabilities of prosthetic hands is important to assist clinical decisions. Knowledge of the abilities of a new generation of devices possessing multi articulated digits, is being built slowly. This project measures the function of the hands currently on the market. It builds on an earlier study of conventional single axis hands.

### **Method**

Repeated measures of the function are made by a single able bodied subject using a socket fastened over the left forearm. Each hand is assessed repeatedly. The tool used is the Southampton Hand Assessment Procedure. The hands under test are the Touch Bionics i Pulse and the RSLSteeper, BeBionic.

### **Results**

The overall scores of both hands is similar (81 for the TB and 72 for the BB). With a similar relationship for the Tripod (89, 81) and Power (88, 70) and marked lower scores for Tips (59, 39) and Extension (88, 83), while the Steeper hand had a higher score in the Lateral grip (70, 74).

### **Discussion**

SHAP is designed to give a measure of the function of the hand. It has been demonstrated that the controller format can have significant impact on the score. For a multi-axis hand this time includes the time to select the appropriate grip. The selection of grips in this test were based on which formats were available and reliable. The ability to select an firm two jaw chuck or lateral grip was key to the successful execution of those tasks. This was different for each of the hands.

### **Conclusion**

While the hands are more complex and attractive than conventional single degree of freedom hands, the current control formats mean they are not any more functional than the older designs. Critically, this measure is in only one of the functional domains and other aspects, need to be factored in to any assessment.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Orthotics: Lower Limb - 3**

**Room 1.06**

Abstract Title: **Clinical Application Of Robotic Orthosis For Patients With Lower Limb Paralysis**

Abstract number: **341**

Authors: **H. Kimura, E. Tanaka, L. Yuge**

Presenter: **H. Kimura**

### **Introduction**

Reacquisition of walking ability can be extremely difficult for patients with lower limb paralysis due to cerebrovascular disorder and spinal cord injury. We have developed a robotic orthosis to correct the gait posture and support the walking ability of patients with walking difficulty.

### **Methods**

The robotic orthosis is equipped with joint angle sensors, a biopotential sensor, a floor reaction force sensor and an ultrasonic sensor, which operates a program to mimic normal human gait. We performed gait analysis in two patients with hemiplegia before and after use of the robotic orthosis. The patients were a 62-year-old man and a 65-year-old woman, both of whom showed hemiplegia due to cerebral infarction. While both patients were able to walk without use of an ankle-foot orthosis, gait posture was far from normal.

### **Results**

Using the robotic orthosis, vertical movement of the hip joint improved 7.4% and 19.5%, respectively, and hip abduction angle during gait improved 25.3% and 14.6%, respectively.

### **Discussion**

Forcing patients with lower limb paralysis to walk passively encourages plasticity of the central nervous system. Because conventional robotic orthoses only support normal gait, limitations exist to the applicability of orthoses in patients with abnormal gait or walking difficulty. Our robotic orthosis assists with leg joint force in accordance with a program for optimal gait, and can thus be used in patients with walking difficulty. Reacquisition of normal walking through the use of a robotic orthosis can be expected to promote the recovery of brain function.

### **Conclusion**

Our robotic orthosis helps correct gait posture in patients with walking difficulty by forcing them to walk normally. We believe that this robotic orthosis can help patients with lower limb paralysis by encouraging plasticity of the central nervous system, leading to independent walking.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Orthotics: Lower Limb - 3**

**Room 1.06**

Abstract Title: **Effect Of Ankle-Foot Orthoses On Gait Biomechanics Of Early Stroke Patients.**

Abstract number: **365**

Authors: **E. Papi, S. Solomonidis, R. Bowers, P. Rowe**

Presenter: **S. Solomonidis**

The aim of stroke rehabilitation is to allow the patient to regain an efficient walking ability. Ankle foot orthoses (AFOs) are nowadays commonly prescribed for this purpose. However, research backed evidence is necessary to determine the best rehabilitation practice and better understand the interaction between AFO and patient capability during gait.

The aim of this study was to investigate the effect of polypropylene solid AFOs on gait biomechanics of early stroke survivors. Three patients, affected by stroke within 2 months from onset, were recruited. 3-D analysis of kinematic outcomes at the pelvis and lower limb joints was pursued at various times during their rehabilitation for a period up to six months. Walking kinematics with and without AFO were compared. For one patient, the contribution of the orthosis to the ankle dorsi/plantarflexion support moment was also quantified, by means of an instrumented AFO.

Influence of the AFO at the ankle, knee and hip was found in all three anatomical planes, with main effects visible in the sagittal plane. The AFO allowed the patient to contact the ground with the heel and safely swing the leg forward reducing toe drag and risk of stumbling. The sound leg also gained benefits from AFO use, demonstrating improved joint kinematics as a result of improved stability in the hemiplegic leg. The AFO contributed to the net ankle moment by providing assistance to the dorsiflexor muscles during the first half of stance phase.

Although this study was limited to three case studies it provides valuable information with regards to the use of AFO in stroke rehabilitation and should encourage the conduction of research in this field.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Orthotics: Lower Limb - 3**

**Room 1.06**

Abstract Title: **The Effects Of Foot Orthoses And Knee Orthoses On Gait Pattern And Muscular Activation Of Patients With Medial Compartment Knee Osteoarthritis.**

Abstract number: **372**

Authors: **C. Lin, L. Chang**

Presenter: **C. Lin**

### **Introduction**

The purpose of this study was to determine the biomechanical mechanisms and effectiveness of foot orthosis (FO) and knee orthosis (KO) for patients with knee OA by the evidence in joint mechanics, muscle activation pattern and proprioception of the patients among different orthotic conditions. Methods Fifteen elders with medial compartment knee OA (7 males and 8 females, age of 67.5 $\pm$ 7.2 years) and fifteen matched controls (3 males and 12 females, age of 63.3 $\pm$ 3.5 years) were recruited in this research to collect the kinetic, kinematic and surface EMG data to analyze the biomechanical alterations in different conditions.

### **Results**

The OA group showed significant differences in certain gait parameters in comparison to the control group. They presented with smaller peak knee flexion angle and knee flexion excursion and had significantly greater values in lateral co-contraction index than medial side. The proprioception test revealed significant differences between the KO and shoes-only condition. The peak knee adduction moment decreased 24.4 % in one FO condition and 17.1 % in the KO condition.

### **Discussion**

OA knee caused gait deviations and led to inappropriate knee mechanics. Poor joint proprioception may potentially reduce joint stability. The orthoses resulted in significant improvements in joint mechanics and re-alignment. And the higher lateral co-contraction pattern responded to the need to stabilize knee joints. The lateral shift of the Center of Pressure allowed the Ground Reaction Force to get closer to the knee joint center and minimized excessive knee adduction moment to improve function.

### **Conclusion**

With the use of lateral wedge foot orthoses or knee orthoses, patients can improve joint mechanical environment and provide appropriate protection. The Results also support orthotic intervention as non-surgical, low-risk and less expensive treatments for patients. And the long-term effects of the orthoses await further study to clarify.

.Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Orthotics: Lower Limb - 3**

**Room 1.06**

Abstract Title: **Care Pathways In The Lower Limb Orthotic Management Of Children With Cerebral Palsy In The Nhs**

Abstract number: **395**

Authors: **S. Lalor**

Presenter: **S. Lalor**

There is little known about the structure, use and implementation of Clinical Care Pathways (CCP) in the lower limb orthotic management of ambulatory children with cerebral palsy in the National Health Service (NHS) in the UK. This is despite the referral, prescription, timing of provision, service delivery method and specifications of an orthosis all impacting on the functionality and overall success of the intervention.

CCP using Evidence Based Practice (EBP) in other neurological conditions have been shown to improve clinical outcomes, raise the standard of care, decrease unwanted variation, use resources efficiently, identify research and development questions and facilitate enhanced communication with patients and also between members of the multidisciplinary team.

An on-line three-part questionnaire using the Delphi technique was sent to orthotists working in the NHS in the UK. The Delphi technique is a validated tool that has been widely used in the health industry, to assist with the development of clinical guidelines and care pathways through group consensus. The technique produces detailed critical examination and Discussion through a series of structured questionnaires. The questionnaires covered all aspects of orthotic treatment including the referral process, assessment techniques, prescription of orthoses, shape capture, fabrication and investigated the implementation of evidence based practice and use of outcome measures. Additionally, this study examined the current literature relating to orthotic provision, service delivery and future research recommendations for ambulatory children with CP.

Analysis of the responses revealed the current status of clinical practice in the NHS. The Results also lead to the development of an orthotist driven CCP for the lower limb orthotic management of children with CP.

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Session Name and Room: **Orthotics: Lower Limb - 3**

**Room 1.06**

Abstract Title: **Effect Of Carbon-Fiber-Reinforced Plastic Knee-Ankle-Foot Orthosis On Gait: A Gait Analysis Study On Polio Survivors**

Abstract number: **443**

Authors: **F. Wada, Y. Nakanishi, N. Kato, K. Hachisuka, M. Arai**

Presenter: **F. Wada**

A carbon-fiber-reinforced plastic orthosis (carbon orthosis) is rigid, lightweight and well-fitting compared with a conventional knee-ankle-foot orthosis (KAFO). We have already reported that compared with the conventional KAFO, the use of carbon KAFO showed the increase in the walking velocity and the step lengths at the orthotic side, and no change in the cadence in the normal subject. The purpose of this study is to examine the biomechanical effect of walking using a carbon KAFO for polio survivors by conducting a 3D motion analysis

### **Methods**

Seven polio survivors ambulated with the aid of three types of experimental KAFOs.: (1) a conventional KAFO, (2) a carbon-fiber-reinforced plastic KAFO (carbon KAFO), and (3) a carbon-fiber-reinforced plastic KAFO that was made to weigh equal to the conventional KAFO by attaching weights to it (weighted carbon KAFO). The subjects walked three times along a 5-m long runway at a self-selected, comfortable speed. The spatiotemporal data were collected using a 3D motion analyzer.

### **Result**

In comparison with the conventional KAFO, the use of the carbon KAFO during gait resulted in a significant increase in the walking velocity, the cadence, and the step lengths at the non-orthotic side. The speed of the weighted carbon KAFO was the same as those of the carbon KAFO.

### **Discussion**

In polio survivors, the spatiotemporal improvements of a carbon KAFO compared with a conventional KAFO were quite different from normal subjects data.

### **Conclusion**

Our data suggest that a carbon KAFO have been found to improve walking velocity, cadence, and step lengths at the non-orthotic sides compared with a conventional KAFO in polio survivors. The data of the weighted carbon KAFO indicated that other factor except the lightweight of orthosis also contributes to these improvements in polio subjects.



Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Rehab Medicine & Surgery - 1**

**Room G.06**

Abstract Title: **The Endo-Exo-Prosthesis For Rehabilitation Of Amputees**

Abstract number: **32**

Authors: **D. Juhnke, H. Aschoff**

Presenter: **D. Juhnke**

Patients with above knee amputation (AKA) face many challenges to mobility including difficulty with socket fit and fatigue due to high energy consumption. The aim of the Endo - Exo-Femur Prosthesis (EEFP) is to avoid problems at the interface between the sleeve of the socket-prosthesis and the soft tissue coat of the femur stump which often impedes an inconspicuous and harmonic gait. In 1999 we began using a transcutaneous, press-fit distal femoral intramedullary device whose most distal external aspect serves as a hard point for AKA prosthesis attachment. The bone guided prosthesis enables an advanced gait via osseoperception and leads to a decreased oxygen consumption of the patient.

43 patients were implanted between 1999 and 2009. Four of the 43 required removal: one for intramedullary infection, one due to stem fracture (replaced), and the two for soft tissue infection. The remaining 39 original prostheses remained. Two pertrochanteric fractures occurred, treated with ORIF. Two bilateral procedures were performed. Initially, twenty patients had chronic soft tissue irritation requiring debridement. This completely resolved by changing the connecting components to a highly polished cobalt chrome. All patients reported increased comfort when compared to socket use. The following additional advantages were observed: improved mobility and endurance, improved proprioception, decreased time required for prosthetic donning, lack of concern regarding changing body weight, and the absence of skin irritation. All patients reported an improvement in sense of position and tactile sensation, leading to an improved gait pattern.

Subjectively, the EEFP represents a significant improvement in terms of comfort. Since the Introduction of high-gloss polished surfaces, soft tissue irritation is largely eliminated. Intramedullary infection has been negligible, as osteointegration seals the medullary cavity within 2-3 weeks. In summary, the EEFP appears to be an attractive option in transfemoral amputees.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Rehab Medicine & Surgery - 1**

**Room G.06**

Abstract Title: **Opinion Of Certified Prosthetists Orthotists On The International Classification Of Functioning, Disability And Health (Icf)**

Abstract number: **176**

Authors: **M. Mlakar, H. Burger**

Presenter: **H. Burger**

### **Introduction**

ICF was endorsed by World Health Organisation as a common language for health and other professionals. It was tested at our prosthetics and orthotics outpatient clinics and found to be useful. The main purpose of the present study was to determine whether medical records with ICF codes are more useful to certified prosthetists and orthotists (CPO) than medical records with ICD diagnoses only.

### **Methods**

All CPO working in clinical practice in Slovenia were included into study. One was not available at the time of the study and two did not want to participate. They answered a structured interview.

### **Results**

Fifteen CPOs participated. Seven of them work in the field of orthotics, five in lower limb prosthetics and three in upper limb prosthetics. Eleven of them are not familiar with the ICF. Approximately 50% of them read medical records of every patient they work with. Sixty percent (60%) think that medical records are a very important part of their everyday practical work. One CPO found medical records with ICF codes not useful at all. Seven CPOs found medical records with ICF codes more useful and seven found them as useful as those without them.

### **Discussion**

In spite ICF has been endorsed ten years ago and we have Slovene translation since 2006, it is still not well known between CPOs and is not included in the school curriculum. Still most CPOs found its use in medical records as useful.

### **Conclusions**

The CPOs included in the study found medical records with ICF codes as useful or more useful than those without them.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Rehab Medicine & Surgery - 1**

**Room G.06**

Abstract Title: **The Results Of Simplified Afo After Minimum Invasive Surgery (Mis) For Spastic Foot Deformity In Patients With Stroke Hemiplegia**

Abstract number: **201**

Authors: **Y. Konishi, K. Asayama, M. Murakami, H. Kodama, F. Hattori**

Presenter: **Y. Konishi**

Foot deformities followed by stroke such as varus, equinus and hammer toe use to require heavy duty AFO. This kind of AFO interferes with various kind of ADL which needs barefoot movement. To cope with this problem, medication, nerve block (using phenol, Botulinum toxin etc.), orthotics and surgical intervention are applying along with physical therapy. We have changed these nuisance types of orthosis to simple one by MIS .

During the past 11 years since 2002. MIS was carried out on 150 cases which consist of the combination of certain deformity involved tendons. The targeted tendons were as follow: tenotomy of tibialis posterior (TP);146, of flexor digitorum longs (FDL);113, of flexor hallucis longs (FHL);109, of flexor digitorum brevis (FDB);16, and the lengthening of gastrocnemius ( by modified Vulpius procedure);102, of tibialis anterior (intra muscular tendon recession);63.The combination of operated tendons were as follow: 5 tendons: Vulpius+TP+FDL+FHL+TA; 49 cases out of 150, 4 tendons: V+TP+FDL+FHL; 42 cases, 3 tendons: TP+FDL+FHL; 22 cases, 2 tendons: V+TP; 11 cases, one tendon FDB etc.; 22 cases respectively.

Post-operative bed rest is not necessary at all. Neuroleptic anesthesia (NLA) and local one were applied during these procedure, and perioperative period was uneventful. Soon after, the patients were encouraged to walk wearing soft casting for a few days postoperatively followed by application of simple, light weighted AFO (such as UD-AFO-long or UD-AFO- short). Bare foot walking or walking with simple AFO is important particularly in traditional Japanese life style on tatamifmat. In many cases, satisfactory Results were obtained both in Japanese and Western life style. Patient's ADL can be improved by combination of MIS and simple orthotics.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Rehab Medicine & Surgery - 1**

**Room G.06**

Abstract Title: **Knee Disarticulation In Orthopaedic Patients: Surgical Technique And Experience Over 13 Years**

Abstract number: **38**

Authors: **N. Patel, R. Fernandes, S. Sooriakumaran, D. Ward**

Presenter: **S. Sooriakumaran**

## **Background and Aims**

Knee disarticulation (KD) is traditionally unpopular because of wound complications and prosthetic intolerance, despite advantages of distal end-bearing, a longer lever arm and lower morbidity. There is now renewed interest following improved surgical techniques and prosthetic availability but studies in orthopaedic patients are lacking. We describe the surgical technique and experience of KD at a regional orthopaedic amputation service.

## **Methods**

Consecutive patients undergoing KD by a single surgeon (DAW) between 1997 and 2010 were reviewed. KD was performed with medial and lateral fasciocutaneous flaps. The patella tendon was sutured to the cruciate ligaments with a gastrocnemius myoplasty to create a cushioned stump. Patient medical and rehabilitation notes were examined, and the timed up and go (TUG) and 2 minute walk tests (MWT) functional outcome tests were measured.

## **Results**

There were 24 patients with a mean age of 52 years (range 10-81): 20 (83.3%) male and 4 (16.7%) female. Surgical indications were infection in 11 (45.8%), chronic pain in 5 (20.8%), knee contracture in 4 (16.7%), chronic regional pain syndrome in 3 (12.5%), limb gangrene in 3 (12.5%), ischaemic ulcers in 2 (8.3%) and non-union in 1 (4.2%) patients. Complications included wound problems in 4 (16.6%) and phantom limb pain in 2 (8.3%). 3 (12.5%) patients required revision surgery – with 1 conversion to a transfemoral amputation. Mean time to the rehabilitation ward was 10 days(5-34) and time to discharge was 57 days (2-405). Functional outcome test times improved with time: at 0, 1 and 6 months post-operatively, the mean TUG test was 22.3, 14.2 (p=0.05) and 20.5 seconds; and the 2 MWT was 80.8, 82 and 76.2 seconds respectively.

## **Discussion**

KD remains a useful orthopaedic technique for a select group of patients. Advances in surgical techniques and prosthetics have led to more acceptable complication rates and good functional outcomes compared to more conventional amputation levels.

Date / Time: **Monday, Feb 4 / 16:15 - 17:30**

Session Name and Room: **Rehab Medicine & Surgery - 1**

**Room G.06**

Abstract Title: **Failed Open Reduction In Charcot'S Arthropathy Of The Foot**

Abstract number: **385**

Authors: **U. Illgner, T. Budny, R. Skowronek, H. Wetz**

Presenter: **U. Illgner**

### **Introduction**

Surgery on diabetic feet goes along with a high rate of complications. Because of the raising number of diabetic patients this means a threat to our health systems.

### **Methods**

In a retrospective study all cases of revision of surgery of Charcot feet in our clinic were included. Type and number of surgeries, infections need of orthoses and ability to walk pre and after use of a standardized surgery using a Hoffmann-II-Fixateure externe were examined. The hypohese was that due to the polyneuropathy standard operation procedures represent a high risk of failure and Charcot feet need special surgery algorithyms.

### **Results**

31 patients were included (20 male and 11 female all suffering from polyneuropathy). Most common reason for revision was failure of material (20 cases) and persisting infection or combination of reasons. After use of the Hoffmann-Fixateure externe only 6 patients had to be revised, no failure of material was seen. The rate of infections declined from 21 to 6 cases ( $p=0,05$ ) and the activity class raised from 1,4 (all inside walker) to 2,3 (outside walker,  $p=0,05$ ).

### **Discussion**

In a collective of complications of Charcot's feet with failed surgery we saw a significant reduction of infections and a significant improvement of walking in the patients changing to a Hoffmann-II-Fixateure. No failure of material was seen. Patients with polyneuropathy are hardly able not to step on the operated feet and broken screws and plates mean a high risk for ulceration and infection, therefore full removal of material seems to be favorable.

### **Conclusion**

Charcot feet represent high risk operations. We propose a standardized treatment and operation management using a Hoffmann-II-Fixateure, which showed to be a secure and cost-effective treatment option.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 4**

**Room 1.03**

Abstract Title: **The Use Of Vibratory Feedback To Improve Postural Stability Of Individuals With Transtibial Amputation**

Abstract number: **455**

Authors: **D. Rusaw, K. Hagberg, L. Nolan, N. Ramstrand**

Presenter: **D. Rusaw**

### **Introduction**

Accurate sensory feedback from the lower extremities is important in the maintenance of postural stability by allowing an individual to be updated about the physical environment. Due to an amputation, individuals who use a prosthesis lack sensory information distal to the amputation level. These individuals have been shown to have reduced postural stability when compared to controls without an amputation when they stand on a stationary surface (Buckley, O'Driscoll et al. 2002; Geurts, Mulder et al. 1991) and moving surface (Buckley, O'Driscoll et al. 2002; Vrieling, van Keeken et al. 2008). The use of vibratory feedback about body orientation has been used in other groups to improve measures of postural stability (Sienko, Balkwill et al. 2008). The aim of this study was to evaluate the use of a vibratory feedback system, applied only to the prosthetic users' affected side, on static and dynamic balance in unilateral transtibial prosthetic users.

### **Methods**

24 transtibial prosthesis users were recruited for the study (mean age 48 years). Three tests were conducted to evaluate the postural stability of the users: Standing Balance, Limits of Stability, and Rhythmic Weight Shift. These three tests were evaluated with and without the use of vibratory feedback relaying information about pressure from under the prosthetic foot.

### **Results**

The use of vibratory feedback increased the mediolateral displacement amplitude of CoP in standing balance and reduced the response time to rapid voluntary movements of the center of gravity.

### **Conclusions**

The performance during the Standing Balance test resulted in increased deviations of the CoP in the mediolateral direction. Performance during the Limits of Stability test indicated faster reaction times. The Results suggest that vibratory feedback may benefit the open-loop (feedforward) mechanisms of postural control in unilateral transtibial prosthesis users.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 4**

**Room 1.03**

Abstract Title: **Transverse Cross Sectional Surface Area And Circularity Consistency For Hands-Off And Hands-On Casting Of Below Knee Residual Limb Using Mri**

Abstract number: **494**

Authors: **M. Safari, A. Buis, P. Rowe**

Presenter: **A. Buis**

### **Introduction**

Socket fit is the most important characteristic of a prosthesis indicated by amputees (1-3). The consistency of the final socket fit for an individual amputee is important. The aim of this study was to examine inter- and intra-cast cross-sectional surface area and circularity consistency of Hands-off and Hands-on casting concepts using MRI.

### **Methods**

Twelve amputee were recruited and the residual limbs were cast four times randomly in a single session, by a single certified prosthetist, twice for Patellar Tendon Bearing (Hands-on) and twice for ICEROSS pressure casting (Hands-off) method. After each cast the residual limb was scanned using MRI scanner. Then transverse cross-sectional surface area (CSSA) and cross-sectional circularity (CSC) of residual limb in all slices of all volume images were automatically calculated. The Intra-class correlation coefficient and t-test were used to analyse the inter and intra cast difference.

### **Results**

Neither Hands-on nor Hands-off intra-cast CSSA and CSC difference was statically significant except for the Hands-on CSC of the first slice. Besides, there was a statically significant difference between the Hands-on and Hands-off in CSSA at the far distal region and in CSC in the proximal region. The Hands-on resulted in a larger intra-cast CSSA mean difference than the Hands-off. The proximal region in the Hands-on casting showed a larger CSSA intra-cast mean difference and variability and a larger inter-cast variability. At the distal region, a larger inter- and intra-cast CSC mean difference and variability were noticed.

### **Discussion**

Although not statistically significant, the smaller Hands-off CSSA mean difference and could be due to the uniform force application around the residual limb and the distal traction of the soft tissue in the Hands-off casting by the casting. The inter and intra cast CSC inconsistency in the far proximal region could be explained by manual dexterity in the Hand-on method

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 4**

**Room 1.03**

Abstract Title: **Management Of Diurnal Residual Limb Volume Change.**

Abstract number: **469**

Authors: **E. Brannigan, K. Murray, A. Buis**

Presenter: **E. Brannigan**

### **Introduction**

Diurnal residual limb volume change is a common problem as seen by the number of amputees who have to change the number of prosthetic socks they use on a daily basis. These volume fluctuations alter the fit of the prosthetic socket and therefore the pressure distribution on the residual limb. This can cause residual limb soft tissue damage and gait deviations. The purpose of this project is to explore the causes of diurnal residual limb volume fluctuations and assess the current solutions.

### **Methods**

Prosthetics and physiological literature was reviewed to ascertain what makes a good socket fit, how volume fluctuations occur and if they can be prevented. Criteria for an optimum volume management system was developed and used to assess current Methods of managing diurnal residual limb volume change.

### **Results**

Vacuum suspension systems have an effect on volume fluctuation, the extent of this effect is unknown and it is unlikely that they prevent it from occurring. Prosthetic socks are inconvenient to use and cannot provide a stiff coupling when used for large volume decreases. Fluid filled inserts are the most effective solution although further product development and testing is needed. Air filled inserts are potentially dangerous as they can cause soft tissue damage and so should be avoided.

### **Discussion**

Very little literature exists on diurnal volume change and studies that have been carried out using out of socket measurement techniques cannot be relied upon for accuracy. Further research using accurate in-socket measurement techniques is required in order to fully understand diurnal volume change.

### **Conclusion**

This project highlights areas of further research which, coupled with a knowledge of physiological volume fluctuation, will enable clinicians to prescribe appropriate volume management tools and contribute to the design of future intelligent volume management systems.



Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 4**

**Room 1.03**

Abstract Title: **Additional Value Of A Microprocessor Controlled Prosthetic Knee In Starting And Stopping**

### **Gait- Pilot Results**

Abstract number: **471**

Authors: **M. Nederhand, E. Prinsen, H. Rietman**

Presenter: **M. Nederhand**

### **Introduction**

Ambulation in small indoor spaces is a continuous process of starting and stopping gait. Transfemoral amputees (TA) need to adapt for the necessary propulsive and braking forces for initiating and terminating gait. During steady state walking Microprocessor controlled knees (MPK) perform better on biomechanical variables than conventional knees (CK), but yielding is minimal. We were interested in the yielding function of a self adapting MPK (Rheo knee, Ossur) during starting and stopping gait.

### **Methods**

Subjects: 4 Unilateral TA, > 1yr postamputation, K2 to K4. Design: Case control, cross over. Outcomes: spatiotemporal, kinematic and kinetic parameters during 3 steps after gait initiation and 3 steps prior to gait termination. Experiment: 5 trials with initiation and 5 trials with termination of gait. Prosthetic foot and knee alignment were similar in both prosthetic conditions.

### **Results**

There were no differences between the MPK and CK in spatiotemporal, kinematic and kinetic parameters during the first 3 steps of starting gait. During stopping gait when the prosthetic leg is the final step (before the closing step), the MPK showed higher stance knee flexion movement (yielding) and a larger stance peak knee flexion angle than the CK. When the prosthetic leg is the second last step there were no differences in stance between the two prosthetic knees.

### **Discussion**

The preliminary Results show that during deceleration of gait, just before termination, yielding of the MPK enables a gradual weight loading on the prosthetic leg. This is in contrast to steady state walking where the yielding function in both MPK and CK seems minimal<sup>1</sup>. The additional value of an adaptive MPK during starting gait is questionable, probably because initiation is predominantly controlled by ankle mechanics.

### **Conclusion**

The adaptable damping forces of a MPK during gait termination may contribute to the ability to maneuver safely in small indoor spaces.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 4**

**Room 1.03**

Abstract Title: **Adaptation Strategies Of The Lower Extremities Of Patients With A Transtibial Or Transfemoral Amputation During Walking: A Systematic Review.**

Abstract number: **133**

Authors: **E. Prinsen, M. Nederhand, H. Rietman**

Presenter: **E. Prinsen**

### **Introduction**

During the period of rehabilitation, patients with an amputation learn to compensate for the loss of sensorimotor function of the amputated body part by gait adaptations in both the intact and amputated leg. This systematic review aims to describe these strategies in terms of joint power or work.

### **Methods**

Multiple databases were searched until November 2011. Studies were selected that compared: (1) intact and amputated leg, (2) intact and a referent leg (leg of an able-bodied), or (3) amputated and referent leg.

### **Results**

A total of 13 studies were identified based on the applied inclusion criteria. Trials studied patients with a TT amputation (n=11), TF amputation (n=1), and both TT and TF amputation (n=1). Results of trials studying TT amputation showed a reduced amount of performed work on knee level of the amputated leg during stance. On hip level, the concentric work of the hip extensor during early stance is increased in the amputated and intact legs when compared to a referent leg. Results of trials studying TF amputation show remarkable similar Results on hip level when compared to the trials studying TT amputation. In addition, push-off of the intact ankle is increased when compared to a referent leg.

### **Discussion**

In both TT and TF amputation, adaptations were seen in the amputated and intact leg. The majority of the adaptation can be attributed to a reduced involvement of the amputated leg in weight acceptance, and the loss of ankle plantar flexors. In addition, muscle groups were identified that are responsible for the adaptations, primarily the hip extensor of both the amputated and intact leg.

### **Conclusion**

Based on these adaptations it can be concluded that the amputated and intact leg are asymmetrical in function. Striving towards gait symmetry based on the idea that symmetry is more functional, seems therefore inappropriate.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Quality Of Life Issues - 1**

**Room 1.05**

Abstract Title: **Quantifying Community Mobility And Social Interaction In Individuals With Lower Limb Amputations**

Abstract number: **55**

Authors: **A. Jayaraman, G. Mathur, R. Lipschutz, T. Kuiken**

Presenter: **A. Jayaraman**

### **Introduction**

Little is known about the complexity of community mobility and social interaction patterns of people with lower limb amputations. Currently, multiple questionnaires and structured interviews are used to assess community ambulation and social integration, although these tools are limited by self and/or proxy report and recall bias. The aim of the current project is to overcome this knowledge gap by combining proven and validated techniques of accelerometry with emerging Global Positioning Satellite (GPS) technology to gain accurate and objective measures of everyday community mobility and social interaction in lower limb amputees.

### **Methods**

Ten individuals with unilateral transfemoral amputations were provided with a commercially available step activity monitor (Orthocare Innovations®), and GPS system (I-Blue 747A). The step activity monitors (SAM) was strapped to the prosthetic limb and GPS was carried in either the purse or wallet of the participants. Participants carried the devices for a period of three months, following which the data was downloaded from the systems and analyzed using Geographic Information System (GIS) software and Google Earth.

### **Results**

The combination of GPS and SAM was able to give us extremely accurate information on the patterns of community mobility and social interaction of individuals using lower limb prosthesis. The outcomes include distance walked; time spent outdoors, mode of travel used, speed of travel, time spent at community destinations, and physical activity.

### **Discussion**

Outcomes measures from this study will help the field of prosthetics accurately quantify usability of different prosthesis, compliance of prosthetic use, and social interaction in individuals with lower limb amputations.

### **Conclusions**

This information will be foundational to understanding how different prosthetic technology and physical interventions can best promote full inclusion of amputees in the every-day community setting.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Quality Of Life Issues - 1**

**Room 1.05**

Abstract Title: **Quality Of Life Of Women With Disabilities Using Orthotic And Prosthetic Devices In South India**

Abstract number: **96**

Authors: **K. Göbel, K. Randboll Jensen, L. Magnusson, R. Gosh**

Presenter: **K. Göbel**

### **Introduction**

Women with disabilities living in developing countries generally suffer from triple discrimination because of their disability, gender and socio-economic position and are therefore assumed to have a lower Quality of Life (QoL). In the present study conducted in South India, women with lower-limb disabilities using orthotic or prosthetic devices were compared to non-disabled women.

### **Method**

119 participants. Socio-demographic data was collected and the WHOQOL-BREF in English and Kannada was used to measure QoL in four domains: physical, psychological, social relationships and environment.

### **Results**

No statistically significant differences ( $p > 0.05$ ) were found in the mean scores of the four domains between the two groups. However, differences related to socio-demographic factors were found: The married test group had lower scores in the physical, psychological and environmental domains compared to the married control group. The test group with children had lower scores in the physical domain compared to the control group with children. Women in rural areas use their assistive devices far less than women living in the city, although no difference in device satisfaction was found.

### **Discussion**

QoL is not determined to be low when living with a physical disability. Marriage and life with children have a greater impact on the QoL of women with disabilities. Higher education levels might help to improve their status and enable full participation in society, underlining the importance of CBR work in this area. Though device satisfaction is quite high, taking environmental factors and women's needs into consideration when developing assistive devices might increase daily use.

### **Conclusion**

Socio-demographic variables play a significant role in determining the QoL - education, income, marriage and children affect domain scores. Methodological constraints and the small sample size suggest further investigation.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Quality Of Life Issues - 1**

**Room 1.05**

Abstract Title: **Health Profiles Of Persons With Lower Limb Loss**

Abstract number: **222**

Authors: **B. Hafner, D. Amtmann, D. Abrahamson, S. Morgan, A. Kajlich, R. Salem**

Presenter: **B. Hafner**

### **Introduction**

Healthcare professionals are increasingly encouraged, expected, or required to document clients' outcomes using standardized instruments and protocols. The Patient Reported Outcomes Measurement Information System (PROMIS) is a suite of reliable, precise, and meaningful self-report instruments designed to assess patients' health. PROMIS-29 is a 29-item survey designed to evaluate patients in seven health domains: physical function, anxiety, depression, fatigue, sleep disturbance, social role-participation, and pain interference. PROMIS-29 T-scores are centered on US national norms. Health status of persons with limb loss in these domains is unknown.

### **Methods**

PROMIS-29 was included in a cross-sectional survey of prosthetic users. Respondents were recruited via O&P clinics, magazine advertisements, list-servs, consumer websites, and social networks. Selection criteria included 18+ years of age, ability to read English, unilateral lower limb amputation, traumatic or dysvascular etiology, and use of a prosthesis to ambulate. Surveys also included questions pertaining to respondents' general health, amputation, prostheses, living environment, activity levels, assistive devices, mobility, balance, concentration, and demographic characteristics.

### **Results**

The PROMIS-29 instrument was administered to 650 persons with limb loss (mean age=53, SD=14). Participants reported significantly lower physical function (M=43, SD=9,  $p<0.01$ ) and fatigue (M=48, SD=10,  $p<0.01$ ) and more pain interference (M=55, SD=9,  $p<0.01$ ) than national norms. Reported anxiety, satisfaction with social roles and activities, depression, and sleep disturbance were similar to US norms.

### **Discussion**

Persons with lower limb loss report significantly worse physical function, significantly more pain interference, and significantly less fatigue than the general US population. These findings suggest that reduced capacity for physical activity and pain associated with limb loss may inhibit regular performance of activities.

### **Conclusion**

Standardized instruments like PROMIS-29 can inform clinical practice through accurate measurement of patients' symptoms and quality of life indicators. Reference data presented here may serve to facilitate use of PROMIS-29 in clinical practice and limb loss research.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Quality Of Life Issues - 1**

**Room 1.05**

Abstract Title: **The Use Of Focus Groups To Aid In The Development Of A Mobility Outcome Measure**

Abstract number: **75**

Authors: **D. Abrahamson, S. Morgan, D. Amtmann, R. Gailey, B. Hafner**

Presenter: **D. Amtmann**

## **Introduction**

Restoration of mobility after amputation is an important goal of lower-limb prosthetic care. Focus groups can be used to enrich our understanding of mobility, allowing users of prostheses to share their lived experiences. The purpose of this study was to identify conceptual gaps in our understanding of environmental factors that influence prosthetic mobility as described by the following subdomains: obstacle avoidance, time, distance, ambient conditions, attentional demands, terrain, and external loads. Results will inform the development of a self-report item bank for measuring mobility with lower-limb prostheses.

## **Methods**

Four focus groups were conducted across the United States, representing differing environments encountered by prosthetic users. Purposive sampling was used to recruit lower-limb prosthetic users who were diverse with respect to level of amputation, age, gender, race/ethnicity, etiology, and time since amputation. Focus groups of 6-12 people lasting 1.5 to 2 hours were facilitated using a semi-structured approach to guide Discussions related to mobility. Transcripts were collaboratively analyzed by two research prosthetists using a phenomenological approach.

## **Results**

Participants discussed ways that environment factors impact mobility. Examples included how walking in sand (terrain), hot temperatures (ambient conditions), and crowds (obstacle avoidance) increased the difficulty of prosthetic ambulation. Additionally, conversation during walking (attentional demands), walking long distances (distance), moving quickly (time), and lifting heavy objects (external loads) were noted to challenge prosthetic users.

## **Discussion**

The proposed subdomains comprehensively described the impact of environment on prosthetic mobility, no new subdomains were added. Focus group Results enhanced understanding of how environmental factors affect mobility, providing a meaningful foundation for development of an item bank measuring lower-limb prosthetic mobility.

## **Conclusion**

Focus groups provided valuable information about environmental conditions encountered by persons with limb loss and facilitated development of a comprehensive instrument to measure prosthetic mobility.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Quality Of Life Issues - 1**

**Room 1.05**

Abstract Title: **Poliomyelitis Patients In South India – A Study Measuring Quality Of Life**

Abstract number: **334**

Authors: **S. Wallén, J. Jonasson, L. Magnusson, R. Ghosh**

Presenter: **J. Jonasson**

### **Introduction**

The aim of this study was to examine and compare quality of life scores for three different groups with different living situations, all with a history of poliomyelitis and explore factors affecting their scores in four different quality of life domains in India.

### **Method**

91 participants with poliomyelitis from three different settings were included in the study. The groups were recruited from city, rural area and urban slum. The WHOQOL-Bref questionnaire was used to measure quality of life in four domains; physical health, psychological health, social relationships and environment.

### **Results**

Significant difference ( $p < 0,05$ ) were found between the groups in three of the domains. In the physical health and the social relationship domain the group from the city scored significantly higher than the group from the urban slum. In the environmental domain the group from the city and the group from the rural areas scored significantly higher than the group from the urban slum. No significant difference was found in the psychological health domain between any of the three groups.

### **Discussion**

When treating disabled persons, it is important to not only provide a person with an orthotic device, rehabilitation and inclusion in society is also very important to work with to increase a person's quality of life.

### **Conclusion**

It was found that the possibility to maintain the orthopedic devices and the opportunity earn an income influenced the quality of life scores positively. The living environment and rehabilitations services did not influence the scores in the psychological health domain.

The study was conducted in collaboration between Mobility India and School of health science, Jönköping University, Sweden.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 1**

**Room 1.06**

Abstract Title: **The Use Of Defo'S Shorts In The Treatment Of Abduction Contracture Of The Hipjoint**

Abstract number: **7**

Authors: **A. Suzuki, Y. Matsumoto, M. Takahashi, T. Kitakouji, C. Takeuchi, M. Matthews**

Presenter: **A. Suzuki**

### **Introduction**

This paper will present and discuss effectiveness of Dynamic Elastomeric Fabric Orthoses(DEFO's )shorts that the use of Lycra&reg; garments to contracture of the hip joint with arthrogryposis multiplex congenita(AMC). Usually, the treatment of contracture of the hip joint use rigid hip bracing, but AMC need brace very early so it is very difficult to wear rigid hip brace made by hard plastic and metal, because it is heavy and hard .From experience obtained in the treatment of rigid contracture of the hip joint , we tried a new concept of using specifically designed DEFOs shorts. This paper will discuss a single case presentation and resultant evidence to provide a basis for Discussion into the use on DEFO's shorts in non-operative contracture of the hip joint correction.

### **Method**

The DEFO's shorts was designed to provide a adduction and stability of hip joint of a 5 months old girl presenting with a rigid contracture of the hip joint in 40°. The shorts designed hip abduction 30° to provide force to adduction ,and extended from a waist to legs to provide fixation for the compressive component of the shorts and a basis of stability for the base of hip joints.

### **Results**

From initial X-rays and photograph, the hip abduction reduced 40° to 0° following supply of the shorts. @The angle remained the same both in and out of the orthoses. @Compliance with the 23 hour wearing regime was 100% with the shorts.

### **Discussion and Conclusion**

From this paper the DEFO's shorts was effective to rigid contracture of the hip joint with AMC . But the report similar to this paper was not founded, so this result indicates that a large study is required to further explore these effects.



Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 1**

**Room 1.06**

Abstract Title: **Exploring The Views Of Children, Parents And Clinicians To Contribute Towards The Development Of Upper Limb Prostheses**

Abstract number: **42**

Authors: **T. Sims, M. Donovan-Hall, C. Metcalf**

Presenter: **T. Sims**

Upper limb (UL) dysfunction can have an impact on development at all stages of childhood (Ibbotson, 2002). There is, however, a rejection rate of UL prostheses of up to 50% amongst children (Shida-Tokeshi, et al., 2005). Research has suggested that children may choose to use a different prosthesis depending on the task (Egermann et al, 2008), but there is a distinct absence of the views users. Inclusion of end, lay and professional users is crucial to successful development of medical devices as unless devices are examined in the cultural and social context in which they are used the effectiveness of the devices will be limited (Ram et al, 2005).

This research explores the views of children, parents and professionals on UL prostheses to contribute towards the design of prosthetic ULs for children. Stage 1 of this study has been completed. This involved eight children (aged 8 – 15), with experience of using an UL prosthesis, and five parents participating in focus groups and interviews.

Preliminary findings demonstrated that children may choose to use a prosthesis as an aid in activities, to prevent unwanted attention and to have fun. They may choose not to wear a prosthesis because it is more of a hindrance than a help or because they are satisfied with who they are. Areas for development identified included appearance, comfort, weight, movement, ease of use and for assistance with specific activities. These findings were used to inform the development of new prototype prostheses.

In stage 2 of this study (May 2012) prototype prostheses will be shown to participants in focus groups and interviews in order to further develop the designs and explore themes in more depth.

Stage 3 of this study (May–Sept 2012) will involve exploring the views of clinicians and gaining their feedback on prototypes developed.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 1**

**Room 1.06**

Abstract Title: **Gait Pattern In Children With Cp And Leg Length Discrepancy, Effects Of An Extra Sole.**

Abstract number: **94**

Authors: **R. Zügner, I. Stefansdottir, M. Nyström-Eek**

Presenter: **R. Zugner**

### **Introduction**

Cerebral palsy (CP) is the most common cause of motor problems in children. The gait pattern is often different from normal with slow velocity and increased energy consumption. Factors affecting the gait are muscle tone, impaired motor control, muscle contractures, skeletal deformities and leg length discrepancy. Asymmetrical gait pattern is described in normal children with leg length discrepancy. It gives a limp, reduced power at push-off, walk on tiptoe or to walk with flexed knee. Leg length discrepancy can be treated surgically, with insoles or elevation of the sole on the short leg. The purpose of this study was to examine if compensation of leg length discrepancy in the form of insole or sole on the short leg leads to a change in movement pattern during walking in children with spastic CP.

### **Methods**

Children with spastic CP 7-15 years old and a leg length discrepancy  $> 1$  cm, were included in the study. Computerized gait analysis with registration of kinematics and kinetics in hip, knee and ankle: barefoot, with shoes and with an extra sole for the shorter leg.

### **Results**

Differences from normal gait were found at all levels. Preliminary data indicates that with shoes and extra sole there were more symmetric step length, stance phase, and improved knee extension during stance phase together with increased power at push off in the ankle.

### **Conclusions**

For a child with CP small differences in leg length can cause an abnormal gait pattern. Clinical experience suggests that compensation of leg length discrepancy in children with spastic CP can lead to a more normal and symmetric gait pattern. Insoles or elevation of shoe are simple and cost effective means to improve walking ability in children with CP.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 1**

**Room 1.06**

Abstract Title: **Estimation Of Recurrence With Dennis Brown Splint And To Describe The Issues Related To Non-Compliance In Patients With Club Foot.**

Abstract number: **95**

Authors: **Z. Zahid, I. Zia**

Presenter: **Z. Zahid**

Club Foot is a congenital abnormality of foot with idiopathic etiology. incidence is 1.2 of per 1000 live births. In club foot ankle in a plantar-flexed and inverted position with the heel, mid-foot and forefoot adducted and inverted producing a cavus deformity.

### **Objective**

- To find out the ratio of relapse in patients using Dennis brown splint.
- To describe the issues related to non-compliance of the Dennis brown splint.

### **Materials & Methods**

70 patients with corrected club foot using Dennis brown splints for the maintenance of the correction followed by Ponseti method. parents were interviewed for the issues related to non-compliance to the bracing program and to check the relapse rate of the deformity. Duration of the study was 12 months followed by the bracing.

### **Results**

It is founded that there is 24% reported with recurrence of deformity during bracing program.

issues of non-compliance consist the following ratio

1. 47%reported with skin problem.
2. 45% reported with residual adduction of the foot part.
3. 30 % reported that their babies withdraw the foot from the shoes.
4. 70% of the families do not have even basic education which also adds to the poor outcomes.

### **Conclusion**

- It is founded that relapse rate is 24% because of the issues related to the non-compliance from which main issue is skin problem.
- The second other cause is repeated residual adduction.
- Most of the families have very low education so that it was founded very difficult to counsel them.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 1**

**Room 1.06**

Abstract Title: **Effect Of Custom Molded Rigid Foot Orthosis On The Functional Lumbar Scoliosis In Children**

Abstract number: **242**

Authors: **B. Kim, I. Chang, I. Park, E. Sim**

Presenter: **B. Kim**

### **Introduction**

It is not uncommon for the clinicians to encounter a child with nonstructural spinal malalignment in the lumbar region accompanied with certain problems in the foot. This type of clinical problems has been taught not to treat as this is a self limiting benign problem. In Asian countries like Korea shoes are not worn in-house environment with no protection under the foot when a child has problems in the foot. As this functional problems can progress into the abnormal structural spinal curves such as scoliosis, lordosis or kyphosis later in their lives clinical practice guideline is warranted.

### **Methods**

Fifty children with functional scoliosis with hyperpronation of the feet were included in this study. To correct hyperpronation of the feet custom molded rigid biomechanical foot orthosis (BFO) was fitted and encouraged them to wear BFO in the shoe while they are not in the bed. Physical examination to measure resting calcaneal stance position (RCSP) angle and pelvic alignment followed by simple radiographic evaluation of the feet with and without weight bearing and whole spine in standing were taken before, 2, 3, and 6 months after fitting BFO. Stretching and strengthening exercises of the lower extremities and paraspinal muscle were encouraged throughout the study period. Other fifty children in the same age and gender distribution with similar problems who refused to be fitted with BFO were encouraged to exercise in the same way and evaluated as a control group. The data was collected and statistically analyzed.

### **Results**

Statistically significant improvement in spinal alignment in the simple radiographic evaluations were seen in the group with BFO compared to the control group without BFO.

### **Discussion and Conclusion**

BFO may play an important role in the prevention of the progression of spinal malalignment in children with foot problems.

Date / Time: **Tuesday, Feb 5 / 09:00 - 10:15**

Session Name and Room: **Paediatrics - 2**

**Room 1.06**

Abstract Title: **Management Of Children With A Congenital Deficiency Of The Leg: N1 Case Study**

Abstract number: **69**

Authors: **O. Teap**

Presenter: **O. Teap**

### **Introduction**

Congenital deficiency of the leg is very rare. Sometimes, congenital aplasia is treated by surgical modality before prosthetic intervention is done. Surgical intervention can cause later complications for children amputee which hampers their future development. This case presents about a happy Sri Lankan's child after receiving different prosthetic designs.

### **Methods**

Muditha, a four and half years-old boy was brought to the clinic by his mother with bilateral orthoprosthetic devices. The mother reported regarding the outcome of previous devices that "Muditha did not to wear them due to poor suspension and poor aesthetics as well as they were too heavy to wear with sidebar on the right side". Due to poor outcome of those prostheses the doctors and surgeons were thinking about making amputation his legs. After subjective and objective assessment, two different prostheses were prescribed as below knee designs with supra-condylar suspension to control knee instability medially.

### **Results**

The outcome of the new the prostheses were better than previous ones in terms of cosmetic appearance, suspension, as well as less restriction with wearing and less weight. The child walks with more balance, less knee instability as well as walk much faster. By giving new prosthetic designs, the child's legs were saved from the amputation which is thought by doctors and surgeons.

### **Discussion**

If the prosthetic outcome is not satisfactory according to patients/caregiver or P&O, alternative device should be tried by consultation with other P&Os and technicians. External distant resources can be helpful for different interventions. Doctors or surgeons should not decide to amputate immediately without discussing with other disciplines or alternative method.

### **Conclusions**

Congenital deficiency of the leg can be treated with different modalities. Various prosthetic designs can be made to meet individual patients. Surgical should be the last solution where the prosthetic invention is failed.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 5**

**Room 1.03**

Abstract Title: **Effect Of Prosthetic Ankle Units On Roll-Over Shape Characteristics During Walking In Persons With Bilateral Transtibial Amputations**

Abstract number: **83**

Authors: **S. Gard, P. Su, R. Lipschutz, A. Hansen**

Presenter: **S. Gard**

### **Introduction**

The objective of this study was to determine how foot-ankle roll-over shape was affected by a prosthetic ankle component that increases sagittal-plane motion. By increasing motion at the ankle during stance phase with the addition of a compliant prosthetic ankle joint, we hypothesized that the roll-over shape radius of the prosthetic foot and ankle would be reduced. Similarly, the increased ankle motion was expected to decrease the effective foot length of the ankle-foot system.

### **Methods**

Subjects with bilateral transtibial amputations were recruited for this study. Subjects signed consent forms that were approved by Northwestern University's Institutional Review Board. Quantitative gait data were acquired using an 8-camera real-time motion capture system and 6 force-plates as subjects walked with and without Endolite Multiflex Ankle Units along a 10m walkway. For both conditions, subjects used Seattle Lightfoot II feet.

### **Results**

Seventeen subjects completed the study. Ankle motion increased from a mean of 13.0 degrees to 19.4 degrees while walking with the prosthetic ankle units ( $p < 0.001$ ). The subjects' roll-over shape radii were significantly less with the prosthetic ankle units than for the baseline condition ( $p < 0.001$ ), but the effective foot length was not affected by the prosthetic ankle units ( $p = 0.066$ ).

### **Discussion**

Prosthetists should carefully consider the effects of combining different prosthetic components on overall functional performance of their patients. When fitting someone with a prosthetic ankle unit, the prosthetist should consider selecting a prosthetic foot with a slightly stiffer keel in order to provide a more appropriate roll-over shape for the prosthetic foot-ankle combination. Doing so could improve walking biomechanics and ultimately serve to increase the efficiency of gait.

### **Conclusions**

The increased ankle motion provided by the Multiflex Ankle Units in this study decreased the radius of the ankle-foot roll-over shape. However, the effective foot length was not affected.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 5**

**Room 1.03**

Abstract Title: **A Preliminary Evaluation Of A Hydro-Cast Trans-Femoral Prosthetic Socket Design, A Proof Of Concept**

Abstract number: **297**

Authors: **A. Buis, M. Kamyab, S. Hillman, K. Murray, A. MCGARRY**

Presenter: **A. Buis**

### **Introduction**

This study reports on a research project that has utilised, for the first time, a hydro-casting technique to create a trans-femoral prosthetic socket. Outcome measurements of the Hydro-Cast (HC) socket were compared with a prosthesis produced by conventional ischial containment (IC) technique.

### **Methods**

A trans-femoral amputee was provided with two interventions, one copy of the existing prosthesis and one with a Hydro-Cast socket. Outcome measures included: Dynamic stump/socket interface pressure distribution (Tekscan™), Femur movement relative to the socket (Ultrasound technology), Full body motion capture and analysis (Vicon™).

### **Results**

Results indicate that sockets produced by both techniques, generated similar dynamic interface pressures. The average pressure of the HC system is more uniform during toe-off/ double support compared with that of the IC system. No marked differences were observed between the two conditions for any upper or lower body gait parameters or in the temporal and distance parameters. The range of movement of the femur within the HC prosthetic system was considerably less as compared with the IC system.

### **Discussion**

Adherents of the most widely used design philosophies for trans-femoral sockets have described how their approaches influence or control the motion of the femur relative to the stump tissues and the socket. Although a proof of concept study, Results indicate the possibility that the HC socket may offer improved medio-lateral stability compared to the IC socket as used by the test subject. This is also highlighted by Kahle (2002) who removed different socket elements systematically in a case study examining trans-femoral socket design.

### **Conclusions**

The Conclusions of this study were significant because it is feasible to produce an acceptable prosthesis with the HC technique. Additionally, it seems that the fit of this prosthesis is more comfortable than compared with the old style prosthesis. However, more users should be investigated.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 5**

**Room 1.03**

Abstract Title: **Influence Of A Microprocessor Controlled Prosthetic Knee On Biomechanics Of Gait Initiation, Preliminary Results.**

Abstract number: **475**

Authors: **E. Prinsen, M. Nederhand, H. Rietman**

Presenter: **E. Prinsen**

### **Introduction**

Gait initiation requires the generation of propulsive forces, which are generated by decoupling the centre of mass (CoM) and centre of pressure (CoP). The impact of the CoM velocity has to be absorbed after the first step, which can be difficult when leading with the prosthetic leg. Because microprocessor controlled prosthetic knees, such as the Rheo Knee, show improved stance stability, these may be beneficial during gait initiation by enabling greater decoupling.

### **Methods**

Four unilateral transfemoral amputees (> 1 year after amputation; functional level : K2- K4) were included and measured twice, once with their own mechanically passive prosthesis and once with the Rheo Knee (8 weeks acclimatization). Measurements were performed using a 6-camera Vicon system and two forceplates. Prosthetic foot and knee alignment were similar in both prosthetic knee conditions

### **Results**

When starting with the prosthetic leg, one subject showed a larger decoupling of the CoM and CoP when using the Rheo, resulting in a higher CoM velocity at the end of the first step. In one subject no differences were found and in two subjects, decoupling was lower. When starting with the intact leg, two subjects showed a larger decoupling of the CoM and CoP when using the Rheo, resulting in a higher CoM velocity at the end of the first step. In one subject, no notable differences were found. In one subject the decoupling was slightly lower when using the Rheo.

### **Discussion**

The Results of this preliminary analysis showed no clear differences between both prosthetic knee conditions. Although microprocessor controlled knees improve stance stability, subjects did not show consistent improvements in decoupling and CoM velocity when leading with the prosthetic leg.

### **Conclusion**

The Results of this preliminary study indicate that a microprocessor controlled prosthetic knee does not improve decoupling of the CoP and CoM during GI.



Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 5**

**Room 1.03**

Abstract Title: **Effects Of Variable Stiffness Prosthesis On Walking Kinematics During Load Carriage**

Abstract number: **488**

Authors: **A. Auyang, E. Chu, A. Kregling, Q. Chen, K. Collier, J. Shim**

Presenter: **A. Kregling**

Daily activities often involve load carriage during locomotion. Examples of such activities may include light loads such as carrying groceries or heavy loads like a heavy suitcase. In able-bodied subjects, load carriage at 125% and 150% of body weight does not change ankle or knee kinematics. This is most likely achieved through modulating joint torques about each of the joints to maintain invariable joint kinematics. In a person with a lower limb transtibial amputation, the loss of a functional ankle Results in decreases in resources available for the neuromuscular system to maintain invariable joint kinematics. Prescription of categories and stiffnesses for typical prosthetic feet are often based on daily activity. Regardless of prescription, these feet are typically mono-stiffness feet. The purpose of this study is to determine whether a passive variable-stiffness prosthetic foot will allow unilateral amputees to maintain more invariant joint kinematics as compared to a traditional mono-stiffness foot. Nine unilateral transtibial amputees were tested in a straight line walking task at self-selected-preferred speeds with (130% BW) and without additional weight. Subjects were tested in these conditions using a mono-stiffness foot (Freedom Innovations Sierra) and a passive variable-stiffness foot (Freedom Innovations Thrive). The category/ stiffness (or lowest stiffness for the variable-stiffness foot) of each test foot was based on what the subject's prosthetist had prescribed them. The Results showed that while both test feet resulted in similar joint trajectories throughout the gait cycle, the variable stiffness foot resulted in no change in maximum range of motion while the mono stiffness foot showed statistically significant increase in maximum range of motion in the loaded condition. We conclude that a variable stiffness foot, while still not able to provide the range of function of an intact ankle, does provide additional resources that allow the subjects to perform kinematically similar to able-bodied subjects.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 5**

**Room 1.03**

Abstract Title: **Long-Term Experiences With A Hydraulic Ankle Capable Of Self-Alignment – A Review And Development Roadmap**

Abstract number: **240**

Authors: **S. Zahedi, N. Stech, D. Moser, G. Harris, J. Mccarthy, A. Mcdougall, J. Ross**

Presenter: **J. Ross**

### **Introduction**

Contrary to previous scientific belief the foot seems to play a crucial role in the overall optimisation of gait performance, stability and symmetry. A self-aligning hydraulic ankle has been developed and fitted to over 3000 amputees with an overall positive feedback on overall comfort, performance, increase in both confidence and stability and energy efficiency.

### **Methods**

Over 3000 fittings have been reviewed in general and a brief survey on selected amputees' feedback has been conducted. In this survey the subjects were asked about their previous foot type and experience, the perception using the self-aligning foot and the impact on their activities of daily living. Additional feedback was provided by the supervising prosthetist. Beside of the surveys, biomechanical studies with several trials have been carried out both on transtibial, knee-disarticulated and transfemoral amputees revealing kinematic and kinetic effects.

### **Results**

Especially the brief survey of selected amputees' feedback proves the vision of self-aligning ankle-foot prosthesis as a medical necessity from our point of view. It confirms that the concept enables amputees a more voluntary control on self-alignment and hence a more natural optimisation of the overall movement performance. This is believed to be preferable especially when negotiating ramps or standing on inclined terrain as the ankle-foot itself adapts to the ground so that compensational effects in the knee, hip and upper body can be reduced in comparison with standard composite feet.

### **Conclusion**

It might be a promising way to develop a range of products based on the adaptive and self-aligning properties to broaden the range of possible applications within lower limb prosthetics and enable to give the benefit of more comfort and a smoother roll-over to a broader range of patients.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Rehab Medicine & Surgery - 2**

**Room 1.05**

Abstract Title: **Car Adaptations For Subjects Following Upper Limb Amputation**

Abstract number: **81**

Authors: **H. Burger, Marin, A. Zupan, A. Fidler**

Presenter: **H. Burger**

### **Introduction**

Amputation - even of a very small part of one finger - Results in decreased pinch and grip force and consequently in problems with many activities of daily living, including driving. People following upper limb amputation have more problems with driving and need more adaptations of the car than people following lower limb amputation (Fernandez et al., Arch Phys Med Rehabil 2000;81:288-91). The aim of our study was to find out which car adaptations are suggested to people following upper limb amputation.

### **Methods**

Medical documentation of all persons aged 18+ following upper limb amputation performed in the last five years who visited our outpatient clinic was reviewed.

### **Results**

Thirty-seven persons (27 men), aged 38 years on average, fulfilled the inclusion criteria. All except two were fitted with prosthesis. Seven were not sent for assessment of driving abilities; the rest were still able to drive, but they needed from zero up to four car adaptations. The most frequently suggested adaptation was automatic transmission, followed by moving of the commands from one side of the wheel to the side held by the non-amputated limb, a knob on the wheel, and standard assisted steering. Only three persons were allowed to drive with the prosthesis.

### **Discussion**

Our findings are similar to those reported by others. Persons following upper limb amputation have problems with driving and most of them need car adaptations for safe driving. It is important that clinicians working with them are aware of that and refer them to driving assessment.

### **Conclusion**

People following upper limb amputation need car adaptation for safe driving.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Rehab Medicine & Surgery - 2**

**Room 1.05**

Abstract Title: **Osteoporosis Among Adult Filipinos With Unilateral Lower Limb Amputation**

Abstract number: **227**

Authors: **J. Montes**

Presenter: **J. Montes**

### **Introduction**

In patients with lower limb amputation, mobility and weight bearing activities may be limited. It may cause generalized and regional osteoporosis. This study was undertaken to determine prevalence and risks factors of osteoporosis among adult Filipino amputees.

### **Methodology**

Participants (n=19) were interviewed after securing informed consent. Demographic profiles, prosthetic information and risk factors of osteoporosis were inquired. Participants underwent screening using Sunlight Omnisense® 8000S mobile bone assessment device to determine bone mineral density (BMD). The non-amputated tibia was used as reference part. Bilateral study was done only among participants with below knee amputation (BKA).

### **Results**

Mean age is 44.5 ± 14.1 years. Majority were males (74%), unemployed (79%), and married (68%). Ten participants (53%) have above knee amputation (AKA) followed by 8 BKA (42%) and only one with hip disarticulation (5%). Mean duration of amputation was 29.7 ± 31.0 months. Majority (58%) were using prostheses. Majority were non-smokers (63%) and non-alcoholic drinkers (53%). More than half have non-modifiable risk factors (53%). Most (95%) were drinkers of caffeine-containing drinks.

### **Discussion**

General prevalence of osteoporosis as determined by presence of osteoporosis in any limb is 63.2% (95% CI: 38.4%; 83.7%). For participants with BKA, prevalence of regional osteoporosis on the residuum is 100.0% (one sided 97.5% CI: 39.8%; 100.0%). However, this is only based on 4 participants because of machine's limitation. Positive osteoporosis screening was commonly observed among elderly participants, male, married, unemployed, long standing BKA and non-prosthetic users. There may be progression of demineralization on the residuum over time because of insufficient mechanical weight loading, disuse atrophy and lack of muscular action. Risk factors identified were cigarette smoking, alcoholic drinking and caffeine intake.

### **Conclusion**

All patients with lower limb amputation may develop osteoporosis because of disuse, altered biomechanics and risk factors similar to the general population.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Rehab Medicine & Surgery - 2**

**Room 1.05**

Abstract Title: **Akan®: An Improvement For The Trans-Femoral Amputee?**

Abstract number: **319**

Authors: **A. Lacraz, G. Carmona, M. Assal**

Presenter: **A. Lacraz**

### **Introduction**

End-weight-bearing has a number of biomechanical advantages in lower limb amputations while providing more comfort to the patient. Despite recent progress in prosthetic materials and techniques, end-weight-bearing is not possible for patients with mid-thigh amputation. The “osteointegration technique” has addressed this issue, but at a high technical cost. The goal of this research was to develop and evaluate the design and surgical technique of an implant that consists of a stem and a submuscular cap, offering an end-weight-bearing surface for mid-thigh amputations.

### **Material and Method**

AKAN® (Above Knee Amputation Nail) is an implant that has a cemented stem of different sizes adapted to the femoral shaft anatomy. A circular cap, with an angulated neck reproducing the angle between the anatomical and mechanical axes of the femur, is fixed to the distal end of the stem. The surgical approach includes a long anterior flap so that the incision will not be on the end-bearing surface, but will be located posteriorly. The myodesis is performed by securing the muscle attachments through predrilled holes in the cap. Scanographic studies on cadaveric specimens, as well as finite element studies of the implant were performed.

### **Results**

The scanographic and finite element studies have allowed for validation of the design of the AKAN®. Several trials on cadaveric specimens have led to the exact step-by-step surgical procedure.

### **Discussion**

This preliminary study, with the utilization of a series of cadaveric specimens, has validated the implant and the surgical technique.

### **Conclusion**

Based on these favorable Results the project has been submitted to our University Hospital Ethics Committee for implementation of a clinical trial.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Rehab Medicine & Surgery - 2**

**Room 1.05**

Abstract Title: **Effect Of Diabetes On Postoperative Ambulation Following Below Knee Amputation**

Abstract number: **326**

Authors: **A. Saraf, A. Gupta, J. Prakash, J. Prakash**

Presenter: **A. Saraf**

### **Introduction**

Ambulation forms an important part of rehabilitation program after lower limb amputations. Diabetes Mellitus and its complications are commonly associated with amputation. In spite of this, there is an absence of studies on the effect of diabetes on the post operative ambulation of an amputee. This study analyses the role of diabetes as an independent factor affecting post operative ambulation and compares it with non diabetics.

### **Material and Methods**

The present study followed 105 patients; 48 diabetics and 57 non diabetic amputees. Their post operative ambulatory level was compared by using Pinzur et al ambulation scale. Both groups were age, sex and BMI matched.

### **Results**

There was a worsening of ambulatory level in 33.3% diabetics as compared to 10.7% in non diabetics postoperatively. Of the prosthetic users, 78.4% were in non diabetic group and 21.6% were in diabetic group. 17.6% of prosthetic users required additional support, of whom 66.7% were diabetics.

### **Discussion**

Diabetics have a poorer ambulatory level as compared to non diabetics. Further the incidence of prosthesis usage and its duration is also less in diabetic group. Diabetics have to use additional support more often than non diabetics

### **Conclusion**

Diabetes Mellitus is an independent factor which has an adverse effect on the functional outcome of a patient after below knee amputation.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Rehab Medicine & Surgery - 2**

**Room 1.05**

Abstract Title: **Roehampton Stump Score - A Method Of Estimating Quality Of Stump For Prosthetic Rehabilitation**

Abstract number: **340**

Authors: **S. Sooriakumaran, M. Uden, S. Mulroy, T. Collins**

Presenter: **S. Sooriakumaran**

### **Introduction**

It is widely recognised that the quality of amputation surgery has a strong impact on prosthetic rehabilitation outcome. No validated method of evaluating quality of amputation stump was identified from literature search. We have developed this method of scoring transtibial and transfemoral stumps. The salient features of the stump that influence early prosthetic fitting, socket comfort and weightbearing were identified.

### **Methods**

The scoring sheet was completed for all new amputees during their initial assessment. The following ten parameters were scored: wound healing; stump pain; length of stump; shape of stump; bone end as evaluated using X-ray; muscle cover; proximal joint range and power; sensation; vascular perfusion; and skin condition. Each parameter was scored between 0 to 10 giving a maximum total score of 100. The date of amputation, Name of surgeon, Name of hospital and surgical technique were noted.

### **Results**

Since August 2011, 82 stumps have been scored. The study will be completed with 100 stumps and Results will be analysed fully for the presentation in February 2013. The preliminary analysis has identified inadequate shaping of bone end and muscle cover. High scores were noted in most of the other parameters.

### **Discussion**

This scoring method offers an objective assessment of quality of stump. The overall high scores indicate a significant improvement in quality of amputation surgery in recent years. Potential areas of improvement of bone contouring and muscle attachment were identified.

### **Conclusions**

The plan is to validate Roehampton Stump Score and to encourage colleagues to use it routinely. We believe this would improve both quality of amputation surgery and prosthetic rehabilitation.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 2**

**Room 1.06**

Abstract Title: **Effects On User Mobility And Safety When Changing From A Dynamic Prosthetic Foot To A Bionic Foot**

Abstract number: **497**

Authors: **A. Ludviksdottir, M. Nicholls, T. Ingvarsson, K. Gunnsteinsson, K. Gruben**

Presenter: **A. Ludviksdottir**

### **Introduction.**

The PROPRIO FOOT is the first powered, bionic prosthetic foot that was commercially available.

### **Methods**

LLA using a carbon fibre foot were eligible for study participation. The IRB approved study was a self-controlled trial. Subjects were measured at baseline on their own prosthesis. Then, changed to a bionic foot for four weeks and were measured again. Four validated outcome measures, PEQ-MS (primary endpoint), Ramp Assessment Index (RAI) and Stair Assessment Index (SAI) 2 and 2MWT 6 were used to assess mobility. The Activity Balance Confidence (ABC) 5 scale, plus a questionnaire on falls developed for the study were used to assess safety.

### **Results**

Eight LLA completed the study, 5 AK and 3 BK amputees. The mean age and weight were  $49,4y \pm 12y$  and  $92,6kg \pm 27kg$  respectively. The PEQ-Mobility score increased from 4,08 at baseline to 4,74 while on the bionic foot. This increase is significant at the 95% level ( $p=0,045$ ). For the 2MWT no difference was identified between the two feet. The mean scores for the RAI and HAI while walking up and down ramps/stairs, showed trend towards an improvement across all four conditions when changing to a bionic foot ( $p>0.05$ ). For the ABC, the mean score improved from 89,9 to 96,4 after the intervention ( $P> 0.05$ ). Finally, on average over the past four weeks stumbles decreased from 9,9 to 5,3 and falls dropped from 3,4 to 1,0 when transferring to the Bionic Foot.

### **Conclusion**

Despite the limitation of the study which is small sample size, Results indicate improvements in mobility and reduced risk of falling as reported by users, while on the bionic foot –which may relate to the intelligent functions offered by the bionic foot. In particular, the toe lift in swing and terrain adaptation. To confirm this a larger study is needed



Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 2**

**Room 1.06**

Abstract Title: **Clinical Application Of Self-Report And Performance Based Outcome Measures To Determine Clinical Effectiveness.**

Abstract number: **353**

Authors: **R. Gailey, V. Agrawal, I. Gaunaurd, A. Finnieston**

Presenter: **R. Gailey**

### **Introduction**

Outcome measures can be used to evaluate clinical progress, establish goals, or simply determine current functional capabilities of people with limb loss. The purpose of this study was to determine the clinical application of the Prosthetic Evaluation Questionnaire - mobility Scale (PEQ-MS13), the Locomotor Capabilities Index (LCI), the Amputee Mobility Predictor (AMP) and 6-minute walk test (6MWT).

### **Methods**

Ten transtibial amputee subjects were assigned to two groups based on cause of limb loss (5 PVD/ 5 traumatic) for an 8 week trial, receiving a specialized prosthetic training program consisting 4 gait related movement patterns, 2 home exercises and prosthetic foot specific techniques to negotiate sitting, standing, ramps and stairs. The aforementioned measures were administered at base-line and subsequently every two weeks to determine differences between training period and the four categories of prosthetic feet.

### **Results**

ANOVA was performed to compare differences between groups and interventions. Of the four outcome measures only the AMP detected differences with the PVD group demonstrated significant differences between baseline and training plus all categories of prosthetic feet ( $p < 0.05$ ) while the traumatic group demonstrated difference between baseline and the SAFE, Talux and Proprio feet ( $p < 0.05$ ).

### **Discussion**

After receiving the specialized training the PVD group demonstrated improvement functioning at a higher classification level and therefore qualifying by government standards for all categories of prosthetic feet. Prosthetic specific training in conjunction with advanced prosthetic feet such as the Talux and Proprio Foot improved function in the traumatic group.

### **Conclusion**

Advanced prosthetic foot systems and specialized training can improve functional capabilities as measured by the performance-based outcome measure the AMP. The ability to maximize prosthetic performance and objectively demonstrate differences is essential for comparative effectiveness healthcare systems.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 2**

**Room 1.06**

Abstract Title: **Evaluation Of Dynamic Prosthetic Alignment Techniques For Individuals With Transtibial Amputation**

Abstract number: **361**

Authors: **J. Andrysek, C. Chen, K. Fairley, W. Heim, R. Clements**

Presenter: **J. Andrysek**

### **Introduction**

Prosthetic alignment, arranging a custom fitting socket in relationship to the residue limb and an artificial limb section, is an important part of the prosthetic fitting process, and ultimately of the rehabilitation of transtibial amputees. Prosthetic alignment is typically performed by prosthetists and is primarily based on subjective assessments of the patient's comfort and walking performance. Recently, technologies have become available to provide objective guidance during the alignment process. The Compas™ system is one such instrument; however, scarce evidence exists about how effective it is, and how best it can be utilized in the clinic. The aim of this study was to determine if an instrument-assisted alignment technique would improve patient outcomes when compared to the conventional subjective alignment technique.

### **Methods**

Both conventional and instrument-assisted prosthetic alignment techniques were evaluated and compared among 8 adult individuals with a unilateral transtibial amputation. Kinetic and kinematic gait parameters were collected over two sessions using functional walk tests and questionnaires.

### **Results**

Data showed that although there was no significant difference between the two techniques in gait stability and kinetic patterns, insights were gathered from the biomechanical effects due to change of alignment and from prosthetists on the clinical usefulness of the Compas™ system.

### **Discussion**

Participants demonstrated similar alignment outcomes having received both alignment techniques. However, Results suggested biomechanical characteristics of an individual's gait may be affected by each alignment change. These can guide improvement of future generations of the Compas™ system, and provide insights to prosthetists when they perform alignment clinically.

### **Conclusion**

The findings from this research may improve patient care by providing guidelines and insights into the effective clinical use of instrument-assisted techniques for optimally aligning prosthetic limbs.

Date / Time: **Tuesday, Feb 5 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 2**

**Room 1.06**

Abstract Title: **Factors Influencing The Reliability Of Different Designs Of Goniometer: A Literature Review**

Abstract number: **369**

Authors: **F. Mohsin, A. McGarry, R. Bowers**

Presenter: **F. Mohsin**

### **Introduction**

Different designs of the goniometer are available for clinical measurements of joint range of motion (ROM), including: universal goniometers, gravity-dependent goniometers and electrical goniometers. Reliability of the goniometer is essential in clinical practice. Several factors can influence reliability, including: pathology, number of testers, type of motion, joint characteristics and procedure followed. Hence, it is important to understand how reliability can change with these factors.

### **Methods**

An electronic and manual literature search was conducted into the reliability of different goniometers. A variety of search terms were used with no limits or restrictions. Papers sourced were graded according the Scottish Intercollegiate Guideline Network guidelines.

### **Results**

Normal subjects and patients with variety of pathologies participated in the studies reviewed. The active and passive motion of lower limb joints was studied. Both intratester and intertester reliability was examined. Several studies directly compared between the reliability of different goniometric designs.

### **Discussion**

Variation in methodology and measurement procedures across different studies affected the ability to make comparison between them. The majority of studies concluded that intratester measurements were more reliable than intertester measurements. Reliability of measurements varied across joints involved, with measurements of more complex joints proving less reliable than simple joints. In addition, the reliability of the measurements altered depending on pathology. Moreover, some studies confirmed that measuring active motion was more repeatable than passive motion. Furthermore, some studies suggested that standardising the method of measurement increases reliability. Finally, reliability differed between the different goniometric designs and most studies stated that goniometers should not be used interchangeably.

### **Conclusion**

In Conclusion, clinicians should be cautious when: choosing the appropriate type of goniometer and interpreting or comparing measurements taken using different designs. Additional studies of appropriate design should be conducted to provide better understanding of goniometer measurements obtained.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 2**

**Room 1.01**

Abstract Title: **Requirements For Effective Use Of Pattern Recognition Controlled Multiple Degrees Of Freedom (Dof) Transradial Prostheses In The Habitual Environment**

Abstract number: **103**

Authors: **J. Kalmar, J. Van Vliet**

Presenter: **J. Kalmar**

### **Introduction**

There is still insufficient experience with pattern recognition (PR) and multi-electrode systems outside of the laboratory environment. This work shows the strengths and weakness of such systems during the whole fitting process and during the usage in the habitual environment of the patient.

### **Methods**

A 4 week patient-trial was made with a Michelangelo® hand and an electric wrist (4-DOF) controlled by 8 sEMG sensors. These were placed circumferentially around the forearm and their signals continuously recorded using a data-logger. Before commencement of the trial, the training of the PR system was carried out. The patient then used the system in his normal environment.

### **Results**

The main strength of the system is the faster and more intuitive control. The weakness is that this is only given if the patterns have small deviations. At home both an expert and laboratory equipment is missing to provide feedback regarding mismatches. During the first 2 weeks therefore, performance was unsatisfactory. Then a PC based feedback system was provided at home, allowing the patient to see the classification Results of his patterns online. By self-training, the Results in the latter 2 weeks improved to full acceptance of the system.

### **Discussion**

Some intuitive movements proved not independent enough or generated too weak EMG to be used. With anatomical knowledge suitable alternatives can be found and retrained effectively by the patient with use of the feedback system.

### **Conclusions**

The main benefit of pattern recognition leads to both a significant higher acceptance of the use of prostheses and an improved rehabilitation result. For this however, it is necessary to support the patient in learning to provide stable and independent muscle patterns. We showed that early stage training is required, as is a patient feedback system for pattern deviations, such as a PC software providing real-time visual classification information.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 2**

**Room 1.01**

Abstract Title: **Mechanical Testing And Design Refinement Of A Low Cost Multi-Functional Terminal Device - The Unb Hand**

Abstract number: **144**

Authors: **A. Clawson, A. Wilson, E. Scheme, D. Rogers, P. Kyberd**

Presenter: **P. Kyberd**

There are currently two multifunctional hands that are commercially available to the end user. Although offered, their high costs can be prohibitive, limiting their adoption. The aim for this project was to create a terminal device with the dexterity of these products but within the cost typically associated with a single degree of freedom solution.

After identifying the grasp types that are most useful for standard ADL'S, the minimum degrees of active freedom needed to achieve them was determined. A solution involving three motors, novel transmission systems and sensory integration was produced to realise this. The package size is equivalent to a 7.25' conventional hand size to accommodate the maximum number of users. The outer shape and size was initially modelled after the outside of an existing passive prosthetic glove. Based on preliminary Results, an aluminum endoskeleton was adopted with the overall shape being formed using plastic components for the non-load bearing surfaces.

The project has evolved through three iterative prototypes with the current gamma solution undergoing extensive mechanical testing. Use of a load cell in conjunction with real-time data acquisition software enabled the recording of peak force levels for individual digits and the thumb at multiple degrees of flexion. The force generated by various grasp patterns, including precision, tripod, power and lateral grasps was also measured. The measurement protocol also included testing of resistance to being back driven. During all procedures the associated current draw and position were recorded, from which the speed of closing for each joint was calculated. Long term cyclic and destructive testing was also performed. Following the long term testing the above tests were repeated and the Results compared. A Discussion on the techniques used during the development of the UNB Hand, including manufacturing Methods and mechanical refinements based on testing Results will be presented.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 2**

**Room 1.01**

Abstract Title: **Intermanual Transfer In Upper-Limb Myoelectric Prosthetic Training In Children And Adults Using A Prosthetic Simulator**

Abstract number: **130**

Authors: **S. Romkema, R. Bongers, C. Van Der Sluis**

Presenter: **S. Romkema**

### **Introduction**

Myoelectric prosthetic training should start within the first month after amputation for the best **Results**. To start training directly after an upper-limb amputation intermanual transfer can be used. Intermanual transfer implies that motor skills learned at one side of the body, transfer to the other side. This suggests that by practising the unaffected arm, in the period between amputation and prosthetic fitting, the affected arm will also improve. Practising the unaffected arm is possible using a prosthetic simulator, a myoelectric prosthesis that can be attached to a sound arm. Scarce literature in children suggests that intermanual transfer is present from five years on, and improves further with age.

### **Aim**

The aim was to determine whether intermanual transfer effects could be detected after training with a myoelectric prosthetic simulator in adults and children.

### **Methods**

Able-bodied right-handed adults (N=48, mean age: 24.6y) and children (N=48, mean age 5.1y) participated in two separate experiments. The participants were randomly assigned to an experimental or a control group. The experimental group performed a five-day training program with a simulator. To determine the improvement in skill, a test was administered before, after, and six days after training. The control group only executed the tests. The training program was performed with one ('unaffected') arm; tests were performed with the other ('affected') arm. Movement times, the time from the beginning until completion of the task, were recorded.

### **Results**

In both experiments, the movement time decreased significantly more ( $p < .05$ ) in the experimental group compared to the control group, indicating faster handling of the prosthesis.

### **Conclusion**

Intermanual transfer was present after training with a myoelectric prosthetic simulator in children and adults. These **Results** are important as training can start early in rehabilitation after an upper-limb amputation.

This work was supported by Grant 60-62300-98-119 from ZonMW.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 2**

**Room 1.01**

Abstract Title: **Influence Of Tasks On The Validity Of The Assessment Of Capacity For Myoelectric Control (Acmc)**

Abstract number: **131**

Authors: **H. Lindner, A. Eliasson, L. Norling Hermansson**

Presenter: **H. Lindner**

### **Introduction**

The Assessment of Capacity for Myoelectric Control (ACMC) is an observational based instrument that evaluates the ability to operate a myoelectric prosthetic hand. It is performed during the execution of bimanual tasks chosen by the clients. Although the ACMC does not assess task performance, it is unknown whether the clients' ability measures are influenced by factors such as task complexity. The study aim was therefore to develop standardized tasks and to examine whether (i) the clients' ability measures are influenced by the tasks (ii) the tasks function the same across different client characteristics based on age, sex, prosthetic side and experience.

### **Method**

Six tasks were chosen from ACMC raters' suggestions and standardized for the ACMC. Myoelectric prosthesis users (n=58, mean age=20, 31 males) were recruited from the Örebro University Hospital, Sweden. Each user performed 3 tasks. All task performances were videotaped and rated on the 22 ACMC items according to a 4-point capability scale.

Many-facets Rasch analysis was used to (i) examine whether the three ability measures of each user were significantly different from each other, and (ii) to reveal if a particular client characteristics was scored differently in a particular task.

### **Result**

No significant difference in the ability measures was found in the majority of the sample – only three sporadic users were significantly different in one or two of their tasks. This implies that the client's ability measures are not influenced by the tasks.

No significant difference was found related to prosthetic side and experience. Minor difference was found in sexes and two age groups (age 7 to 15, over 15) but the differences were too small to be clinically relevant.

### **Conclusions**

This study provides further validity evidence of the ACMC. Research with more challenging tasks is needed to confirm the findings.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 2**

**Room 1.01**

Abstract Title: **Universal Coupler For Upper-Limb Prostheses**

Abstract number: **247**

Authors: **L. Sutton, T. Williams, A. Clawson, A. Thomas, J. Lipsey, J. Sensinger**

Presenter: **J. Sensinger**

### **Introduction**

Several socket-mounted couplers allow users to interchange terminal devices, including body-powered couplers and the de-facto standard for myoelectric prostheses: the Otto Bock quick-disconnect coupler. Recent improvements in myoelectric prostheses are incompatible with the Otto Bock coupler because they can inadvertently unscrew the terminal device. A new standard interface is required that meets the needs of these powered devices. This standard coupler will provide a universal interface for both body-powered and myoelectric prostheses.

### **Methods.**

The Rehabilitation Institute of Chicago (RIC), the University of New Brunswick (UNB), and Liberating Technologies, Inc. (LTI) suggested a list of requirement that the standard should meet after a series of meetings. This draft was presented during a workshop at the 2011 Myoelectric Controls Symposium. Feedback from over 40 participants—including prosthetists, engineers, manufacturers, and end-users—was incorporated into the standard, which was then further refined by a majority of upper-limb manufacturers at the American Orthotics and Prosthetics Annual meeting.

### **Results.**

RIC, UNB, and LTI have fabricated several prototypes of coupler designs. Because it seems impossible to meet all of the requirements of the proposed standard, a focus meeting was held at RIC with clinicians and engineers to assess which requirements in the standard should be prioritized. We have created a coupler that allows different aspects of the requirements to be met for different users – yet retains the same standardized interface. We believe this design meets the requirements of all stake-holders.

### **Discussion.**

We will discuss the standard, and the clinician-priority list at ISPO. We will also suggest one or several coupler designs that meet these requirements.

### **Conclusions.**

It is important to establish a standard universal coupler, allowing devices to remain interchangeable between manufacturers. We have refined the proposed standard and established a design that we feel can be adopted as a universal standard.



Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Innovations - 1**

**Room 1.02**

Abstract Title: **Self-Management Training For Prosthetic Rehabilitation: A Participative Innovation Study**

Abstract number: **87**

Authors: **S. Van Twillert, K. Postema, J. Geertzen, A. Lettinga**

Presenter: **S. Van Twillert**

## **Introduction**

Patients with a lower limb amputation need to self manage their condition in everyday life just like patients with chronic conditions such as cardiovascular diseases or COPD. Prosthetic rehabilitation can therefore profit from successful self-management interventions aimed at empowering patients with chronic conditions. Yet a translation towards amputation specific issues is therefore needed.

## **Methods**

Generic treatment principles were extracted from self-management interventions in an extensive literature analysis, providing a general framework for self-management training. Amputation specific issues were gathered by 1) individual and focusgroup interviews with patients on post-discharge problems and 2) an explorative cohort study of thirteen patients on functioning after prosthetic rehabilitation. Merging the generic principles with this amputation specific information led to a self-management training for prosthetic rehabilitation. In co-creation with rehabilitation professionals and patients the self-management training was refined in clinical practice and tested on feasibility.

## **Results**

Combining several research Methods enabled a translation of promising self-management principles into a self-management training for prosthetic rehabilitation. The training encompasses a psycho-educative and motor skill training, both based on problem solving principles. In the psycho-educative training several general self-management skills, like problem management, asking for help, finding necessary information and more disease specific skills like dealing with limb care and problems with prostheses are trained in interactive classes. In the motor skill training problem solving skills in functioning with a prosthesis in different contexts are trained, to prepare the patient for the variety in contexts in their home environment.

## **Discussion**

Employing a participative research approach provided a broadly based patient-driven self-management training. Patients and professionals should more often be seen as collaborative partners in innovation studies. **Conclusion** Integrating self-management principles into prosthetic rehabilitation provides professionals with tools to empower patients in living with the consequences of an amputation.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Innovations - 1**

**Room 1.02**

Abstract Title: **Prosthetic Ankle-Foot System That Adapts To Ramps On Every Step**

Abstract number: **161**

Authors: **A. Hansen, E. Nickel, S. Morin, J. Sensinger**

Presenter: **A. Hansen**

### **Introduction**

Although many prosthetic ankle-foot systems are commercially available, few if any can adapt to sloped surfaces on every step of walking. The purpose of this project is to develop an ankle-foot prosthesis that can adapt to various terrains on every step of walking using only passive mechanical parts—without the need for motors or batteries. Our design uses two stiffness elements and a method of engaging and disengaging one of the stiffness elements at specific times in the gait cycle.

### **Methods**

Our development approach includes iterations of design, fabrication, and testing. We use SolidWorks for computer-aided drafting and finite element modeling of parts as well as simple static models for part interactions. For stiffness elements, we use elastomeric materials and carbon fiber foot plates. For the engagement/disengagement mechanism, we have developed a weight-activated cam clutch system.

### **Results**

We have developed two ankle-foot prototypes. The first prototype had effective stiffness elements, but the engagement/disengagement mechanism was unable to consistently hold desired ankle torque. The second prototype had an engagement/disengagement mechanism that consistently held ankle torque in excess of 250 Nm during bench testing, but would not consistently disengage after unloading. Parts for a third prototype are currently being fabricated to address the problems associated with the first two prototypes.

### **Discussion**

Our group is making progress on the development of a purely passive mechanical ankle-foot system that will adapt to uneven terrain on every step of walking. Tests from the initial prototypes suggest that the current approach is feasible. We plan to report on patient testing in our presentation at ISPO.

### **Conclusions:**

Two prototypes of an adaptable ankle-foot system have been developed and bench tested. This system adapts to uneven terrain on every step of walking. The design is simple and seems feasible as a commercial product.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Innovations - 1**

**Room 1.02**

Abstract Title: **Pro-Mouse**

Abstract number: **533**

Authors: **Paulas R.**

Presenter: **Paulas R.**

### **Introduction**

Human hand performs innumerable functions including number of fine movements in our day-to-day activities. Amputation of upper limb is a great loss and rehabilitation of amputee is a challenging task. Especially, the rehabilitation of bilateral amputees placed in IT, software, and media and designing industries is a difficult job as their carrier is confined on a keyboard and mouse.

### **Method**

Pro-mouse is an input device of a computer, substitute to the regular mouse, designed to use with the stump of an amputee. It has a PCB, with modified scroll wheel and switches with standard components. The outer customized case is designed to facilitate anterior and posterior tilts in order to elevate the device. The upper body is fitted with a platform that operates the left and right click-buttons and an adjustable strap to accommodate the stump, which permits medial and lateral rotation. Anterior tilt enables the scrolling and posterior elevation enables the scroll lock. Dragging is achieved through left rotation of stump and navigation of the mouse.

### **Result**

Pro-mouse is compatible with most of the operating systems and adaptable with USB or PS/2 port. It can be used for right/left or below elbow/above elbow or long/short stumps and is fully adjustable for child or adult stump sizes. Amazingly, upper limb paralyzed patients with minimal pronation and supination function can also easily operate the device.

### **Discussion**

Patient needs little training to operate the device. Most of the professionals are very well acquainted with the computer operations and so it was easy for them to achieve accuracy and speed in the operation.

### **Conclusion**

All the functions of a standard mouse are achieved in the Pro-mouse with accuracy after minimal practice, which enables amputees and upper limb paralyzed to continue their professional career.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Innovations - 1**

**Room 1.02**

Abstract Title: **A Novel Research And Clinical Approach To Using Gel Liners For Collection Of Surface Emg Data For Myoelectric Control**

Abstract number: **151**

Authors: **R. Lipschutz, L. Miller, T. Kuiken, B. Lock**

Presenter: **L. Miller**

### **Introduction**

Gel liners constructed from a variety of materials have proven successful in the fitting of individuals with lower limb amputations for longer than two decades. Prosthetists have also fit gel liners to individuals with upper limb amputations and have reported moderate success in combination with externally powered, prosthetic fittings.

### **Methods**

At the Rehabilitation Institute of Chicago, we have explored a novel approach to collecting EMG data, using our internal software system CAPS, from individuals with both lower limb and upper limb amputations using gel liners with embedded electrodes. Signals have been obtained in both virtual environments and with powered prostheses using either direct control or Pattern Recognition algorithms.

### **Results**

Early fittings with the liner designs have proven more comfortable and easier to don than traditional designs and have permitted us to eliminate the need to connect the wire harness and pre-amplifiers separately. The use of gel liners with embedded electrodes has permitted us to control a virtual avatar, powered upper limb and powered lower limb prostheses.

### **Discussion**

It has been shown that liners with embedded electrodes can be used to provide information to multiple degree of freedom prostheses. The next step in this research is to combine the new liner technology with robust, on-board electronics to control actuated drive units in both upper limb and lower limb prostheses.

### **Conclusions**

Gel liners can be modified in a manner that permits EMG data to be collected without compromising the ease of prosthesis donning, comfort of the socket or robustness of the wire harness. We believe that this method of EMG acquisition will be very beneficial to patients and prosthetist; eliminate some of the clinical challenges and reported drawbacks of liners used in conjunction with myoelectric fittings.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 6**

**Room 1.03**

Abstract Title: **Influence Of A Microprocessor Controlled Prosthetic Knee On Biomechanics Of Gait Termination, Preliminary Results**

Abstract number: **476**

Authors: **E. Prinsen, M. Nederhand, H. Rietman**

Presenter: **E. Prinsen**

### **Introduction**

Gait termination (GT) requires the generation of sufficient braking forces. Vrieling et al showed that the peak braking ground reaction force of the prosthetic leg is decreased. Therefore compensations in the intact leg (predominantly increased braking force production) are needed to terminate gait. Because microprocessor controlled knees improve stance stability and yielding they may be beneficial during GT and thereby possibly reduce reliance on the intact leg.

### **Methods**

Four unilateral transfemoral amputees (> 1 year after amputation; functional level : K2- K4) were included and measured with their own mechanically passive prosthesis and with the Rheo Knee (8 weeks acclimatization). Measurements were performed using a 6-camera Vicon system and two forceplates. The braking forces of the second last step, the last step and the closing step were determined. In addition peak power absorption of the knee and hip of the intact and prosthetic leg were determined during the different steps. Prosthetic foot and knee alignment were similar in both prosthetic knee conditions

### **Results**

When the prosthetic leg made the second last step and the final step, no differences in braking forces were found between both prosthetic knee conditions. Also, there were no differences between the two knee conditions in peak power absorption of the intact and prosthetic leg.

### **Discussion**

No clear differences were found between both prosthetic knee conditions in the amount of braking forces or peak power absorption of the intact and prosthetic leg. This is probably explained by the fact that the ankle is of particular importance for generating braking forces. Because the prosthetic ankle is passive, production of these forces is challenged. The role of the knee during GT is probably limited.

### **Conclusion**

The Results of this preliminary study indicate that a microprocessor controlled knee does not reduce reliance on the intact leg during gait termination.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 6**

**Room 1.03**

Abstract Title: **Dxa Evaluation Of Femoral Amputees With Osseointegrated Prosthesis**

Abstract number: **495**

Authors: **P. Jørgensen, K. Petersen, M. Stilling, I. Mikkelsen, K. Søballe**

Presenter: **P. Jørgensen**

## **Background**

Amputated bones radiologically often seem partly depleted of mineral. In order to study the bone quality in patients operated with osseointegrated (OI) prosthesis we made a systematical evaluation of the mineral content by doing regular dxa-scans before and after surgery.

## **Materials and Methods**

Femoral amputated patients were operated with an OI-prosthesis (Integrum, Sweden) through a two stage (S1 and S2) procedure. At S1 a titanium screw (fixture) is implanted into the bone. Six months later, a rod (abutment) is inserted into the screw with the other end penetrating through the skin (S2) to be fixed directly into the external prosthesis allowing direct transmission of walking forces to the bone.

DXA-scan (osteoporosis, femur hip, ortho hip, total body) was performed at admission, 2 weeks, 3 and 6 months after S1 and 2 weeks, 3, 6 and 12 months after S2.

## **Results**

Four female and six male patients, mean age 48,1 years, have been included.

Four patients have at present finished the rehabilitation period with full weight bearing.

On the amputated side the pre-operative T-score was decreased by 60% (range 56-68) in the proximal femur and 22% (range 16-28) in the ipsilateral pelvis and all but two patients had lumbar spine T-scores below 0. Three patients have been followed for a year after finishing the rehabilitation and show an up to 50 % increase in BMD around the fixture together with an increased T-score of the spine.

## **Conclusion**

Although all patients had a high level of physical activity they all showed a decreased BMD in both the amputated femur and in the ipsilateral pelvis at time of admission. 8 of 10 patients had decreased T- score of their spines. The osseous loading of the amputated bone due to walking with an osseointegrated prosthesis seems to stimulate bone quality both locally and universally

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 6**

**Room 1.03**

Abstract Title: **Movement Optimisation Approach Of An Integrated Microprocessor Controlled Intelligent Biomimetic Limb**

Abstract number: **213**

Authors: **N. Stech, D. Moser, A. Sykes, S. Lang, G. Harris, J. Ochoa, J. Mccarthy, J. Ross, S. Zahedi**

Presenter: **J. Ross**

### **Introduction**

The high degree sophistication of human gait is revealed when prosthetic systems have to replace lower limb functionalities especially after transfemoral amputation. The integrated limb consisting of a microprocessor controlled hybrid knee joint and a microprocessor controlled self-aligning ankle-foot joint shall provide a step towards more intuitive and intelligent artificial lower limb movement. It can finely regulate different resistances both in knee and ankle-foot joint according to the situational requirements.

### **Methods**

A gait study with 5 unilateral amputees was conducted indoors and outdoors. The study examined gait kinematics and kinetics such as bending moment using internal sensor signals of the integrated limb and external sensor signals from a force plate, video vector system and/or a load cell. Resistances variations in knee and foot and their effects on gait were investigated. The data was acquired wireless and post processed in Matlab.

### **Results**

The preliminary **Results** of the biomechanical analysis showed that changes in resistances of the knee joint influence the ankle-foot joint and vice versa. Differences in kinetics and kinematics could be correlated with efficiency and comfort of locomotion in different situational contexts. Especially on uneven ground and inclines the beneficial effect of a globally microprocessor controlled movement optimisation showed in both self-chosen velocity and subjective feedback.

### **Discussion and Conclusion**

Using nature as a role model a distributed sensor-actuator system involving both knee and foot-ankle joint is an intuitive way to improve lower limb prosthetics. The gait study showed that additional support can be provided when knee and foot-ankle joint communicate with each other to deal with the situational requirements. A first step towards future high-tech prosthetics has been done. Next steps should comprise refinements of control and a further integration of an artificial limb that incorporates an intelligent socket to fulfil the vision of a fully integrated biomimetic leg.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 6**

**Room 1.03**

Abstract Title: **Development Of The Transfemoral Fitting Predictor - A Functional Measure To Predict Prosthetic Potential In Transfemoral Amputees**

Abstract number: **9**

Authors: **L. Whitehead, S. Treweek, E. Condie, A. Mcfadyen**

Presenter: **L. Whitehead**

### **Introduction**

The Transfemoral Fitting Predictor (TFP) was developed initially in 2003 as an adjunct to assessment for prosthetic fitting in Dundee. A pilot study on 10 patients suggested that the measure was promising and warranted further evaluation. The current project was designed to measure the validity and reliability of the revised 9 point Transfemoral Fitting Predictor.

### **Aims of Study**

To test the validity and reliability of the TFP on a larger and statistically robust sample of patients To develop a novel, video-base method to assess inter-rater reliability and possible use in tele-health to assist non specialist centres in assessing prosthetic potential

### **Results**

93 of the possible 125 potential participants approached took part in the paper assessment and 75 of those agreed to video Internal consistency (Cronbach's alpha) was very good = 0.92 Step-wise discriminant analysis determined that tasks 7 and 8 discriminated best between those who eventually received a prosthesis. Construct validity showed 2 distinct constructs – tasks 1-4 & 6 and 5 - 9 therefore if the order of 5 & 6 was changed the tool could be split into basic / advanced tasks Inter-rater reliability –  $p > 0.8$  indicating high levels of reliability with tasks 2 & 6 the weakest (bed to WC & back / sit to stand) – all others had a value of  $p > 0.9$

### **Conclusion**

The TFP is a simple, valid and reliable measure of prosthetic potential for transfemoral amputees. The measure is now being used across the UK in many prosthetic centres. Further work would have to be undertaken to determine whether a specific score could determine prosthetic potential, however at present the tool should be used as an adjunct to assessment only.



Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 6**

**Room 1.03**

Abstract Title: **Energy Expenditure Of Transfemoral Amputees Walking With Different Speeds On Different Walking Surfaces**

Abstract number: **253**

Authors: **I. Starholm, T. Gjovaag**

Presenter: **I. Starholm**

### **Introduction**

Measurements of oxygen uptake ( $VO_2$ ) at the preferred walking speed (PWS), is frequently used to assess walking performance of transfemoral amputees (TFA), but previous studies disagree on whether walking on a treadmill is similar to over ground walking. This study investigates what effect treadmill walking (TMW) and wooden floor walking (WFW), using the PWS for the two respective walking situations have on the oxygen uptake and walking economy (Cw) of transfemoral amputees.

### **Method**

The PWS of 8 healthy subjects with transfemoral amputations (mean  $\pm$  SD age was  $37.0 \pm 11$  yrs.) were determined on a motorized treadmill (PWSTM) and on wooden floor (PWSWF).  $VO_2$  ( $ml\ kg^{-1}\ min^{-1}$ ) was measured by a portable analyzer (Metamax 3B, Cortex Biophysik, Germany) during WFW with the PWSWF and PWSTM, and during TMW with the PWSTM and PWSWF, respectively. Cw was calculated as  $VO_2\ ml\ kg^{-1}\ min^{-1} / PWS\ m\ min^{-1}$ .

### **Results**

Results are presented as means  $\pm$ SD. The PWSWF ( $1.22 \pm 0.2\ msec^{-1}$ ) was higher compared to the PWSTM ( $0.89 \pm 0.16$ )  $msec^{-1}$ ,  $p < 0.001$ . During WFW and TMW with the PWSWF the TFAs' oxygen uptake was similar ( $15.6 \pm 3.5$  and  $15.5 \pm 3.8\ ml\ kg^{-1}\ min^{-1}$ , respectively). The oxygen uptake during WFW and TMW with the PWSTM was also similar ( $12.6 \pm 1.5$  and  $12.4 \pm 2.1\ ml\ kg^{-1}\ min^{-1}$ ). The Cw during TMW was similar to Cw during WFW when using the PWSTM ( $0.240 \pm 0.02$  and  $0.242 \pm 0.03\ ml\ kg^{-1}\ m^{-1}$ , respectively). The Cw during WFW was also similar to the Cw during TMW when using the PWSWF ( $0.213 \pm 0.04$  and  $0.213 \pm 0.03$ , respectively).

### **Discussion**

The oxygen uptake is not influenced by the walking surface, but solely on walking speed (physical effort of the TFA). Since PWSTM is slower than PWSWF this affects calculations of walking economy (Cw) on a treadmill, negatively.

### **Conclusion**

Cw is not a good measure of walking performance of transfemoral amputees.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 2**

**Room 1.05**

Abstract Title: **Competencies And Development Of Graduates Of An African Regional Training Centre Working In Low-Income Countries**

Abstract number: **248**

Authors: **S. Sexton, H. Shangali, B. Munissi**

Presenter: **H. Shangali**

### **Introduction**

There is a tremendous need for personnel for prosthetic and orthotic services in Africa. The Tanzania Training Centre for Orthopaedic Technologists has graduated hundreds of students who now work in clinics in different low income countries in Africa. In association with ISPO's USAID funded program "Rehabilitation of physically disabled people in developing countries", we audited graduate clinical skills and competencies and also determined the professional development needs of graduates in 3 African countries.

### **Methods**

Following study recruitment by invitation, visits to graduates in their own clinical setting were arranged in Tanzania, Uganda and Kenya. Each graduate participated in a structured interview with a clinician or educator about lower limb clinical care at the end of a patient review appointment. The graduate and interviewer then identified at least 3 areas for clinical practice development. At the end of the interview graduates were given a note of feedback and a personal development plan.

### **Results**

Graduates work in a range of professional environments ranging from unsupervised lone working to rehabilitation teams. **Results** of the interviews will be presented, revealing similarities and differences between graduates working clinically in the different African countries in terms of patient history taking, patient assessment and prosthetic and orthotic specification and prescription

### **Discussion**

Graduates working in clinical services in Africa are usually expected by the professional community to maintain and improve their clinical competencies in the years after graduation. This is particularly challenging in African countries where there are limited resources or existing professional networks.

### **Conclusions:**

We conclude that it is important to identify specific development needs for individual graduates working in low incomes countries. Detailing a specific development plan can assist the individual clinician to reflect on their practice. This information can, in turn, be used by employers and sponsors to targets precious resources.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 2**

**Room 1.05**

Abstract Title: **The Revised Shape & Roll Prosthetic Foot For Use In Low-Income Countries - Implementation In Haiti**

Abstract number: **414**

Authors: **D. Berman, V. Agrawal, R. Gailey, A. Hansen**

Presenter: **V. Agrawal**

### **Introduction**

The roll-over-shape (RoS) concept was previously used to design the Shape&Roll Prosthetic Foot for resource limited areas. Significant start-up efforts were necessary for the development of this foot, including fabrication of keel molds and a compression molding device. The purpose of this project was to test a revised version of the Shape&Roll Prosthetic Foot, which does not require significant start up efforts, to determine its feasibility for use in Haiti.

### **Methods**

The revised Shape&Roll Prosthetic Foot is fabricated using sawing, sanding, and drilling of solid blocks of plastic material. A computer program was developed to generate a template of the foot that was appropriate for a user's height and weight based on the RoS concept. Instructions on fabricating the foot using the template were developed for technicians in Haiti. Ten prosthetic foot keels were fabricated out of polypropylene using the developed methodology and were fit on transtibial and tranfemoral amputees in Haiti.

### **Results**

The total cost of a foot's keel made using polypropylene was \$20, and the fabrication time was 3 hours for technicians fabricating the foot for the first time. The development process involved printing the 2D template and using it to fabricate a foot from a block of polypropylene. Initial feedback from subjects using the feet has been positive with no reported problems.

### **Discussion**

The tools required for fabrication of the revised Shape&Roll Prosthetic Foot are a computer, printer, bandsaw, drill-press and sander. However, templates could be created for a series of heights and weights, removing the need for the computer and printer. This methodology represents a feasible, sustainable solution for localized production of foot keels.

### **Conclusion**

The minimal resources needed for the fabrication of this foot make it viable and sustainable option for production in low-income countries, as proven by its successful implementation in Haiti.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 2**

**Room 1.05**

Abstract Title: **Creating A Gait Analysis Laboratory In Venezuela: A Combination Of Local And International Efforts**

Abstract number: **316**

Authors: **C. Müller-Karger, R. Torrealba, J. Steele, E. Laurens, B. Amador**

Presenter: **R. Torrealba**

A gait analysis laboratory is essential for quantifying gait disorders, as well as for designing and assessing prosthetic devices. Such facilities are usually equipped with sophisticated devices; such as optoelectronic motion capture systems and force platforms, which require highly-trained personnel for proper equipment operation and maintenance.

In 2009, the Simón Bolívar University (USB), Caracas-Venezuela, received equipment suitable to set up a gait analysis laboratory, as a donation from the International Society of Biomechanics (ISB) in conjunction with its sponsors (Motion Analysis, AMTI and Delsys). The USB provided space and acquired funding to set-up the equipment and renovate the environment so that it was suitable as a fully-functional laboratory. In addition, ISB sponsored a biomechanist to install the equipment and train USB staff in Venezuela. The USB staff continued to seek ongoing training with assistance from a local orthopedic surgeon. Finally, a clinical gait analysis service was opened in 2011.

Twenty patients have been successfully treated. Most cases presented spastic hemiplegia or spastic diplegia secondary to cerebral palsy. The orthopedic surgeon used the gait analysis **Results** to confirm diagnosis and to accurately measure gait parameters deemed essential for surgery planning. Unfortunately, the gait analysis services were temporarily interrupted due to a camera malfunction. However, this issue was resolved in May 2012, with Motion Analysis repairing the cameras at no cost to USB.

International societies such as ISB, ISPO, and WHO, are dedicated to facilitating access to technologies that can meet local needs in Economically Developing Countries. However, to guarantee success of these efforts, it is fundamental that: 1) the required technical and financial support is sustained over time, 2) the laboratory becomes auto-sustainable, and 3) all individuals involved are highly passionate and committed. Otherwise, all efforts and investment will be jeopardized in the future.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 2**

**Room 1.05**

Abstract Title: **A Low Cost Orthosis Nazh For Developmental Dysplasia Of The Hip (Ddh)**

Abstract number: **322**

Authors: **A. Ali**

Presenter: **A. Ali**

### **Introduction**

Dislocation of hip or developmental dysplasia (DDH) is an abnormal development of the hip joint. The ball at the top of the thigh bone called as femoral head is not stable within the socket or acetabulum. The hip joint ligaments which hold it all together may also be stretched and loose. The usual causes are congenital, maternal hormone, position of baby in mother's womb and baby cradles. DDH is more common in girls, firstborn children; breech position babies (bottom-first) and has genetic pre-disposition. DDH can be unilateral or bilateral hip joints. Symptoms are mild to severe as unequal legs length, less mobility on one side, limping, toe walking or duck like gait. Splints as Pavlik Harness close and open reduction surgery and osteotomy are common but relatively expansive solutions.

### **Methods**

A new low cost Orthosis Named as NAZH for DDH is tested among two hundred and ten subjects including male (88) and female (122) ranging in age from 1.5 yrs to 10 yrs during a period of 4 yrs. Pre and post treatment radiological images were taken. Necessary measurements of abdomen (for pelvic band) and thighs(for thigh shells) were taken then device was assembled according to measurements and applied. Limb abduction was increased by adjustment bars attaching thigh bands and to avoid appliance dragging from thigh, supported by pelvic belt.

### **Results**

The patient recovery period was six months to two years depending upon infant/child age and severity of disease. The effectiveness of Orthosis was confirmed by radiological images.

### **Discussion**

The uniqueness of NAZH Orthosis is being its cost effectiveness. This support is twenty times less cost effective, efficient and less time consuming compare to other DDH orthosis. Majority of patients could afford it.

### **Conclusion**

This new orthosis for treating DDH is a positive improvement towards upgradation of basic health facility.

Key Words: DDH, Hip dislocation, Orthosis.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 2**

**Room 1.05**

Abstract Title: **Cost Effective Clubfoot Braces For Low-Income Countries: Defining The Need.**

Abstract number: **458**

Authors: **M. Steenbeek, R. Owen**

Presenter: **M. Steenbeek**

### **Introduction**

Annually between 150.000 - 200.000 children are born with clubfoot deformity of which an estimated 80% occur in developing countries. The Ponseti method is an effective method of obtaining correction of deformity, thus preventing disability. Globally it is recognised as the gold standard for clubfoot treatment. The Ponseti method relies on the use of a Foot Abduction Brace (FAB) to ensure a good result and prevent recurrence. The world-wide demand for affordable FAB's is exceeding the supply.

### **Methods**

Data from programs in 20 low-income countries (LIC's) was collected through the Global Clubfoot Initiative (GCI). GCI is a collaboration of 'clubfoot treatment organisations' providing information and training resources as well as collecting data with a focus on LIC's. Annual (2011) treatment data was collected and calculations made as to need for FAB's.

### **Results**

Data from working locations show that availability of FAB's is a barrier to completion of treatment programs and that there is a shortfall in production of FAB's.

### **Discussion**

Clubfoot treatment programs are being implemented in LIC's and dramatically increasing the numbers of children enrolled. FAB manufacture is not keeping up with demand and needs to be scaled up. Appropriate low-cost FAB's are not yet commonly produced in orthopaedic workshops in LIC's. Orthotic technologists need to support the production of FAB's and provide quality control. Mass production and outsourcing Methods need to be developed.

### **Conclusions**

There is an unmet need for clubfoot FAB manufacture and delivery in LIC's. A standardized module for FAB design and production needs to be included in the curriculum of Prosthetic and Orthotic training schools. Mass production and outsourcing could be a logical and workable solution.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 3**

**Room 1.06**

Abstract Title: **Factors Related To Overuse Syndromes In Subjects Following Upper Limb Amputation**

Abstract number: **129**

Authors: **H. Burger**

Presenter: **H. Burger**

### **Introduction**

The first article on long-term effects of limb amputation was published already in 1978. However, only three other articles on the same topic have been published since, all using postal questionnaires. Only one of them explored the influence of prosthesis use on frequency of overuse syndromes. The aim of our study was to find out the frequency of overuse syndromes in subjects following upper limb amputation, their severity and factors related to them.

### **Methods**

All subjects who visited our outpatient clinic for upper limb prosthetics in 2011 and had no other injury that may cause the same symptoms were included into study. We performed a structured interview and clinical examination.

### **Results**

Forty-two subjects (33 men) were assessed. They had been amputated 4-75 years before (40 on average) and were 61 years old on average at the time of the study. Among them, 52% had shoulder pain, 52% carpal tunnel syndrome, 33% neck pain and 21% elbow pain. The longer the time since amputation, the more frequent was shoulder pain on the non-amputated side. Subjects who used their prosthesis more hours per day had neck and shoulder pain significantly less frequently. Daily use of prosthesis was marginally significantly associated with carpal tunnel syndrome.

### **Discussion**

Like the previous studies, we found that overuse syndromes are frequent in subjects following upper limb amputation. Unlike &#216;stlie (Arch Phys Med Rehabil 2011;92:1967-73), we found that the use of prosthesis may be important for decreasing their frequency.

### **Conclusion**

Overuse syndromes are frequent in subjects following upper limb amputation; some are less frequent in subjects who use their prosthesis more hours daily.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 3**

**Room 1.06**

Abstract Title: **The Roehampton Experience Of Transfemoral Bone Anchored Prosthetic Rehabilitation**

Abstract number: **349**

Authors: **S. Sooriakumaran, M. Uden, J. Sullivan, D. Ward, K. Robinson**

Presenter: **S. Sooriakumaran**

### **Introduction**

Branemark method of bone anchored prosthetic rehabilitation was carried out as a Department of Health funded ethically approved research study. 18 volunteers underwent surgery and rehabilitation according to the Branemark protocol of Osseointegration for Prosthetic Rehabilitation for Amputees (OPRA).

### **Methods**

Suitable patients who have been unsuccessful using conventional socket prostheses were selected. Following the two-stage surgery and gradual loading programme the definitive prosthesis was fitted with a fail-safe mechanism.

### **Results**

The study group was made of 15 males and 3 females all traumatic amputees of age range 21 to 49 years. The system has been in use for a cumulative period of 125 years. Of the 18 volunteers 11 are heavy users, 4 are light users and 3 have had the system removed. One light user has died from an unrelated cause. The incidence of superficial penetration site infection is about 70% and implant related osteomyelitis 33%. The heavy users have warranted abutment and retention screw replacements.

### **Discussion**

Socket related problems are common especially in active transfemoral amputees with short residual limb. Bone anchored prosthesis has enabled this active group of amputees to achieve regular functional level of walking.

### **Conclusions:**

The process of two-stage surgery, protracted course of rehabilitation and regular follow up requires careful patient selection. The successful patients have achieved a high level of prosthetic mobility and overall rehabilitation. A high incidence of infection and mechanical failure of components of the system remain to be addressed. The use of high tensile alloy components and upgraded fail-safe mechanism would be expected to reduce the incidence of mechanical complications.



Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 3**

**Room 1.06**

Abstract Title: **Comparison Of Co-Morbidities In A Lower Limb Amputee Population Nine Years Apart.**

Abstract number: **380**

Authors: **N. Ryall**

Presenter: N. Ryall

### **Introduction**

The National Rehabilitation Hospital, Dublin, is the national centre for amputee rehabilitation in Ireland. Rehabilitation is inpatient-based, consultant-led, multidisciplinary, and CARF-accredited. The patient population is predominantly vascular in aetiology. The aim of this study was to quantify the changes in co-morbidities noted in a lower limb amputee population nine years apart.

### **Methods**

A chart review was undertaken of all patients who were referred for and attended for primary amputee rehabilitation in 2002 and in 2011. Demographic data on level of amputation/s, age, co-morbidities and mobility outcome (SIGAM scale) were gathered. Statistical analysis was undertaken.

### **Results**

115 patients were referred and treated in 2002 compared with 100 in 2011. Patients were on average 64 years in 2002 compared with 66 years in 2011. Total number of co-morbidities rose from 164 in 2001 to 342 in 2011; total impairments from 106 to 176. Obesity occurred in 1% in 2002 compared with 12% in 2011 ( $p < 0.001$ ); cognitive impairment was documented in 9% in 2002 and 22% in 2011 ( $p < 0.001$ ). Additional musculoskeletal impairments were found in 20% in 2002 and 45% in 2002 ( $p < 0.001$ ). Results on mobility grades are not yet finalised for all patients referred in 2011 as some are still completing rehabilitation, but the trend is towards lower mobility levels.

### **Discussion**

There has been a significant increase in major co-morbidities in lower limb amputees over a nine-year period, reflecting general population trends in obesity and co-morbidities of an aging population. Such co-morbidities act synergistically to increase impairment level. These markers of increasing clinical complexity significantly impact on planning, resourcing and delivering prosthetic rehabilitation, as well potentially on prosthetic product development.

### **Conclusions**

A statistically significant trend in increasing amputee patient co-morbid complexity has been found over a nine-year period from 2002-2011.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 3**

**Room 1.06**

Abstract Title: **Effect Of Intensive Rehabilitation On Functional Outcome After Single Event Multilevel Surgery In Cerebral Palsy**

Abstract number: **405**

Authors: **D. Sharan, A. Sasidharan, M. Kumar**

Presenter: **D. Sharan**

### **Introduction**

The functional Results of Single Event Multilevel Surgery (SEMLS) for Cerebral Palsy are closely dependent on the quality of post surgical rehabilitation. The aim of the study was to find out the effect of intensity, type and sequence of postsurgical rehabilitation on the functional outcome of multilevel surgery for cerebral palsy.

### **Methods**

This was a case control study with 20 subjects with mean age of  $8\pm 2.89$  years were enrolled in the study group, while 21 subjects with mean age of  $9.57\pm 3$  years constituted the control group. All the subjects received same surgical procedures by a single Orthopedic Surgeon, which included Orthopedic Selective Spasticity Control Surgery and simultaneous restoration of lever arm dysfunctions. The study group received protocol based, sequenced multidisciplinary rehabilitation for an average of 3 hours per day. The control group received conventional physiotherapy for an average of 45 minutes per day. The chief outcome measures used in the study were Manual Ability Classification System (MACS) and Functional Mobility Scale Version 2 (FMS), before the surgery and at the last follow up after 2 years.

### **Results & Discussion**

There were no significant differences between the two groups before the start of rehabilitation: GMFCS ( $t=0.91$ ,  $p>0.05$ ), FMS ( $t=0.019$ ,  $p>0.05$ ), MACS ( $p>0.05$ ). The Results revealed significant functional improvement among both the groups after the rehabilitation: GMFCS (study:  $t=4.29$ ,  $p<0.001$ ; control:  $t=2.17$ ,  $p<0.02$ ), FMS (study:  $t=4.29$ ,  $p<0.001$ ; control:  $t=3.44$ ,  $p<0.001$ ), MACS (study:  $p<0.001$ ; control:  $p<0.001$ ). While the GMFCS level of study group had improved significantly compared to the control group after rehabilitation ( $t=2.88$ ,  $p<0.001$ ), the improvements in FMS and MACS were not statistically significant.

### **Conclusion**

The study recommended a structured intensive and sequenced rehabilitation protocol for greater gross motor functional improvement after SEMLS for cerebral palsy.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 3**

**Room 1.06**

Abstract Title: **The Role Of Neural Prostheses In Rehabilitation Of Patients With Disability**

Abstract number: **327**

Authors: **M. Sayyadfar, E. Sarhadi, M. Arazpoor**

Presenter: **M. Sayyadfar**

**Background and aim:**

neural prostheses are new generation of prostheses in rehabilitation field in amputee patients. So the awareness and related surveys is not widely available. The aim of this study was to evaluate the development and application of neural prostheses and to utilize this prostheses role in disability and rehabilitation domain.

### **Methods**

we used rehabilitation, neural engineering, neural prostheses, and spinal cord injury key words in Science Direct, ISI web of knowledge, Google scholar, and PubMed data bases and searched related articles in this field. We screened papers according to inclusion and exclusion criteria and selected them.

### **Results**

the use of neural prostheses has had a significant effect on the improvement of the disabilities living, walking and standing in patients with spinal cord injury, cerebral palsy and MS.

### **Conclusion**

based on the evidence it seems in the coming years neural prostheses can be a good alternative to classical rehabilitation devices, using this kind of prostheses in the rehabilitation caused a best improvement in this area, despite of its great advantages, have limitations that are undeniable. It seems that the high price of neural prostheses is the most important challenge of using these devices on disabled people.

Keywords: neural engineering, neural prosthesis, rehabilitation, spinal cord injury, cerebral palsy

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 1**

**Room G.06**

Abstract Title: **Training For Older People With A Femuramputation. A Study Of Exercise Important For Mobility And Confidence In Coping**

Abstract number: **3**

Authors: **J. Schack, A. Bergland**

Presenter: **J. Schack**

### **Objective**

The primary purpose was to get quantitative, empirical knowledge about individual changes in mobility and self-efficacy in a period of six months for older persons who had a transfemoral amputation of vascular reasons and participated in four weeks of training. The second purpose was to evaluate, through qualitative interviews, whether and how the participant's experiences of the training supported or supplemented the quantitative Results. Method Partially mixed sequential dominant status design. An AB-single Subject Experimental Design with multiple nonconcurrent baseline and follow-up was used to get quantitative data, and qualitative interviews were used to explore the participants' experiences six months after the treatment. Four persons were included. One person withdraw. Outcome measure: ABC-scale, 10 meters walk test, 2 minutes test and the L-test. Intervention: The participants received individual training three times weekly. The training was based on "motor learning based mobility training principles" with focus on balance- and walking training.

### **Results**

The **Results** from this study showed improved mobility and self-efficacy after four weeks of training and at the follow-up. The mean improvement in the follow up period was still better than during the baseline period although deterioration was seen. The participants reported different experiences, both positive and negative, of the training period. Mastery experiences and the social support from a therapist were reported to be important. Some of the participants reported improved function in activities of daily living and reduced anxiety. All the participants reported that the prosthetic had great influence on performance and not everyone had a desire for a change in mobility.

**Conclusion** This study indicates that four weeks of individual training has the potential to improve mobility and self-efficacy for older persons with a transfemoral amputation. The study seems to show that mobility and self-efficacy are complex constructs and many factors might influence these constructs.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 1**

**Room G.06**

Abstract Title: **Gross Mechanical Efficiency (Ge) And Physical Strain Of The Combined Arm-Leg (Cruiser) Ergometer In Healthy Subjects**

Abstract number: **72**

Authors: **E. Simmelink, I. Borgesius, R. Dekker, L. Van Der Woude**

Presenter: **R. Dekker**

## **Introduction**

The combined arm-leg Cruiser ergometer is assumed to be a relevant testing and training instrument in the rehabilitation of patients with a lower limb amputation. Gross mechanical efficiency (GE) and physical strain have not yet been systematically established in this form of combined arm-leg exercise compared with other common rehabilitation exercise modes. The purpose of this research is to determine GE and physical strain during steady state submaximal Cruiser exercise in comparison to cycling ergometry and handcycling under similar conditions of external power output.

## **Methods**

10 Healthy men ( $n=10; 24 \pm 1.8$  yrs;  $79 \pm 10.5$  kg) and 12 healthy women ( $n=12; 22.1 \pm 2.4; 65.8 \pm 10.2$  kg) enrolled in 4 submaximal steady state exercise tests on respectively a Cruiser ergometer, a bicycle ergometer, a handbike on a motor driven treadmill and again a Cruiser ergometer. All subjects performed seven 3 min bouts (Power Output (PO) = 20, 25, 30, 35, 40, 45, 20W) at 50rpm. Oxygen uptake, energy cost, ventilation, breathing frequency, heart rate and RPE were monitored. GE was determined from PO and energy cost.

## **Results**

GE of the Cruiser (45W; men:  $13.0 \pm 1.3\%$ , woman:  $15.0 \pm 3.1\%$ ) was not significantly different from cycling (45W; men:  $13.2 \pm 1.9\%$ , women:  $14.6 \pm 1.9\%$ ), yet both were significantly higher than in handcycling (45W: men:  $11.2 \pm 0.8\%$ , women:  $12.2 \pm 2.1\%$ ;  $p < 0.05$ ). A comparable strain was found between Cruiser and bicycle test, but a significantly higher strain for handcycling ( $p < 0.05$ ). Apart from RPE, the repeated Cruiser tests did not show significant differences.

## **Discussion**

In this study in terms of GE there is no significant difference between the bicycle and the Cruiser ergometer at a submaximal level of power output in healthy young subjects. This makes the Cruiser ergometer a very interesting device to use in exercise testing and training in patients with a lower limb amputation.

## **Conclusion**

Cruiser exercise at a submaximal level is comparable in GE and physical strain to leg cycling in healthy subjects.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 1**

**Room G.06**

Abstract Title: **Long-Term Step Activity In Persons With Transfemoral Amputation**

Abstract number: **221**

Authors: **E. Halsne, M. Waddingham, B. Hafner**

Presenter: **B. Hafner**

### **Introduction**

Physical limitations associated with transfemoral amputation (TFA) are often studied in laboratory settings, but little is known about how these limitations extend into the free-living environment. Self-report measures are commonly used to solicit information about participation in life activities. However, surveys alone may be insufficient to assess specific restrictions experienced by those in this population. The purpose of this study was to objectively characterize the mobility dimension of participation of persons with TFA using long-term step activity data and to compare this data to healthy, non-amputees.

### **Methods**

Twelve months of daily step activity were recorded for 17 adults with unilateral TFA. An accelerometer-based monitor collected step activity data on the prosthetic side. Retrospective analysis was conducted to determine mean activity levels and to compare activity between subjects of different Medicare Functional Classification Levels (MFCL).

### **Results**

Subjects averaged 1540 prosthetic steps/day and activity generally increased with MFCL. Activity levels between MFCL-2 and MFCL-3 subjects were not significantly different, but MFCL-4 subjects were significantly different than those classified as MFCL-3 ( $p=0.027$ ) or MFCL-2 ( $p=0.008$ ).

### **Discussion**

Review of TFA step activity revealed restrictions in excess of the 2108-3063 steps/day described in the literature. Average daily levels measured in this study were also substantially lower than the 3500-7500 and 3000-4250 single-limb steps reported for healthy younger and older adults, respectively. MFCL-2 and MFCL-3 subjects were not differentiated as expected, based on their clinical classifications.

### **Conclusion**

Direct measurement of long-term activity complements information derived from self-report instruments to inform the mobility aspect of participation. However, further investigation into long-term performance of the TFA population in the free-living environment is needed to better understand the functional deficits and related participation restrictions experienced by these individuals.

Date / Time: **Tuesday, Feb 5 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 1**

**Room G.06**

Abstract Title: **The Comprehensive High-Level Activity Mobility Predictor (Champ) A Measure Of Higher Level Prosthetic Performance In Service Members With Traumatic Lower Limb Loss**

Abstract number: **351**

Authors: **R. Gailey, I. Gaunaurd, C. Scoville, M. Raya, A. Linberg, K. Roach, S. Campbell**

Presenter: **R. Gailey**

### **Introduction**

Prior to the development of the Comprehensive High-level Activity Mobility Predictor (CHAMP) there was no measure of higher level prosthetic performance. The CHAMP was developed to be safely performed by all unilateral and bilateral lower limb amputees who had achieved a minimum level of prosthetic performance during rehabilitation. This study examined the construct validity and responsiveness of a new performance-based assessment instrument called the CHAMP as a measure of high-level mobility in Service Members (SMs) with traumatic lower limb loss.

### **Methods**

One-hundred eighteen SMs completed the study. Convergent construct validity of the CHAMP was established using the Six-Minute Walk Test (6MWT) as a measure of overall mobility and physical function.

### **Results**

The known group Methods construct validity examined disparities in high-level mobility capability among SMs with different levels of lower limb amputation. The CHAMP score demonstrated a strong positive relationship between 6MWT distance ( $r = 0.80$ ,  $p < 0.001$ ). Significant differences were found in CHAMP score between SMs with different levels of lower limb loss. The MDC for the total CHAMP score was 3.74 points.

### **Discussion**

Because the CHAMP measures speed, power and agility in all directions of movement it has the ability to assist clinicians in determining changes in high-level mobility occur during rehabilitation and has the ability to objectively measure when and how progress is being made by prosthetic users.

### **Conclusion**

Study findings support the CHAMP as valid and responsive performance-based assessment instrument of high-level mobility for males with traumatic lower limb loss.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Paediatrics - 2**

**Room 1.01**

Abstract Title: **A Novel Concept Of Correction Of Ctev By Serial Afo'S Using Ponseti Methodology**

Abstract number: **286**

Authors: **M. Choudhary, N. Singh**

Presenter: **N. Singh**

### **Introduction**

CTEV is a common congenital deformity. Conservative treatment by serial manipulation and casting instituted early in life yields better Results and avoids the need for surgical intervention. The present study aims at using customized ankle foot orthosis on CTEV foot in varying stages of correction based on ponseti's principle of sequential deformity correction and following sequence as abduction, eversion and equinus correction.

### **Method**

Study on five children aged below nine months with supple feet with idiopathic CTEV was done. CTEV scoring done by Pirani method of scoring. Serial AFO were given and changed at every ten days until the equinus deformity persisted after which tenotomy was performed and AFO given for three weeks in corrected position. At each of the visits Pirani scoring was done to assess improvement.

### **Result**

Study follow up awaited.

### **Discussion**

Study follow up awaited.

### **Conclusion**

Study follow up awaited.



Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Paediatrics - 2**

**Room 1.01**

Abstract Title: **Biomechanical Analysis Of Plantar Loading Pattern When Walking With Foot Orthoses For Juvenile Hallux Valgus**

Abstract number: **502**

Authors: **S. Law, W. Chan, S. Au, T. Lui**

Presenter: **S. Law**

### **Introduction**

Juvenile hallux valgus (HV) deformity occurs in the developing foot of teenagers and young children. Non-surgical treatment is always the first option for a patient who has HV deformity. Therefore, a research to evaluate the biomechanics of HV with different orthoses has been launched.

### **Methodology**

Twenty subjects (sixteen female), mean age of 14yrs (range 12yrs-16yrs), with HVA of 22o (range 16o-25o) and 1-2 IMA of 12 o (range 7o-16o) were recruited. Loading pattern over foot plantar surface was evaluated when walking with toe spreader (TS), dynamic HV strap (DHVS), & forefoot binder (FFB) for juvenile HV using Tekscan F-mat sensor.

### **Results and Discussion**

TS or DHVS has been used to adduct the big toe transversely to maintain a better alignment at the first MTPJ. With orthoses, although the big toe was positioned in a lesser deformed position, the dynamic foot loading pattern was shown to be no significant change. During the 'before heel-lift period', lower force loading at the 1st MTH was shown when wearing DHVS. It may suggest DHVS is more effective in 1st MTH region pain relief compare with TS, especially when symptom appear during 'before heel-lift period'. During the 'after heel-lift period', higher force loading at the big toe was shown when wearing DHVS. It may suggest DHVS allow the big toe to act with a higher demand of force after heel-lift. Based on the assumption of better aligned big toe at the 1st MTPJ using orthoses, the increased force loading at the big toe may suggest an augmented function of the 1st ray structure of the foot during walking.

### **Acknowledgment**

I would like to thank you for the generous support from the Hong Kong Orthopaedic Association Research Grant 2009

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Paediatrics - 2**

**Room 1.01**

Abstract Title: **Orthotic Variance In The Conservative Management Of Congenital Talipes Equinovarus Ctev:**

**A Literature Review.**

Abstract number: **265**

Authors: **E. Figgins, K. Thomson, R. Bowers**

Presenter: **R. Bowers**

### **Introduction**

Congenital Talipes Equinovarus (CTEV) affects 1 in every 1000 births. The aetiology is still unknown although there are many theories. Methodology: A critical review of the literature was undertaken of the conservative management of Congenital Talipes Equinovarus. This study evaluated the recent advances, from the year 2000 onwards. Correction of CTEV can be achieved through various Methods such as the Ponseti and French Functional Methods. Numerous databases were searched and specific boolean terms used.

### **Results**

Thirty-seven papers were then evaluated and graded according to SIGN guidelines. Evidence examined showed more favoured Results for the Ponseti method with faster treatment time and improved Results at both short term and long term follow up. Orthotic management showed varying Results. Most of the papers reviewed used different orthoses. Some authors found good Results with Dennis Browne boots and bars, while others found good Results with AFOs or KAFOs.

### **Discussion**

From the critical evaluation of the papers it is clear that there no consensus. No new Conclusions can be drawn from the literature review on how Congenital Talipes Equinovarus should be managed orthotically following the Ponseti method.

### **Conclusions**

Rotational control is vital as improved Results were seen when rotation was controlled by the use of either an abduction bar or by a KAFO. The KAFO extended above the knee and controlled rotation from there. All the papers highlighted that there were still issues with compliance with regards to orthotic management and this remains an area which requires further work and investigation.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 7**

**Room 1.02**

Abstract Title: **Arm Forces During Assisted Sit-To-Stand And Stand-To-Sit Activities In Unilateral Lower-Limb Amputees**

Abstract number: **197**

Authors: **M. Stalin, V. Agrawal, C. O'Toole, R. Gailey , R. Gailey, I. Gaunaurd**

Presenter: **M. Stalin**

### **Introduction**

Sit-to-stand and Stand-to-sit are important activities of daily living and are performed 43-56 times per day by amputees. Few studies have investigated the biomechanics of these activities in unilateral lower limb amputees. While the asymmetrical weight distribution between the intact and prosthetic limbs is well established, the role of arms in supporting body weight during arm-rest assisted rising and sitting has not been investigated.

### **Methods**

10 unilateral Trans-femoral (TFAs), 12 unilateral Trans-tibial Amputees (TTAs) and 12 controls participated in the study. Subjects performed arm-rest assisted sit-to-stand and stand-to-sit activities on a standard height chair in response to a verbal command. A custom-built Matscan system was used to collect the vertical Ground Reaction Forces (GRFs) from the chair and feet at a sampling frequency of 50Hz. Force on arms and feet were determined at the seat-off and seat-contact event for sit-to-stand and stand-to-sit activities respectively. Symmetry indices (SI) between the amputated/non-dominant and intact/dominant legs as well as arms on the amputated and intact sides were calculated.

### **Results**

For sit-to-stand, the SI between the lower limbs were: TFAs&#8594;36.8%; TTAs&#8594;71.4%; Controls&#8594;94.5%; and between upper limbs were: TFAs&#8594;83.7%; TTAs&#8594;92%; Controls&#8594;95%. For stand-to-sit, the SI between the lower limbs were: TFAs&#8594;48.5%; TTAs&#8594;69.3%; Controls&#8594;93.4%; and between upper limbs were: TFAs&#8594;93%; TTAs&#8594;89.9%; Controls&#8594;91.7%.

### **Discussion**

Amputees supported more weight on the arms than the legs during sit-to-stand, compared to the controls. In amputees, the greater weight on intact leg is concurrent with the greater weight on the arm of the prosthetic side. During stand-to-sit, there were no differences in arm SIs between amputees and controls.

### **Conclusion**

Amputees with limited arm strength may experience difficulty in performing the sit-to-stand activity. High force on arms may result in secondary co-morbidities in the upper limb joints. Training techniques to reduce asymmetry in both lower and upper limbs should be developed.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 7**

**Room 1.02**

Abstract Title: **An Indigenious Design Of Shoulder Disarticulation Prosthesis.**

Abstract number: **237**

Authors: **N. Ojha, S. Sahu**

Presenter: **N. Ojha**

### **Introduction**

The main function of upper limb is to set

1. Reach
2. Manipulation
3. Prehension activities

Therefore reaching activities are driven by proximal joints like elbow and shoulder. Hence no reaching, manipulation and prehension activities are possible in case of shoulder disarticulation amputee. The development of simple functional shoulder disarticulation prosthesis with shoulder cap and modified harness and peroneal operated lever for shoulder, elbow and terminal device is quite amazing.

### **Methods**

The multi lever mechanism, forming an amplifying unit which is responsible for functional oscillation of arm and forearm with driving of terminal device.

### **Results**

Control cable system and chest strap is attached as per general principle, peroneal strap terminated with dog hook through a cable and attached with posterior lever of shoulder joint. By scapular elevation, the posterior lever pulled downward resulting arm flexion. Cable attached to control attachment strap displaced resulting in forearm flexion and sound side shoulder flexion will be sources to operate the elbow lock and unlock for operation of terminal device.

### **Discussion**

The design consists of shoulder cap. The shoulder joint and its extension lever joined with arm unit below the shoulder joint and it is extended posteriorly, connected with peroneal strap through a cable. The lower end of the arm, upright is attached with elbow joint as per requirement. The prosthesis is suspended with basic shoulder harness and dual control cable system and modified figure '9' harness is attached to cable of the elbow lock and unlock. This shoulder disarticulation prosthesis is operated through body power sources on the principle of shoulder driven tenodesis orthosis.

### **Conclusion**

This is a versatile simple endoskeletal design shoulder driven functional prosthesis, it restores more comfort and function and provides more freedom of movement which brings jubilant smile on the face.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 7**

**Room 1.02**

Abstract Title: **Effects Of The Hypobaric Iceross Seal-In® X-5 Membrane On Prosthetic Suspension And Quality Of Life: Comparison With The Standard Suction Socket System.**

Abstract number: **453**

Authors: **S. Brunelli, A. Delussu, F. Paradisi, R. Pellegrini, D. Zenardi, Á. Lúdvíksdóttir, D. Roberto, M. Trallesi**

Presenter: **A. Ludviksdottir**

## **Introduction**

The study aimed at evaluating the influence of a hypobaric Iceross Seal-In® X-5 Membrane (HIS) on pistoning and quality of life compared to the standard suction socket (SSS) in unilateral transtibial amputees (TTA).

## **Methods**

Main inclusion criteria: a) unilateral TTA, b) SSS prosthesis user for at least 18 months, c) a K level 3-4. The Pistoning test (PT) was used to compare vertical movement of the stump within the socket. We used the Gholizadeh's approach (2011). The PTs were carried out when TTAs were wearing their SSS, and after 2, 5 and 7 weeks of HIS use. Prosthesis Evaluation Questionnaire (PEQ) was administered at the beginning and at the end of the study.

## **Results**

Ten TTAs male (age 44,9±9,5) were recruited. They had been using a SSS continuously for at least 6 h/day. The PT mean vertical displacement changing from full weight bearing on the prosthetic limb to non-weight bearing was 7.5±4.7mm with SSS, and 4.7±3.1, 4.6±2.9, 3.6±3.1mm with HIS after 2, 5 and 7 weeks of HIS use respectively. The difference between the SSS and the last HIS PT was statistically significant ( $p=0.016$ ). Adding 30 N to the prosthesis, the mean vertical displacement increased to 12.4±5.6mm with SSS, and 6.7±4.1, 6.1±3.1, 5.6±3.1mm with HIS after 2, 5 and 7 weeks of its use, showing a significant reduction in the three evaluations with HIS ( $p=0.025$ ,  $p=0.010$ ,  $p=0.006$  respectively). A significant improvement in the PEQ domains "Appearance", "Ambulation" and "Well being" were registered with HIS use.

## **Discussion**

Reliable socket suspension is the key to control over the prosthesis and important for socket comfort. The reduction of pistoning movements provided by HIS use, seems to be associated with an improvement in the quality of life as reported by users.

## **Conclusion**

HIS use determined an improvement in prosthesis comfort compared to SSS.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 7**

**Room 1.02**

Abstract Title: **A Prosthesis Design Platform Centred On Digital Amputee**

Abstract number: **277**

Authors: **C. Rizzi, G. Colombo, G. Facoetti**

Presenter: **C. Rizzi**

This paper presents a new design platform for lower limb prosthesis centred on the patient's digital model and based on a fully computer-aided and knowledge-guided approach. The biomechanical model of the amputee is created using a biomechanical simulation tool and enriched with amputee's characteristics (e.g., anthropometric measures). These represent the key elements that guide the new prosthesis development process. The proposed design platform provides the technicians with a set of tools to design, configure and test the prosthesis in a virtual environment. It assists the technicians step by step providing suggestions and rules (e.g., socket shape manipulation). It comprehends two main environments: the Prosthesis Modeling Lab and the Virtual Testing Lab.

The first permits to generate the 3D assembly of the prosthesis, crucial to virtually study prosthesis set-up and patient's walking. It includes the virtual Socket Laboratory to create the 3D socket model through an ad hoc SW module, Named Socket Modelling Assistant, integrated with FE tools to study the limb-socket interaction and a commercial 3D CAD system to configure and assembly the prosthesis. Configuration procedure and electronic sheets have been developed to choose automatically the appropriate components for the amputee and accordingly size them.

The Virtual Testing Lab permits, once created the amputee's avatar wearing the prosthesis, to set up and evaluate prosthesis functionality simulating postures and movements. In collaboration with the technical staff of an orthopaedic laboratory, the platform has been experimented as far as concerns the modelling phase while only preliminary Results have been obtained for the virtual testing lab.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 7**

**Room 1.02**

Abstract Title: **An Interim Analysis Of The Effect Of The Genium Knee On Balance And Stability**

Abstract number: **202**

Authors: **J. Highsmith, R. Miro, D. Lura, L. Mengelkoch, J. Kahle, W. Quillen, R. Dubey**

Presenter: **J. Kahle**

## **Background**

While the C-Leg has Grade-B level evidence supporting its safety efficacy[1] in the transfemoral amputee population, there are still areas for further improvement. This study's purpose was to determine if the new Genium microprocessor knee could improve multi-directional stepping, the limit of stability and patient perception of safety following accommodation.

## **Methods**

This interim analysis presents Results of the first eight subjects in an ongoing clinical trial of 20 subjects. Subjects were male (mean[SD] age: 52y[15.1]) with non-dysvascular etiology and utilized a C-Leg for >1y. At enrollment subjects randomized to either continue C-Leg use or accommodate with a Genium. C-Leg subjects acclimated 2wks with a newly fitted Trias foot. Genium subjects were acclimated to the Trias and Genium prior to testing. Following initial testing, subjects crossed-over to the second condition and acclimated as previously described prior to re-testing.

## **Outcomes**

Four Square Step Test(4SST)[2]. Limit of Stability(LOS) Testing as measured on a Biodex-SD suspended force platform. Prosthesis Evaluation Questionnaire-Addendum(PEQ-A)[3] for mental energy in ambulation, and stumbles and falls. Statistical Analyses: Paired t-tests at an a priori significance level of  $p<0.05$ .

## **Results**

Subjects' mean 4SST times decreased 2sec (15%;  $p<0.05$ ) with Genium use and similarly, the overall LOS score improved by 10% but this difference was not significant. Four of eight directions in the LOS test improved with the Genium; three of these were on the sound side. For the PEQ-A, 9/14 questions showed an improvement with the Genium and of these, 2 reached statistical significance.

## **Conclusion**

Subjectively, TFA's reported an improved safety experience with Genium use which is consistent with objective stability measures including multi-directional stepping and limits of stability testing.

1. Highsmith, M.J., et al. Prosthet Orthot Int, 2010.
2. Dite, W. and V.A. Temple. Arch Phys Med Rehabil, 2002.
3. Hafner, B.J., et al. Arch Phys Med Rehabil, 2007.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 8**

**Room 1.03**

Abstract Title: **Investigation Of In Vivo Prosthesis/Residual Limb Stiffness Using A Novel Impact Test**

### **Apparatus**

Abstract number: **160**

Authors: **E. Boutwell, S. Gard**

Presenter: **S. Gard**

### **Introduction**

Shock-absorbing components are often prescribed in transtibial prostheses to cushion the residual limb from forces transmitted through the prosthesis. However, while subjective data typically indicate increased comfort and preference for these components, quantitative gait analyses have not been able to demonstrate that altering prosthetic stiffness substantially changes the overall limb stiffness in vivo. The purpose of this study is to use a novel technique to provide reliable in vivo estimates of overall limb stiffness as the prosthesis stiffness is systematically varied.

### **Methods**

Subjects with a unilateral transtibial amputation are positioned on a custom impact testing apparatus with their prosthetic limb outstretched, elevated a short distance (9cm), and released in a controlled drop during which the prosthesis contacts a rigidly mounted force platform. This platform measures impact force while a motion-capture system tracks relative limb displacements, enabling overall limb stiffness to be calculated. Prosthetic stiffness is modified with a shock-absorbing pylon. The five stiffness conditions include the manufacturer-recommended stiffness for the subject, and 50%, 75%, 125%, and 150% of this stiffness, administered in randomized order. Variables of interest include peak impact force and overall limb stiffness, both of which are hypothesized to decrease in lower prosthetic stiffness conditions.

### **Results**

Data collection for this study is ongoing. Preliminary data indicate that changing the prosthetic stiffness affects the magnitude of the forces generated during impact. A reduction in the peak impact force of 83.4 N (10.3% body weight) has been observed between the lowest and highest stiffness conditions.

### **Discussion**

Our data indicate that peak force magnitudes decrease during in vivo impact testing as prosthesis stiffness is reduced, a result that has not been demonstrated consistently in previous gait analyses. This finding may indicate that subjects modulate overall limb stiffness during gait in response to changes in prosthetic stiffness.



Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 8**

**Room 1.03**

Abstract Title: **Factors Influencing Rehabilitation Outcome For Lower Limb Amputees At The Red Cross Hospital, Sweden**

Abstract number: **91**

Authors: **L. Gudmundson, H. Sundgren, M. Skubic-Bergqvist**

Presenter: **H. Sundgren**

### **Introduction**

The walking school at the Red Cross Hospital (RCH), Sweden, serves the entire Stockholm County Council, as a specialist center for people with lower limb amputation. Our goal is to enhance the patient's possibilities to develop walking abilities with prosthesis. During 2011 we had approximately 200 treated patients and 2600 visits. The aim of this presentation is to investigate differences in rehabilitation outcome depending on gender, age, cause and level of amputation.

### **Methods**

A total of 31 patients, (23 men and 8 women, mean age=54, 6 years). Inclusion criteria: Lower limb amputees that had undergone a rehabilitation program at the RCH, re-visiting the walking school 2010-2011 to get a new remittance on prosthesis. The rehabilitation outcome has been measured with the Timed up and go test (TUG), Locomotor Capability Index (LCI) and 4 square step test (4SST).

### **Result**

Men had generally better Results than women (LCI mean 51/47 points, TUG mean 9/11 seconds), although women had better Results in 4SST (mean 8/9 seconds). Patients of older age had poorer Results than the younger (LCI mean 44/55). Trauma as amputation cause gave better Results than amputations caused by illness (LCI mean 51/50, TUG mean 8/12, 4SST mean 8/10). Transfemoral amputees performed better than transfemoral amputees (LCI mean 46/52, TUG 14/8 and 4SST 11/8). 97% of the patients are using the prosthesis daily, 84% more than 10 hours/day. 71% are walking without walking aids indoors and outdoors.

### **Discussion**

Men are overrepresented in the subgroup amputation caused by trauma. This subgroup has better Results than amongst patients with amputations caused by illness and may be one explanation to why men generally have better Results than women.

### **Conclusions**

These findings indicate that there are differences in rehabilitation outcome amongst lower limb amputees depending on gender, age, cause and level of amputation.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 8**

**Room 1.03**

Abstract Title: **Prosthetic Use With Transfemoral Osseointegrated Prostheses - Long Term Prospective Results From The Opra-Study**

Abstract number: **108**

Authors: **K. Hagberg, Ö. Berlin, R. Brånemark**

Presenter: **K. Hagberg**

### **Introduction**

Patients with transfemoral amputation (TFA) can today be treated with bone-anchored prostheses. The osseointegration treatment includes two surgeries and rehabilitation. The prospective OPRA-study aim to report outcome on patients with TFA treated in Sweden. It includes 51 patients (55% male, 45% female, mean age 44.2 years, amputation cause 65% trauma, 23% tumor, 12% other) treated with 55 implants (4 treated bilaterally). Patients were included between year 1999-2007. The aim is to report long term outcome on prosthetic use from the OPRA-study.

### **Methods**

Patients answered the Questionnaire for individuals with Transfemoral Amputation (Q-TFA) preoperatively (baseline) and 1, 2, 3, 5, 7 and 10 years postoperatively. The Q-TFA Prosthetic Use score (0-100) is the primary efficacy variable. A score of 0 means the prosthesis is not used any day/week and 100 means it is used 7 days/week during >15 hours/day. A Prosthetic Use score of =90 is considered very high.

### **Results**

The baseline Prosthetic Use score was Md 52 (n=51). At baseline 20% did not use a prosthesis at all and 33% reported a score =90. At 2-years six patients were lost to follow-up: 3 implant removed, 1 deceased, 1 withdrawn due to other disability, 1 lost to follow-up. At 3-years 1 more implant had been removed and 1 more patient deceased. The Prosthetic Use score at each follow up was Md 90 (n=45), 90 (n=45), 90 (n=40), 95 (n=34), 100 (n=22) and 95 (n=10) at 1, 2, 3, 5, 7 and 10 years respectively.

### **Discussion**

The study is ongoing and reported Results include data until april 2012. The Prosthetic Use score gives no information on prosthetic mobility or problems. Such data is also assessed and will be reported in the future.

### **Conclusions**

Patients treated with osseointegrated transfemoral prostheses report high prosthetic use up to 10 years after treatment.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 8**

**Room 1.03**

Abstract Title: **Documenting The Rehabilitation Process Of Patients With Lower Limb Prosthesis**

Abstract number: **509**

Authors: **J. Block, D. Heitzmann, S. Wolf**

Presenter: **D. Heitzmann**

### **Introduction**

Patients following an amputation usually try to get back to walking. Different professions are involved in this process. Several tools are available to monitor the rehab process. But not all tests are practical for every patient at every stage of the rehab process. In this study the rehab progress was monitored and patients passed different tests, which were selected according to their current capabilities.

### **Methods**

7 subjects with lower limb amputations were measured in this ongoing study (1 TT; 3 TF; 3 HipEx). Patients spent min. two weeks near the hospital. In parallel their prosthesis was fitted, different prosthetic components tested, adjusted and they attend gait education and/or physical therapy. Patients were asked to write a diary, documenting their perception and activities. The LCI was asked at the beginning and end of the rehab. Depending on their abilities they performed the 2min-walk-test, level walking, stairs, slopes and outside terrain with video analysis. Kinematics and kinetics (when walking without aids) was captured via 3D-gait-analysis-system. Static adjustment was documented with a LASAR posture device.

### **Results**

Available tests can be grouped by min. required patient capabilities. Time distance parameters and left/right symmetry are indices showing how the user gets familiar to prosthetic walking. A diary illustrates the learning process from the patient side and is a helpful feedback for the professionals.

### **Discussion**

Measurements at the beginning and end of the treatment are sufficient to document an improvement, but subjects are often unable to perform the same tests at early and later stage in training.

### **Conclusions**

Performing standardized tests at defined points in the rehab helps to document the process. It's difficult to detect effects of single interventions. The outcome is affected by the socket design, prosthetic parts, adjustments as well as physiological and mental capabilities.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 8**

**Room 1.03**

Abstract Title: **Malawian Prosthetic And Orthotic Users' Performance And Satisfaction With Their Lower Limb Assistive Device**

Abstract number: **115**

Authors: **L. Magnusson, G. Ahlström, N. Ramstrand, E. Fransson**

Presenter: **L. Magnusson**

### **Introduction**

This study aimed to investigate patients' performance and satisfaction with their lower limb prosthetic or orthotic device and their satisfaction with prosthetic and orthotic service delivery in Malawi.

### **Method**

Eighty-three patients participated in the study. Questionnaires were used to collect self-reported data.

### **Result**

Ninety per cent of prosthetic and orthotic devices were in use. Patients were quite satisfied with their device (mean score of 3.9 out of 5) and very satisfied with the service provided (mean score of 4.4 out of 5). The majority of patients were able to move around the home (80%), rise from a chair (77%), walk on uneven ground (59%) and travel by bus or car (56%). Patients had difficulties or could not walk at all on; stairs (60%) and hills (79%). Thirty-nine percent reported pain when using the assistive device. Forty-eight percent of the devices were in use but needed repairs and 10 % were never used or completely broken. Access to repairs and servicing were rated by patients as most important, followed by durability of the device and follow up services. Lack of finances to pay for transport was a common barrier to accessing the prosthetic and orthotic centre.

### **Discussion**

Prosthetic and orthotic devices can be further improved in order to accommodate for ambulation on uneven surfaces, hills and stairs, as well as increasing patients' ability to walk long distances with reduced pain.

### **Conclusion**

Patients were satisfied with the device and service received and the majority of prosthetic and orthotic patients in this study reported increased mobility when using their assistive devices. However, patients reported pain associated with use of the device and difficulties were experienced when walking in hills and on stairs. Costs associated with transport to the prosthetic and orthotic facility prevented them from receiving follow-up and repair services.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 3**

**Room 1.05**

Abstract Title: **The Use Of Multiple Sensors In The Control Of Prosthetic Arms**

Abstract number: **110**

Authors: **P. Kyberd, A. Poulton**

Presenter: **P. Kyberd**

### **Introduction**

Humans control their body by integrating sensory inputs to create knowledge of the body's disposition. When a person is using a prosthetic limb, some of these modalities may be absent, but many more are hard to integrate into the control of their prosthesis. An example is the ability to maintain the hand orientation while the body position changes as the person gets up from a chair or reaches forward. This is simple with an intact arm, but when there is a loss above the elbow, the ability to correct the change in angle of the forearm as the arm reaches forward, is challenging. If additional sensors are added to the arm then this task can be devolved to the electronic controller.

### **Method**

The second generation ToMPAW arm, contains microcontrollers that can take integrate additional inputs from accelerometers in the arm. While this idea was put forward in the 1980s, it is only with the advances in electronics, that these ideas can be pursued. The hand, elbow and wrist are controlled sequentially, switched from the shoulder harness. When the hand instructed to hold an object, the rest of the arm is informed and the orientation of the wrist and forearm be maintained relative to gravity. If the user switches control to the elbow or wrist they can override the position and change it.

### **Results**

The arm has been prepared for the single subject who was a long term user of the and advanced arm. The velocity of the correction motions has been reduced so that the arm does not over react to small changes in attitude, but steady co-ordinated movements can be corrected for, until the wrist or elbow reaches their range limits.

### **Conclusion**

Microprocessor controllers and cheap sensor technology can be combined to give prosthetic arms more autonomy.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 3**

**Room 1.05**

Abstract Title: **Searching For Optimal Channel Configuration And Number In Multichannel Myoelectric Prosthesis Control**

Abstract number: **138**

Authors: **D. Boere, H. Witteveen, H. Hermens, J. Rietman**

Presenter: **D. Boere**

## **Introduction**

A higher number of intuitively controllable functions in myoelectric forearm prostheses might be obtained using pattern recognition and multichannel configuration. However, it is unknown what configuration is optimal. We tested dependency of channel configuration and number on the performance of an eight-motion classifier.

## **Methods**

EMG signals of 8 wrist and hand motions from 10 able-bodied subjects were collected using a grid of 4x10 monopolar electrodes. Three approaches were applied: 1) forming channel-subsets (varying length of 1 to 12) by selecting channel pairs corresponding to six specific muscle regions; 2) a sequential forward selection algorithm, which starts with an empty subset and successively adds the channel that yields maximum increase of the classification performance, until performance does not improve anymore; 3) selection of circumferential arrays, using all (10) and every other channel (5) in a circumference of the grid as channel-subsets. Using RMS over 150ms-signals of each selected electrode, nearest neighbor classifiers were trained and tested. Classifier performances were calculated for both average reference (AR) and bipolar (BP) derivation for all approaches.

## **Results**

For the muscle-specific configuration, optimal result was obtained with 5 BP-channels: 97.6% accuracy. For the selection algorithm, optimal result was obtained with 6 AR-channels: 97.5%. The circumferential selection of 10 AR-channels gave 98.2% and 5 BP-channels 96.17%.

## **Discussion**

Increasing channel number up to 4 improved performances substantially for all configuration approaches. After that, performances increased minimally. Although a BP 5-channel muscle-specific configuration seems to be the optimal number and configuration, it requires 10 electrodes on the forearm. In this respect, an AR 10-channel circumference configuration might also be optimal.

## **Conclusion**

For this set of contractions, no substantial differences in classifier performance were found for the different approaches and derivations when using 5 or 6 channels. The circumferential array is the most practical way of positioning electrodes.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 3**

**Room 1.05**

Abstract Title: **Functional Comparison Of Voluntary Opening And Voluntary Closing Body-Powered Prostheses**

Abstract number: **249**

Authors: **J. Sensinger, S. Cohick**

Presenter: **J. Sensinger**

### **Introduction**

Body-powered devices use one of two types of prehensors. Voluntary opening (VO) prehensors require the user to pull on the cable to open the device but can then relax, allowing the rubber bands on the device to provide the grasp force. This method is easy to use but limits the grasp force to that of the rubber bands. Voluntary closing (VC) devices require the user to pull on the cable to close the device in a grasp, thus giving the user more pinch force and control. However, VC prehensors typically require continued user-generated force to maintain the grasp. This study had two goals: First, to compare the objective function of VO and VC devices across a range of grasp patterns and activities of daily living. Second, to analyze if a new type of device that could switch between the VO and VC modes would improve function.

### **Methods**

Three able-bodied subjects wearing a bypass transradial prosthesis performed the Southampton Hand Assessment Protocol (SHAP) using a Hosmer 555 VO device and an APRL VC device.

### **Results**

The average index of functionality was 43.3 for the VO device, 36.7 for the VC device, and 51 if the best device for each task was used.

### **Discussion**

All three subjects performed more quickly with the VO device for certain tasks (light and heavy extension grip tasks and screwdriver task), whereas they performed more quickly with the VC device for others (e.g. heavy lateral grip, coin moving). This is consistent with the questionnaire responses. We will present data at ISPO on 25 able-bodied subjects and many transradial amputees.

### **Conclusion**

The most efficient way to complete all of the tasks in a SHAP test would be to use a device that could switch between VO for some of the tasks and VC for others.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 3**

**Room 1.05**

Abstract Title: **Type Of Feedback While Learning To Control Force With A Myoelectric Prosthesis.**

Abstract number: **143**

Authors: **R. Bongers, H. Bouwsema, C. Van Der Sluis**

Presenter: **R. Bongers**

### **Introduction**

The feedback a therapist can provide to enhance learning the use of a myoelectric prosthesis is an important aspect in the development of a training program. The aim of this study is to examine a new virtual task to train grip force control with the prosthetic hand, while two types of feedback are tested for their contribution to the learning.

### **Methods**

Able-bodied participants (N=32) were randomly assigned to two groups. Group 1 received feedback in the form of knowledge of Results (KR), group 2 received feedback in the form of knowledge of performance (KP) during training. Participants trained force control in 5 sessions in a two-week period, receiving KR or KP feedback after every trial. The training consisted of a virtual game, in which participants were instructed to shoot a ball, placed in a slingshot, into a target, all displayed on a computer screen. Release angle and velocity of the ball were determined by the participants using a handle, equipped with force sensors. To test the performance in force control of the prosthetic hand, the grip force was assessed in a set of force control tasks during a pretest, a posttest and a retention test.

### **Results**

Preliminary analysis of the tests showed that participants who received KR feedback were better able to control grip force compared to participants who received KP feedback. The performance of the KP group deteriorated in the retention test. Future effort will involve further analyses of performance in the test phases as well as during the training.

### **Discussion/Conclusion**

To enhance the learning of grip force control in a prosthetic hand, participants might benefit more from feedback given in the form of knowledge of Results than that of knowledge of performance. This implies that occupational therapist should provide this type of feedback during training.



Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 3**

**Room 1.05**

Abstract Title: **Measuring Physical And Psychosocial Outcomes Of Patients Using Multi-Articulating Hand Prostheses**

Abstract number: **430**

Authors: **A. Goodwin, D. Atkins**

Presenter: **A. Goodwin**

### **Introduction**

Patient outcomes studies in upper limb prosthetics are traditionally limited, and as technology develops in the field of upper limb prosthetics the options available to Prosthetists and patients are constantly increasing. It is important to ensure these technological advancements are translated into improved outcomes and functional benefit to the upper limb patient.

### **Method**

The Patient Care Pathway is an online tool designed to collect information before and after a patient is fitted with a prosthesis. This tool is being used internationally in clinics fitting i-limb ultra prosthetic hands. This tool not only collects validated outcome measures of the Disabilities of the Arm, Shoulder and Hand (DASH) and Trinity Amputation and Prosthesis Experience Scales (TAPES) but also documents a client-centered approach to the prosthetic rehabilitation experience and achievement of personal and functional goals.

### **Results**

The **Results** of over 50 patients fitted with i-limb ultra hand prosthesis, completing the Patient Care Pathway forms, prior to fitting and at regular intervals post-fitting during 2012, will be presented. The TAPES provides a measure for each of the areas of psychosocial adjustment, activity restriction and satisfaction with their prosthesis; the DASH study provides a disability score for the patient. The patients' duration of wear of the prosthesis, activities of use, and the impact of functional therapy training on patient outcomes will also be presented.

### **Discussion**

As patients and Prosthetists seek information on the effectiveness and application of advanced prosthetic hand technologies, this data will provide a greater understanding of patient usage of upper limb prostheses assisting clinicians in patient selection and appropriate prosthesis prescription.

### **Conclusion**

The Patient Care Pathway enables the clinician to gather a broad collection of patient outcome data, thus providing insight into the functional and quality of life benefits of advanced prosthetic upper limb technology.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Pedorthics - Footwear - 1**

**Room 1.06**

Abstract Title: **Effectiveness Of Insoles In Preventive Treatment Of Diabetic Patients**

Abstract number: **10**

Authors: **U. Tang, R. Zügner, R. Tranberg**

Presenter: **U. Tang**

### **Introduction**

Insoles and shoes are frequently prescribed to people with diabetes to prevent occurrence of foot ulcers. Use of insoles and stable shoes decreases the plantar peak pressure (PPP) in regions of interests (ROI). These regions are defined as metatarsal phalangeal joint 1-2 and heel. The aim of this study was to compare three different types of insoles with respect to pressure distribution. Main outcomes were plantar pressure and incidents of ulcers in the first 12-month period.

### **Method**

114 patients with diabetes: 62 males and 52 females; type I/II n=31/83; mean (SD) duration of 12.3 (11.2) years; age 58 (15.5), BMI: 28 (4.7); neuropathy in 39% of the people. Patients were recruited from Dep. of Prosthetics and Orthotics at Sahlgrenska University Hospital, Gothenburg. Patients were randomized in three groups: group 1) prefabricated insoles, group 2-3) custom made insoles of EVA 35 and 55 shore respectively. Inclusion criteria: diabetes, > 18 years; ability to walk independently. Examination takes place at baseline and subsequently every 6 months until 24 months is reached. The test includes: in shoe pressure measurement with F-Scan™; questionnaires; and foot examination.

### **Result**

Pressure measurement at baseline shows mean PPP values less than 282 Kpa for all types of insoles in ROI. After twelve months mean PPP was below 272 Kpa. Twelve months use of the insoles gives following values in heel region: prefabricated insole 240 (SD 74); EVA 35sh 187 (68) and EVA 55sh 171 (73). A significant difference was seen in heel region between prefabricated insoles and insoles of EVA 35sh and 55sh ( $p=0,001$ ). Only one case was reported with ulcers during the first twelve months.

### **Discussion and Conclusion**

All three types of insoles show acceptable Results regarding distribution of pressure with a low incident of ulcers.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Pedorthics - Footwear - 1**

**Room 1.06**

Abstract Title: **The Role A Total Contact Insole In Diminishing Foot Pressures Following First Ray Amputation In Diabetics**

Abstract number: **175**

Authors: **R. El-Hilaly, O. El-Shazly, A. Amer**

Presenter: **R. El-Hilaly**

### **Introduction**

In diabetic subjects, reulcerations following first ray amputations are particularly frequent. The natural history of first ray amputation is characterized by a reulceration and consequent reamputation rate. Treatment usually includes an in-shoe intervention designed to reduce plantar pressure by using insoles and a variety of off-the-shelf products. Our aim was to investigate the effects of a suggested total contact insole on the plantar pressure reduction in patients with partial first ray amputations.

### **Methods**

Twenty subjects (mean age 60year, mean body mass index 27 kg/m<sup>2</sup>) with diabetes mellitus and partially amputated first ray of one foot. Plantar pressure data were recorded using Matscan Tekscan systems (ver. 6.34, Boston USA) while standing and taking a step for three conditions (shoe, shoe + total contact insole, and shoe + flat insole). For each condition tested, plantar pressures were determined at the five metatarsal areas, mid foot area and medial heel and lateral heel areas.

### **Results**

Twenty patients completed the study over one year The mean age of the participants was 60 years, mean Body mass index was 27kg/m<sup>2</sup>. Pressures diminished significantly ( $P<0.05$ ) in tested areas using the total contact insole while standing and walking However while using the Flat insole, significant pressure changes were only seen while walking, during standing pressures diminished significantly at M1, MF, MH and LH areas ( $P<0.05$ ). A highly significant change in pressures (decrease) with the total contact insoles during walking in all areas except for the M1 area ( $P<0.001$ ) as compared to that of Flat insole. Discussion We designed the insole to adequately conform to the irregularities of the foot. The total contact insole was more effective in diminishing pressures than the regular flat insole.

### **Conclusion**

The conforming total contact insole showed a promising significant reduction in plantar pressures indicating a very useful design of such orthoses.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Pedorthics - Footwear - 1**

**Room 1.06**

Abstract Title: **A Proximally Placed Rocker Bar And External Ankle Moments During Walking And Slow-Speed Running**

Abstract number: **98**

Authors: **K. Postema, S. Sobhani, E. Vd Heuvel, J. Zwerver, J. Hijmans, R. Dekker**

Presenter: **K. Postema**

### **Introduction**

Achilles Tendinopathy is a common overuse injury in runners. In daily practice a proximally placed rocker at the shoe is prescribed regularly, to reduce tension on the Achilles Tendon. The Masai Barefoot Technique shoe in fact is provided with a proximally placed rocker bar. It produces a small decrease of the external ankle dorsal flexion moment during the third rocker while walking (Nigg et al, 2006). However, no information is available on the effects of a proximally placed rocker bar on the ankle moments during slow-speed running.

### **Methods**

Sixteen healthy recreational runners were tested in the Motion Lab Rehabilitation of the University Medical Center Groningen, using a VICON motion capture system and a force plate (AMTI).

### **Intervention**

one pair of running shoes with and one without a proximally placed rocker bar with sole stiffening. The subjects walked at comfortable speed and ran slowly (approximately 7 km/h). Seven trials in both situations were measured with a maximum speed variability of 5%.

### **Results**

With a rocker bar the maximum external dorsal flexion moment decreased during walking and slow running in all subjects, with an average of 15 and 11% respectively. Also the moment over time (Nms) and the power (W/kg) decreased in both situations.

### **Discussion**

It was striking that in every subject the maximum external dorsal flexion moment decreased. A decrease of the external moment goes hand in hand with the same decrease of the internal ankle moment. The internal moment arm stays approximately the same during the motion trajectory of the ankle during the third rocker. This means that the force of the Calf Muscles decreases 15 and 11% respectively, during walking and slow-speed running.

### **Conclusion**

A proximally placed rocker bar causes a decrease of tension on the Achilles Tendon during walking and slow-speed running.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session name and Room: **Pedorthics – Footwear - 1**

**Room 1.06**

Abstract Title: **Traditional vs. Digital in the design and manufacture of custom orthotic insoles**

Abstract number: **481**

Authors: **D. Swatton, C. Lawrie**

Presenter: **D. Swatton**

A study of the quantitative merits of a wholly digital approach over traditional methods in the production of a pair of custom orthotic insoles. Many laboratories are aware of digital technology that can be utilised in the consultation, prescribing, design and manufacture of custom orthotic insoles but there is little quantitative evidence of the improvements that can be obtained when adopting a total or partial digital process. This study offers clarity and thus enables laboratories to make more informed decisions on digital investment.

### **Methods**

Selections of typical laboratories were consulted that had previously been using traditional data capture, design and manufacturing processes and have now converted to a digital process. In order to obtain comparable results laboratories creating similar style orthotics that are now using similar types of CAD/CAM technology were consulted.

### **Results**

The level of improvements varied but for a typical laboratory the average costs per pair reduced by 400%, returns for adjustments reduced by 800%, and the return on their investment was within 2 years but as little as 8 months. For the practitioner the data capture process was on average reduced to just one minute and lead times cut from over a week to a little as 48 hours.

### **Conclusions**

It is clearly evident that adopting a digital process from initial consultation through to delivery has significant quantitative improvements for both the practitioner and laboratory as well as a better experience for the patient. The key to improvements is the quality and application of the CAD/CAM tools that enable the 3D capture of the patient's foot, completion of a digital prescription, instant transmission to the lab, and rapid design of the orthotic and then an efficient use of milling machines and materials to create the orthotic before it is sent back to the practitioner.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Education - 1**

**Room G.06**

Abstract Title: **Smart Materials Inspiring Innovation In P & O Field**

Abstract number: **23**

Authors: **S. Rout, A. Sinha**

Presenter: **S. Rout**

'Playing God' is actually the highest expression of human nature. Our machines will become much more like us, and we will become much more like our machines. In the era of artificial intelligence some materials immerse with the ability to sense, stimulate, process and actuate a response. These are lifeless but still act different from other conventional materials when placed in specific environments. These materials are so called smart materials. The field of Prosthetics & Orthotics developed from the era of iron and wood to an ultra modern era of light and ultra light composites. The evolution of smart materials adds more reasons to the development of this field in the material aspect. There are different smart materials like Shape memory alloys, Magnetic Rheological Fluid, Piezoceramics whose properties can be sensibly utilized in Prosthetics and Orthotics Arena. In this paper I have highlighted some of the Smart materials, their features and uses in rehabilitation field. I believe that the information about these advance materials will definitely help the young P & O professionals and students to utilize these materials in different R & D projects in future.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Education - 1**

**Room G.06**

Abstract Title: **Embedding Engineering Skills Into Prosthetics And Orthotics Degree Education: Examples Of Approaches Implemented And Outcomes**

Abstract number: **41**

Authors: **N. Hamzaid**

Presenter: **N. Hamzaid**

### **Introduction**

It has been established that Degree of Prosthetics and Orthotics program should address topics on developments in biomedical and rehabilitation engineering, which undeniably have led to improved diagnosis, new intervention and more reliable outcome evaluation.

### **Methods**

Courses employed, apart from the curricular which has significant engineering components were i) Biomechanics of Prosthetics and Orthotics, ii) Biomechatronics, iii) Invention assignment in Prosthetics and Orthotics Clinical Practice.

### **Results**

In Biomechanics of Prosthetics and Orthotics, each student undertake 3D motion analysis of a prosthesis user and an orthosis user under different walking conditions. Study design development and data analysis were conducted to make comparisons between the different gait characteristics set by each student pair under the supervision of the lecturer. Students were able to apply 3D biomechanics software skills to quantify patients' gait performance and supplement their future clinical prescription and assessment. In Biomechatronics course students were exposed to the principles of Rehabilitation Engineering technology and the latest integrated engineering application in the field of Prosthetics and Orthotics. As a group assignment they designed a prototype of smart prosthetic leg, which was conducted using a cooperative approach where each group member was responsible for one design component. The invention design assignment as part of their Clinical Practice required each individual students to make use of their clinical experience and propose a better solution, technically, for a selected problem they encountered during the course.

### **Discussion and Conclusion**

These exercises links their clinical assessment skills with the technical skills of motion analysis to justify gait assessment, and trained them to work integratively in a group to produce an optimal solution based on research and product development. As Prosthetics and Orthotics students with adequate engineering background and skills, they were also able to critically analyze their clinical practice experience with an ingenious eye for design.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Education - 1**

**Room G.06**

Abstract Title: **Training Of Orthopaedic Technologists In Francophone Africa: A Challenge**

Abstract number: **59**

Authors: **K. Aklotsoe, A. Kpandressi**

Presenter: **K. Aklotsoe**

### **Introduction**

P&O appears to be new business in most developing countries, including those of Francophone Africa. The training of health technical professionals is a concern of governments only when it is about doctors, nurses ... and not for orthopaedic technologists (OT). Our aim is to show the needs (numbers) of OT in Francophone Africa to mobilize governments to invest more in the training of OT.

### **Methods**

We identified the population of Francophone and Lusophone Africa. We identified the OT of those regions, trained at ENAM-L and elsewhere. We also identified the necessary number of OT for quality cares in a given population according to the standards of WHO.

### **Results**

Population: 259.5 millions

Number of trained OT at ENAM from 1976 to 2011: 212 (7.56%)

Number of trained OT elsewhere: 10 (0.44%)

Required number of OT Cat. I and II: 2803

Difference: 2,581 (92%)

### **Discussion**

The number of OT trained until now is only 8%. This number is inadequate and can not address the issue of access to P&O cares for the Physically Disabled. The training of the remaining 92% was and remains a challenge. It would not be an impossible mission because it is a continental challenge. The solution is to raise the admission capacity of ENAM in order to get more students and reinforce its teaching staff.

### **Conclusion**

The situation of the orthopaedic services should call out to all. The lack or inadequacy of qualified OT contributes to poor quality cares. OT training should be the prerogatives of academic and normative institutions, and be included in the priorities of states.



Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Education - 1**

**Room G.06**

Abstract Title: **Alliance Of Prosthetics And Orthotics Schools-Asia (APOS)**

Abstract number: **70**

Authors: **T. Heang**

Presenter: **T. Heang**

### **What is APOS?**

APOS is a group of training institutes and their supporters in Asia which including core members from Prosthetic and Orthotic Schools in Cambodia, Thailand, Vietnam, Sri Lanka, and Pakistan. The alliance consists of board, task officers, and repository officer, and the members in those committees are representatives from each core member school. The cooperation was initiated in 2003 with the development of staff exchange, annual meeting and the sharing resources with the financial support from The Nippon Foundation.

### **Why APOS?**

The alliance is established for ensuring the quality of care and education of prosthetic and orthotic professionals for the benefits of patients in the region by conducting a series of activities that helps to strengthen and deepen the professionals in the region.

### **APOS Activities**

#### **a. Staff exchange**

APOS fosters staff exchanges among its members and supporters with all level of staff in the professions, so that staff can share their experiences, learn from other schools, and improve cooperation and communication.

#### **b. Mentoring**

It is a capacity building program within the school with the help from expert for specific topic to assist the development of skills and promote the quality of prosthetic and orthotic services and education that finally provide good care to patients.

#### **c. Web-base resource sharing**

APOS has its repository site that is taken care by a repository group to upload all useful information into database that can be accessed by all members at each school as a resource sharing and learning from each other for ensuring best practice of professionals.

### **Conclusion**

The alliance is a good model for capacity building in the region that can help to provide a better care to patients by improve the quality of education at the school.

Date / Time: **Tuesday, Feb 5 / 16:15 - 17:30**

Session Name and Room: **Education - 1**

**Room G.06**

Abstract Title: **Four Different Trial Knee Disarticulation Prosthesis For Teaching Prosthetists And Physicians**

Abstract number: **244**

Authors: **B. Kim, I. Chang, S. Bok, J. Huh, K. Cho**

Presenter: **B. Kim**

### **Introduction**

Recent advances in the prosthetic components have provided the amputees, prosthetists and prescribing physicians with great opportunity to select knee joints or foot and ankle assembly from too many possibilities in the market. Biomechanical data may give some answers to this question however, it is still unclear to the professionals how amputee would function with the newly developed items on the market. Experimental prostheses were designed for the professional in this field to experience the differences in the functions of the parts of the knee disarticulation prosthesis.

### **Methods**

For the able bodied to try on 4 different right knee disarticulation prostheses were assembled with the different combination of knee joints and foot and ankle, and finished with the adjustable carbon fiber socket with posterior opening to accept the able bodied right leg with the knee bent around 90 degrees. Ten healthy male professionals participated in this study. After initial gait training comfortable walking speed was evaluated followed by the computerized 3 dimensional gait analysis with 4 different prostheses. A questionnaire was collected to evaluate the learning effect of these trials. Data were collected and statistically analyzed.

### **Results**

Walking with these trial prostheses was found to be a good learning tool for the professionals to understand the real function of the different parts of the prosthesis with different combination of the knee and foot and ankle. These experiences helped them to understand function of the parts better with the Results of the biomechanical data from 3-D motion analysis.

### **Discussion and Conclusion**

These 4 trial knee disarticulation prostheses have been wonderful teaching tool to students of all levels including physicians and prosthetists for better understanding of the functions of the different knee and foot and ankle components.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Orthotics: Lower Limb - 4**

**Room 1.06**

Abstract Title: **Outcome Of 23H Bracing For Tip-Toe-Walking Children With Cerebral Palsy**

Abstract number: **452**

Authors: **C. Grasl, A. Kranzl, R. Csepan**

Presenter: **C. Grasl, MSc**

### **Introduction**

One of the most common problems in patients with Cerebral palsy is the deterioration of the musculoskeletal system, especially the legs and feet, manifested in tip toe walking. As conservative treatment there are orthopaedic shoes, splints, physiotherapy and in more severe cases injections of Botulinumtoxin in combination with serial casting to avoid operation. Fulltime-Bracing with orthopaedic devices is one of the more recent options. Aim of the study was to proof the functional outcome orthopaedic dynamic orthotics.

### **Patients/Materials/Methods**

A total of 10 children with CP, hemi- or diplegic, were included. All patients were free ambulating, tip-toe-walking before the first examination and treatment. GMFCS classification ranged from I-II. Patients were adjusted with dynamic ankle foot orthosis including the ring shaped foot support developed by Baise/ Pohlig. 3D-Gait-Analysis has been done to discriminate differences before treatment and after 3 months. No orthosis was worn during the analysis.

### **Results**

All patients changed their initial contact from toe to heel. Ankle joint ROM improved significantly. Improvements in the knee-joint in sagittal plane like the reduction of hyperextension in mid stance, better max. knee flexion timing and increased maximal knee-flexion in swing. Maximum of ankle moment was increased. Maximal ankle-power increased significant.

### **Discussion/Conclusions**

This study shows the positive effect of bracing with night-and-day splints for 23 hours. A long wearing time of the splints, nearly 24h per day for 3 months in combination with the design of the orthosis are the key features. The ankle joint pattern towards to improve to normal. The slightly reduced walking speed, slightly increased ankle power at push off and a better foot progression angle indicates a better functional outcome. The question is how long can this improvement be maintained? 23h bracing with splints showed significant improvements concerning gait parameters and can be recommended as a treatment option.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Orthotics: Lower Limb - 4**

**Room 1.06**

Abstract Title: **Mechanical Properties Of A Spring-Hinged Floor Reaction Orthosis**

Abstract number: **470**

Authors: **Y. Kerkum, M. Brehm, A. Buizer, J. Van Den Noort, J. Harlaar**

Presenter: **Y. Kerkum**

### **Introduction**

Floor Reaction Orthoses (FROs) are commonly prescribed in children with cerebral palsy (CP) walking with excessive knee flexion. FROs are stiff, and aim to counteract excessive knee flexion in midstance, by shifting the Ground Reaction Force forward. However, an FRO also impedes plantar flexion in preswing, thereby obstructing push-off power. Spring-like FROs might create push-off power by storing and releasing energy. Literature shows that energy cost of walking with an ankle-foot orthosis in adults can be minimized by optimizing its stiffness. Recently, a new type of hinge with adjustable springs was designed, which can be integrated into an FRO. Biomechanical optimization of the stiffness requires quantification of the hinge's mechanical properties. This study aims to quantify the mechanical properties of this hinge build within an FRO.

### **Methods**

One FRO with an integrated Neuro Swing® ankle joint (Fior & Gentz) was constructed and mechanical properties of five springs were measured with BRUCE (Bregman et al., 2009). Each spring was fully compressed and released three times, while hinge angles and exerted net moments were continuously measured. The spring's range of motion (ROM)[°], stiffness[Nm/°], threshold[Nm], and hysteresis[%] (loss of energy calculated as percentage of stored energy) were averaged.

### **Results**

Stiffness ranged from 0.01Nm/deg to 1.61Nm/deg. Hysteresis (14.0%-28.5%) decreased with increasing stiffness, while threshold (1.4Nm-20.6Nm) was higher for stiffer springs. ROM varied between 6.2° and 13.9°.

### **Discussion**

Although hysteresis is present, resulting in loss of energy that potentially could be used for push-off, FROs with integrated springs might still be beneficial, since conventional FROs can't store energy at all. However, it remains unknown whether these springs are sufficiently stiff to counteract excessive knee flexion in gait in CP. This is subject of further research.

### **Conclusion**

The Neuro Swing ankle joint are potentially effective in optimizing FROs in children with CP.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Orthotics: Lower Limb - 4**

**Room 1.06**

Abstract Title: **A Systematic Literature Review Comparing Ankle-Foot Orthoses And Functional Electrical Stimulation In The Treatment Of Patients With Multiple Sclerosis.**

Abstract number: **472**

Authors: **E. Davidson, R. Bowers**

Presenter: **E. Davidson**

### **Introduction**

Statistics reveal that approximately 2.5 million people have been diagnosed with MS worldwide. This research aimed to review all available literature on the use of Ankle-Foot Orthoses (AFO) and Functional Electrical Stimulation (FES) for the treatment of gait difficulties in MS.

### **Methods**

An extensive systematic search was carried out using the electronic databases Embase, Medline, CSA Illumina, DyNamed, The Cochrane Library, Science Direct, ISI Web of Knowledge and The Knowledge Network. Of the full texts sourced only 14 experimental papers were considered appropriate for critical appraisal in this literature review.

### **Keywords**

Multiple Sclerosis, MS, Ankle-Foot Orthosis, AFO, Ortho\*, Splint, Brace, FES, Functional Electrical Stimulation, Rehabilitation, Function, Gait

### **Results**

The most reported outcomes were walking speed and energy expenditure. Six of the nine FES trials reported a statistically significant increase in walking speed while one reported a non-significant decrease. Of the four AFO trials, three reported an increase in walking speed, although only one was statistically significant, and one trial showed a decrease. Psychological Cost Index (PCI) was commonly utilised as an indication of energy expenditure. Two of the four AFO trials reported a decrease in PCI compared to four of the nine FES, (three significant). Only the direct comparison trial and two of the five AFO trials, reported on stance phase kinematics, with the others focusing on swing phase related outcomes. The variation in outcome measures makes comparison between AFO and FES challenging.

### **Conclusions:**

This literature review highlights several limitations in the current evidence base, particularly a lack of baseline information regarding participants and interventions being investigated. Few studies adequately report the biomechanical effects of FES and AFO. The majority of the reviewed studies are of a low level of evidence. Considerably more research is required of an elevated standard to strengthen evidence to inform future clinical practice.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Orthotics: Lower Limb - 4**

**Room 1.06**

Abstract Title: **Walker Braces Improve Gait Compared To Traditional Walking Casts**

Abstract number: **339**

Authors: **M. Nicholls, T. Ingvarsson**

Presenter: **A. Ludviksdottir**

### **Introduction**

Walker braces are promoted as offering a more natural gait or ease of ambulation compared to traditional casts. One benefit of this is to improve patient mobility. This study investigated whether walker braces improved gait compared to traditional casts.

### **Methods**

Ten healthy subjects with no recent history of lower limb injury gave informed consent and were recruited. The subjects' symmetry of gait was measured using an instrumented treadmill. Symmetry was estimated by calculating the difference in single stance time, as a percentage of the gait cycle, between the left and right leg, with zero indicating perfect symmetry. Measurements were taken at self-selected speed for eight conditions: no brace, below the knee fibre glass walking cast and three types of walker braces (Rebound, Equalizer and Aircast). Analysis of covariance was performed on the data using self-selected speed as a covariant.

### **Results**

Gait symmetry with no brace was better than all other conditions (-0.46%,  $p < 0.05$ ). Gait symmetry while wearing the Rebound (3.17%) or the Equalizer (3.31%) was better than while wearing the fibreglass cast (6.53%,  $p < 0.05$ ). Symmetry with the Aircast (4.41%), was not different to fibreglass cast.

### **Discussion and Conclusion**

The Results show that gait symmetry is worse when wearing a brace or a walking cast compared to not wearing a brace or walking cast. However, some braces allow for greater gait symmetry than a walking cast. This suggests that walker braces may improve gait by improving gait symmetry in comparison to a walking cast. The differences seen between braces could reflect the different sole designs and hence new sole designs may improve gait further. The strength of these Results is limited by the fact that all subjects were healthy. Nevertheless, for patients who are allowed to weight bear, these braces may offer an advantage over walking casts by improving mobility.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Orthotics: Lower Limb - 4**

**Room 1.06**

Abstract Title: **Orthotic Treatment Using Shoe Inserts For Talipes Planovalgus In Children**

Abstract number: **302**

Authors: **T. Asami, K. Kodama, N. Akiyama, N. Yamanouchi, K. Yamamoto, Y. Nanri, S. Tokuda, Y. Arizono**

Presenter: **T. Asami**

### **Introduction**

The process of growing can cause deformities of the plantar aspect in children. Talipes planovalgus is one of the deformities that afflict children. The plantar aspect deforms as the child grows, and if the condition remains unimproved when the child reaches puberty, it can cause foot pain, fatigability, abnormal gait, and other problems.

### **Subjects and Methods**

Our medical department provides lifestyle guidance and orthotic treatment using shoe inserts to talipes planovalgus patients. In this study we evaluated the effectiveness of orthotic treatment for 102 patients between January 2004 and December 2008 using arch supports, metatarsal pads, and shoe inserts with medial wedges. Evaluations were made of subjective symptoms, objective findings (Carter and Wilkinson criteria for joint laxity, plantar aspect, x-ray), and other aspects.

### **Results**

Of the symptoms of talipes planovalgus, the improvement rate for abnormal gait and fall risk was high. Objective findings showed the following Results. The incidence of the longitudinal arch during weight bearing improved from 2.94% at first examination to 57.8% at final examination, and the incidence of the transversal arch during weight bearing improved from 2.0% at first examination to 22.5% at final examination.

### **Discussion and Conclusion**

Opinions are divided on orthotic treatment of flat feet in children. However, the Results of this study show that it is effective in providing lifestyle benefits by improving abnormal gait and fall risk. In addition, early correction of the alignment of the lower extremities during childhood, a period when the bones have great plasticity, is important to children's growth. In other words, we believe that orthotic treatment using shoe inserts for talipes planovalgus in children is one effective method.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 9**

**Room 1.03**

Abstract Title: **Spinal Motion During Walking In Persons With Transfemoral Amputation With And Without Low Back Pain**

Abstract number: **150**

Authors: **S. Fatone, R. Stine, A. Rodriguez, S. Gard**

Presenter: **S. Gard**

### **Introduction**

Gait abnormalities may contribute to the high incidence of low back pain (LBP) in persons with transfemoral amputation (TFA), but few studies have explored spinal motion during walking. We investigated spinal motion during walking in persons with unilateral TFA with and without LBP.

### **Methods**

Persons with unilateral TFA were tested in the motion analysis laboratory while walking at their comfortable self-selected speed. Reflective markers were placed on the body using a modified Helen Hayes configuration and on the back using a regional spine model. Two tailed t-tests were used to compare data between groups ( $\alpha = 0.05$ ).

### **Results**

Data were collected from 7 persons with LBP and 8 without. The groups did not differ in body mass index, time since amputation, residual limb length, hip flexion contracture, socket comfort score, walking speed, or step width. The group with LBP had a longer intact limb step length and the group without LBP had a longer amputated limb step length. Lower body kinematics (e.g. vaulting, hip hiking) were typical of persons with unilateral TFA. Both groups had anterior pelvic tilt that peaked in terminal stance and rapidly rotated posteriorly at prosthetic toe off, with greater variability in this pattern of motion in the LBP group. We observed a coupling of motion between the pelvis, lumbar and thoracic spines with the majority of motion occurring as the prosthesis transitioned from stance to swing. The two groups had similar patterns of motion at the pelvis and thoracic spine, but opposing motions in the lumbar spine in the latter half of stance with the LBP group demonstrating out of phase motion.

### **Discussion/Conclusion**

Pelvic and spinal motion patterns are different among individuals with TFA depending on whether they have LBP or not. Further research is required to identify the underlying sources of these differences.



Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 9**

**Room 1.03**

Abstract Title: **Gait Strategies Of Transfemoral Amputees Walking Downhill**

Abstract number: **109**

Authors: **D. Heitzmann, M. Alimusaj, J. Block, T. Dreher, F. Braatz, S. Wolf**

Presenter: **D. Heitzmann**

### **Introduction**

Current hydraulic and microprocessor controlled prosthetic knee joints for trans-femoral amputees (TFA) enable the user to flex the prosthetic knee throughout weight bearing of the prosthetic limb. TFA are able to use this functionality while alternate walking down stairs or descending inclines. However, clinical practice shows that not all TFA use this so called "stance phase flexion" on slopes, especially on inclines with a moderate angle.

### **Methods**

Five male TFA (48.6y±12.9y/99.5kg±20.3kg/1.77m±0.06m) were fitted with a microprocessor controlled prosthetic knee (Rheo Knee II TM) and a common prosthetic foot (Variflex EVO TM / all parts Ossur, Reykjavik, Iceland). TFA underwent a conventional clinical gait analysis while walking down slopes of 2.5°, 5° and 7.5°. TFA walked at self selected speed and with their preferred strategy. For reference purpose, eleven healthy subjects (NORM/3 female;8 male/29.6y±4.6y/74.4kg±13.8kg/180.7cm±7.8cm) finished the same protocol.

### **Results**

Prosthetic knee kinematics show that the five TFA have adopted two different strategies for walking down the slopes of 5° and 7.5°: 1) to bend the prosthetic knee in stance 2) to keep the prosthetic knee in stance extended. On the shallow 2.5° slope none of the TFA tends to bend the prosthetic knee in stance.

### **Discussion & Conclusions**

For the shallow 2.5° slope none of the TFA uses stance phase flexion of the prosthetic knee. However, for steep slopes this strategy seems to be favorable, possibly for a better control of gait speed. Noticeably, all TFA slow down when they switch from strategy 2 to 1. However, not all users change their strategy. This might be due to individual

### **References**

Further, the length of the incline, technical properties of the knee and the alignment of the prosthesis may influence this choice of strategy.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 9**

**Room 1.03**

Abstract Title: **Experiences Of Providing Prosthetic And Orthotic Services In Sierra Leone - The Local Staff'S Perspective**

Abstract number: **114**

Authors: **L. Magnusson, G. Ahlström**

Presenter: **L. Magnusson**

### **Introduction**

In Sierra Leone, West Africa, there are many people with disabilities in need of rehabilitation services after a long civil war. The aim of this qualitative study was to explore the experiences of prosthetic and orthotic service delivery in Sierra Leone from the local staff's perspective.

### **Method**

Fifteen prosthetic and orthotic technicians representing all the rehabilitation centres providing prosthetic and orthotic services in Sierra Leone were interviewed. The interviews were transcribed and subjected to latent content analysis.

### **Results**

One main theme emerged: Sense of inability to deliver high-quality prosthetic and orthotic services. This main theme was generated from eight sub-themes: Desire for professional development; Appraisals of work satisfaction and norms; Patients neglected by family; Limited access to the prosthetic and orthotic services available; Problems with materials and machines; Low public awareness concerning disabilities; Marginalisation in society and Low priority by the government.

### **Discussion**

There is a need for educating more prosthetic and orthotic staff to a category I or II level in Sierra Leone. To increase access to prosthetic and orthotic services there is a need to focus on making materials available for the fabrication of prosthetic and orthotic devices and to facilitate transport for patients to reach the services.

### **Conclusions**

The findings illustrated traditional beliefs about the causes of disability and that the public's attitudes need to change in order to include and assign value to people with disabilities. Support from international organizations was considered necessary as well as educating more prosthetic and orthotic staff to a higher level.

Magnusson L, Gerd Ahlström G. Experiences of Providing Prosthetic and Orthotic Services in Sierra Leone — the Local Staff's Perspective. Disability and Rehabilitation. Accepted for publication February 2012

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: Prosthetics : **Lower Limb - 9**

**Room 1.03**

Abstract Title: **A Methodological Approach To Integrate Psychological Factors To Lower Limb Prosthetic Functional Design**

Abstract number: **105**

Authors: **P. Beckerle, O. Christ, M. Windrich, S. Rinderknecht, J. Vogt, J. Wojtusch**

Presenter: **J. Wojtusch**

### **Introduction**

As user-centered development (UCD) involves users for an understanding, objective assessment and utilization of their needs, it represents a promising approach to develop improved user-friendly prostheses. Hence, human factors have to be identified and integrated into development.

### **Methods**

To identify relevant factors and assess the amputees' requirements, a literature review, questionnaire Results and interviews are considered. Further, models of the identified factors' impacts on the development and Quality Function Deployment (QFD) for the translation from the human understanding to technical design are prepared for evaluation with amputees. The important body scheme integration (BSI) is examined in experiments with unharmed subjects exploring a Rubber Leg Illusion similarly to the Rubber Hand Illusion.

### **Results**

Besides BSI, satisfaction and feeling of security (FOS) show to be important factors for UCD. Satisfaction is linked to quality of life (QoL) and time of daily use and influenced by appearance, usability and functional properties of prosthetic components. FOS seems to be an issue of the overall system leading to reliability and balance during use. BSI also affects QoL and might lead to more user-friendly prostheses. Technical functions (enabling) contrary to characteristics from the user's view (predisposing) seem to be perceived as different properties. The first ones are utilized: Functional units are identified and assessed. Models and QFD are used for their evaluation and translation to technical development. The technical functionality is reviewed and extended based on a comparison of functional and psychological aspects of the units and the overall concept.

### **Discussion**

The elaborated approach should enable to involve users during the whole development process. Yet, it is not validated with a sufficient number of users.

### **Conclusions**

Substantiating this approach with sufficient data is necessary – e.g., a comparative analysis to solve conflicting goals. It is promising for the development of future user-friendly prostheses.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 9**

**Room 1.03**

Abstract Title: **Secondary Posterior Keel In Carbon Fiber Prosthesis Changes The Foot-Ground Kinetic Interactions During Walking**

Abstract number: **484**

Authors: **A. Kregling, A. Auyang, E. Chu, Q. Chen, K. Collier, J. Shim**

Presenter: **A. Kregling**

### **Introduction**

Shock absorption is seen as the phase of gait when the swinging foot rapidly decelerates through the heel rocker (heel contact through foot flat). For amputees, their prosthetic ankle-foot-units' heel emulates this heel rocker, which contributes to load acceptance. Carbon-fiber prosthetic ankle-foot-units are often distinguished by their physical design, mechanical behavior, and functionality. A carbon fiber design engineered with a secondary posterior keel (z-shaped heel) was developed as a walking foot to improve gait by increasing shock absorption. However, the biomechanical responses of this type of prosthesis have not been thoroughly evaluated. The purpose of this study was to investigate the kinetic interactions between the new prosthesis with a secondary posterior keel and the ground during walking.

### **Methods**

Eight healthy unilateral transtibial amputee subjects (7 males; 1 female) wearing two different prostheses, single posterior keel (Freedom Innovations Sierra) and secondary posterior keels (Freedom Innovations Renegade), during two walking conditions (unloaded and loaded with 30% BW) at a self-selected-speed. The vertical ground reaction forces were recorded and analyzed for evidence of shock absorption. Results The prosthesis with the secondary posterior keel showed the lowest initial peak force and smallest rate of force development. It also showed a longer stance phase, thereby keeping a similar impulse to the single keel foot and allowing for a lower rate of force production. These findings became more pronounced in the loaded condition.

### **Discussion**

Amputees that wish to participate in multiple activities without pain from shock on their residual limb would benefit from a shock absorbing component since higher peak and rate of force have been reported to be associated with elevated gait injuries.

### **Conclusions**

The prosthesis with the secondary posterior keel (Freedom Innovations Renegade) may play a role in reducing long-term injuries while providing vertical shock absorption during regular walking and during increased loads.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Education - 2**

**Room 1.05**

Abstract Title: **ISPO Cat 1 Pathway For A P&O Program In Japan**

Abstract number: **315**

Authors: **M. Uchida**

Presenter: **M. Uchida**

The first P&O school in Japan started in 1982. the P&O Act was established by The Ministry of Health, Labor and Welfare(MHLW) in 1987, and the profession became established with a nationally recognized medical care qualification. As of 2012, there are 9 schools around Japan. Kobe College of Medical Welfare (KMW) made initial meeting with ISPO in Nov. 2009. This meeting set an agreed pathway for the four year program in P&O to move to an initial consultation in Mar. 2010 and then move to a formal ISPO Cat. I Evaluation in Mar. 2012. The initial consultant report said Overall the current four year program in P&O at KMW is well positioned in most of the necessary aspects and elements that are required to attain official ISPO Cat.1 status. but on other hand, it indicated The offsite clinical experience needs to be examined further to enhance and standardize the process.

The MHLW requires 180 hours of clinical training, but this does not provide students with sufficient clinical skills right before graduation. In Japan, students basically complete their studies at school, take the national exam, and then receive their license. The system which recognizes specialist medical professions through clinical experience in the certification system using intern education or each specialist associations is firmly entrenched in Japan. KMW with ISPO Japan proposed Japanese model of ISPO Cat.1 Individual Accreditation Examination including 15 month internship to guarantee the quality of post-graduation clinical experience. The proposed post-graduate internship period and competency exam will help facilitate the development of a high standard of competency for those graduates who chose to enter this process. It is a very positive development for ISPO and ISPO Japan to have this process be included as a required element for those wishing to attain Cat.1 status.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Education - 2**

**Room 1.05**

Abstract Title: **Strengthening Prosthetics And Orthotics School Research Strategy: Case Study**

Abstract number: **317**

Authors: **M. Samala, S. Srithumboon**

Presenter: **M. Samala**

### **Abstract**

This article presents case studies of prosthetic and orthotics programs that have created enduring research efforts.

### **Introduction**

Sirindhorn School of Prosthetics and Orthotics had officially established on September 4, 2002. The school aimed to produce well qualified Prosthetists and Orthotists in Bachelor degree level in the Name of Bachelor of Science in Prosthetic and Orthotic. In March 2009, school was recognized ISPO standard Category I.

Research project is a significant component of undergraduate students at Sirindhorn School of prosthetics and Orthotics, Mahidol University. The research project provides the student a study basis for acquisition of in-depth knowledge in particular areas of Prosthetics and Orthotics through conducting basic research in their area of interest.

To achieve the aim related to recent and future condition as mentioned, Sirindhorn School of Prosthetics and Orthotics (SSPO) necessary to strengthening in an appropriate and right academic work in order to create framework for producing student research with academic standard quality leading to social development.

### **Methodology**

Policy Mixed Research Methodology was used. Content analyses were used to analyze Results of by institutional survey and stakeholders interview. The population consisted of all staff in SSPO and experts in prosthetic and orthotics filed.

### **Result and Discussion**

To begin creating an infrastructure for school research and to create research collaboration within and outside institute. In order to maintain the quality of research and assist the student, SSPO provides strategic support in terms of funding, facilities and supporting documents.

### **Conclusion**

Sirindhorn School of Prosthetics and Orthotics contributes to students of success by providing this opportunity to undergraduates. The well organized facility supports are a key ingredient in the SSPO undergraduate research.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Education - 2**

**Room 1.05**

Abstract Title: **Pipos Academic Clinical Placement For Semester Vii And Viii Students**

Abstract number: **442**

Authors: **U. Jabeen**

Presenter: **U. Jabeen**

### **Introduction**

PIPOS provide opportunity to its undergraduate students of semester VII and VIII (14-18 students) for clinical placement at centers that provide P&O services in different areas of Khyber Pakhtoon khwa and Azad Jammu Kashmir. The Aim is to expose the undergraduates to P&O practice in clinical environment under careful supervision

### **Learning Objective**

- Enhancement of professional development of the students under clinical supervision
- To provide knowledge and understanding of patient protocol of the centers
- Get experience of patient care and good communication with both patients, their families and rehabilitation team
- To have experience to work effectively as part of an interdisciplinary team in rural and urban areas Centers:

Seven PRSP centers and 02 ICRC administrated centers offer the clinical placement to students of PIPOS, where they have to work under the mentoring of P&O with 4-5 years of experience and supervision of expatriates.

### **Students' Submission**

- Log books
- Report
- Problem based learning

### **PIPOS faculty Role**

Senior faculty members from PIPOS visit these centers as per planning to assess the skills and progress of the students. They attend the Power Point Presentations made by students; check the log books and guide the students in report writing.

### **Outcomes**

At the end of clinical placement the students should be able to work independently while providing quality rehabilitation services. Since 2009 three clinical placements were held successfully.

### **Challenges**

- Female students face challenges while working in remote area of country
- It is quite challenging for students to in areas that are away from their institute.
- Students deal with variety of cases with multiple problems.

### **Conclusion**

Up till now clinical placement is successfully accomplished. Students got good skills in clinical and technical areas. However, there are certain challenges that needs to be addressed for betterment of placement.

Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Education - 2**

**Room 1.05**

Abstract Title: **The Conceptual Foundations Of Modern Educational Standard Of Training Prosthetics Specialists**

Abstract number: **446**

Authors: **E. Shataeva, L. Tomasevic**

Presenter: **E. Shataeva**

### **Introduction.**

A significant change in modern prosthetic-orthopedical activity became the transition from system of help to service delivery. Market relations are actively included into systems of social help everywhere. Demographic situation in developed countries leads to expansion of the market. Big part of these services is paid by state and private insurance foundations.

### **Methods**

Analyze of improvement of prosthetic-orthopedical activity during last 10 years from the position of system analyze allow to see its basical tendencies, perspectives and problems.

### **Results**

Rapid development of mechatronics, computer technologies largely expanded technical possibilities of this activity. At the market appeared completely new products and services. Existence of market relation in this sphere, from one hand, stimulates the improvement of quality of products and services, on another, their price. Working within these relations, service provider is interested to receive more profit and more costumers. The achievement of social result in the form of optimal prosthetic–orthopedical help for the reasonable price is not the main goal of the service provider. Moreover, part of offered of the market prosthetic-orthopedical services can have a character of aggressively advertised “need”, which has nothing to do with real Results. Problems of equity in the provision of prosthetic-orthopedical services to different categories of patients in such market situation are not considered.

### **Discussion**

Implementation of standards for prosthetic-orthopedical services doesn't resolve problems of their optimization fully. Only specialist (interdisciplinary group) for every concrete situation can determine and provide the optimal amount of rehabilitation services, including prosthetic-orthopedical ones. Therefore, exactly these specialists should be responsible for decision regarded patient. This responsibility, first of all, has bioethical component.

### **Conclusions**

Modern educational standards of training prosthetic specialists should greatly enhance bioethical part of educational programs of all special disciplines. Bioethical principles should become the foundation of training of rehabilitation and health care specialists.



Date / Time: **Wednesday, Feb 6 / 09:00 - 10:15**

Session Name and Room: **Education - 2**

**Room 1.05**

Abstract Title: **Assessing Learning-Style Preferences Of Rehabilitation Professional Students Attending Mobility India Training Institute In Bangalore, India.**

Abstract number: **462**

Authors: **M.R. Ghosh, R. Kumar**

Presenter: **V. Masilamani**

### **Introduction**

Students attending training programmes represent from diverse groups in terms of age, culture, experience in rehabilitation field and level of preparedness as learners. The greatest challenge that trainers face today is improving the level of student satisfaction with the curriculum and learning environment. Students have specific learning style

### **References**

One characterization of learning style is to define the learners preferred mode of leaning in terms of sensory modality by which they prefer to take new information. Trainers need to understand the learning strategies of students in order to facilitate their learning.

### **Methods**

The VARK questionnaire developed by Neil Fleming was used to identify the learning style of Prosthetics, Orthotics & Rehabilitation Therapy Students. A total of 39 students (13 female and 26 male) completed the questionnaire. The validated VARK questionnaire consists of 16 items which identify four different learning styles: visual, auditory, reading/writing and kinesthetic. Descriptive statistics were used to identify the learning styles of students.

### **Results**

Data indicated that 31.2% of students preferred learning by single sensory modality and 68.8% preferred multiple learning styles. Among 39 participants, 6.4% were (visual), 8% (auditory), 7.7% (reading/writing) and 9.1% (kinesthetic) learners.

### **Discussion**

We found that many students preferred to learn by more than one mode of information presentation. Trainers can develop their pedagogical strategies if they know the preferred modes of learning of their students. This allows them to change from their own preferred mode of teaching towards the learning

References of students which may help to develop their knowledge, skills and attitudes and that may enable them to become a competent student.

### **Conclusion**

The Results of the study would help trainers to be aware of differences and broaden their teaching strategies as per students learning

References and create a learning environment which is more productive and enjoyable.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: Prosthetics : **Upper Limb - 4**

**Room 1.01**

Abstract Title: **Changes In Movement Characteristics While Learning To Use A Myoelectric Prosthetic Simulator**

Abstract number: **142**

Authors: **R. Bongers, H. Bouwsema, C. Van Der Sluis**

Presenter: **R. Bongers**

### **Introduction**

Training increases the functional use of upper limb prostheses. However, the way training should be set up has received little attention in scientific literature. To develop an evidence-based training program, one first has to know how people learn to use their prosthesis.

### **Aim**

To examine changes in behaviour while practicing with an upper limb myoelectric prosthesis and to study how the neuromotor system learns to incorporate the characteristics of the prosthetic device.

### **Methods**

Able-bodied participants were assigned to an experimental condition (N = 31) or a control condition (N = 31). Participants in the experimental condition, randomly assigned to one of four groups, practiced with a myoelectric simulator for five sessions in a two-week period. Group 1 practiced direct grasping, Group 2 practiced indirect grasping, Group 3 practiced fixating, and Group 4 practiced a combination of all three tasks. The Southampton Hand Assessment Procedure (SHAP) was assessed in a pretest, posttest, and two retention tests. Participants in the control condition performed SHAP two times, two weeks apart with no practice in between. Compressible objects were used in the grasping tasks. Time scores, changes in end-point kinematics, joint angles and force control were examined.

### **Results**

The experimental group improved more on SHAP than the control group ( $p = .00$ ). Global positioning was learned relatively quickly as improvement leveled off after three days of practice, whereas learning to control grip force required more time. Object rigidity affected coordination of grasp as the more compressible objects required longer grasping times and lower hand closing velocities.

### **Discussion/Conclusion**

The neuromotor system learned to adapt to the prosthesis for gross movement patterns rather quickly, while fine motor control aspects seems more difficult. A training program should therefore spend more time on learning fine control aspects than on gross movements with the prosthetic hand during rehabilitation.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 4**

**Room 1.01**

Abstract Title: **Body Structures And Physical Complaints In Upper Limb Reduction Deficiency: A 24 Year Follow Up Study**

Abstract number: **251**

Authors: **S. Postema, C. Van Der Sluis, K. Waldenlöv, L. Norling Hermansson**

Presenter: **S. Postema**

## **Introduction**

In children with upper limb reduction deficiency (ULRD) scoliosis has been reported but the development of these spinal deviations over time is unclear. Furthermore, little is known about the development of other upper body structures and potential physical complaints in this population. Also, the influence of prosthesis use on the development of body structures or complaints is unknown.

## **Aim**

To describe upper body structures of persons with unilateral ULRD and the development of these structures over time, to examine the presence of physical complaints in this population, and to study the effect of prosthetic use on body structures and physical complaints.

## **Method**

A prospective cohort study with a follow-up period of 24 years was conducted. Twenty-eight persons (age 8-18 years at inclusion) with ULRD and 62 matched controls underwent measurements of upper-arm, trunk and spine and answered study-specific questionnaires at baseline and follow-up. In addition, at follow-up the Brief Pain Inventory and the Quick Disability of Arm, Shoulder and Hand questionnaires were answered.

## **Results**

Within-subject differences in structures of the arm and trunk were shown in patients but not in controls both at baseline and follow-up. Spinal deviations were greater in patients compared to controls. No structural scoliosis was found. Self-reported disability was higher in patients compared to controls. Differences in back pain and effects of prosthesis use could not be detected.

## **Discussion**

The structural within-person difference between body-halves may explain the findings of spinal deviations. The rates of physical complaints were remarkably low, compared to other studies. This might be due to differences between persons with ULRD and acquired upper limb amputations, level of deficiency, prosthetic use or age.

## **Conclusions:**

Persons with ULRD have consistent differences in upper body structures over time. Deviations of the spine, probably of functional origin, do not proceed to clinically relevant scoliosis.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 4**

**Room 1.01**

Abstract Title: **Force Perception During Ipsilateral Scapular Cutaneous Anchor System Versus Figure Of 9 Shoulder Harness Operation**

Abstract number: **262**

Authors: **M. Hichert, D. Plettenburg, G. Smit**

Presenter: **M. Hichert**

### **Introduction**

For years the disadvantages of shoulder harnesses are known: discomfort, skin irritations, pain, numbness and nerve damage, as well as a poor cosmetic value. In 2007 Debra Latour presented her Ipsilateral Scapular Cutaneous Anchor System as an alternative for the conventional shoulder harness. Compared to the conventional shoulder harness the shoulder protraction of the sound side as a control action is deactivated. A promising solution, but does this anchor system also provide sufficient feedback to the user while operating the prosthesis?

### **Methods**

A prosthesis simulator was fitted to 10 subjects without arm defect. The first series of experiments was conducted with the anchor system and for the second series a Figure of nine harness was used. A force sensor placed on the control cable measured the cable activation forces the subjects created. The measured force was fed to a laptop running a LABVIEW programme. The subject was requested to reproduce a given force and hold it as constant as possible for 10 seconds. Visual feedback was enabled every second repetition. The constant error between created force and reference force as well as the standard deviation of the created force were calculated.

### **Results**

No significant differences were found for the constant error whereas the standard deviation of operating forces seems to be significant lower during the operation with the anchor system compared to the harness.

### **Discussion**

Even if no differences were found in terms of constant errors, subjects seem to be able to hold a given force at a more constant level with the anchor system. Less deviation in operating forces means better control on the terminal device.

### **Conclusions**

In terms of force feedback the anchor system seems to be the preferred system.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 4**

**Room 1.01**

Abstract Title: **Assessment Of Prosthesis Use By Visual Attention Analysis**

Abstract number: **275**

Authors: **F. Popa, P. Kyberd, A. Hussaini**

Presenter: **A. Hussaini**

Recent studies show that visual attention behaviour changes as individuals get more comfortable, skilled or confident with their activities, or when they are less distracted. Differences in visual attention are noticeable when analysing activities where individuals display different levels of skill. Novices usually display longer fixations than experts. This study investigates the visual attention patterns of prosthesis users while they perform the Southampton Hand Assessment Procedure. Eye metrics are acquired using an eye tracking device placed on the subject's head, which is capable of recording both the scene and the eye movements of the participant and combining them in a manner that allows visual attention to be measured.

Three prosthesis users and an able bodied individual were tested in an experiment which involved picking up four coins from different locations on a table and placing them in a container. The task was chosen due to its relative difficulty and amplitude of hand and eye movement necessary for accomplishment. Compared to other SHAP tasks, this specific activity required repetitive movement of the hand, fine grasping ability and a consistent and thorough eye movement over the field of view.

Longer fixations were observed in the case of prosthesis users, mostly at the hand or the surroundings of the grasping area. On average, prosthesis users spent more than one second per fixation (1.27s &#963;=1.04s; 1.65s &#963;=1.36s; 1.82s &#963;=1.77s) as opposed to the healthy individual (0.37s &#963;=0.08s). Maximum fixations ranged between 3.26s and 5.03s for the prosthesis users, while the able bodied fixated at most for 0.46s.

**Results** are consistent with previous visual attention studies and suggest that employing visual attention analysis to prosthetics is viable. Underlining longer fixations in the case of prosthesis users, which was expected, is a sign that new means of understanding prosthesis use may be possible using eye metrics.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: Prosthetics : **Upper Limb - 4**

**Room 1.01**

Abstract Title: **Acceptance Of Powered Prosthesis In Upper Limb Congenital Deficiency**

Abstract number: **357**

Authors: **R. Munjal, G. Vankateshwara**

Presenter: **R. Munjal**

### **Introduction**

The aim was to know the acceptance and possible reasons for rejection of the powered prosthesis in congenital upper limb deficiency patients with particular emphasis on the sidedness, level of deficiency and gender of the patient over a decade of follow up. The convention is to provide the prosthesis as baby starts object manipulation. There is limited literature available about the ideal age for providing cosmetic or functional prosthesis, rejection rates and outcomes

### **Method**

59 patients with congenital upper limb deficiency over the past 15 years were considered for the study. The inclusion criteria were congenital deficiency, upper limb pathology and regular follow ups until 5 years post prosthetic usage. The information regarding the demographics, level of deficiency, current prosthesis, and current activity level with or without the prosthesis was collected.

### **Results**

A total of 32 (54%) males & 27 (46%) females were considered. There was left upper limb deficiency in 38 (64%) and right upper limb deficiency in 21 (36%). The transradial deficiency was the commonest with 37 (62.7%) cases, followed by wrist, hand and longitudinal deficiencies. About 12 were wearing cosmetic prosthesis and rest were provided with powered prosthesis. Prosthesis was provided in 47 (~80%) and prosthesis was subsequently abandoned in 9 (~15%) cases. There is significant correlation noted between sidedness and abandonment in that all the 9 cases who abandoned use were powered prosthesis & had left upper limb deficiency (Pearson chi-square p-value 0.015) of which 6 cases were at transradial level.

### **Conclusions**

85% continue to use the prosthesis. Intensity of use varies with early school age to senior school age. There is a dominance of patients with localisation to left upper limb deficiency who abandon the prosthesis over a period of time which needs further evaluation. Surprisingly, none of the cosmetic prosthesis use was abandoned.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Paediatrics - 3**

**Room 1.02**

Abstract Title: **The Orthotic Management Of Deformational Plagiocephaly: A Review Of The Current Literature**

Abstract number: **356**

Authors: **R. Kakaiya, A. MCGARRY**

Presenter: **R. Kakaiya**

Deformational plagiocephaly (DP) is an asymmetrical flattening of the skull in infancy due to prolonged external force in one area. The recent increase in infants presenting with deformational plagiocephaly has seen more interest in the subject. The deformity can be corrected by cranial orthosis or by active repositioning. This literature review aims to compare **Methods** of shape capture, determine the more successful method of intervention and also explore the relationship between DP and developmental delay.

Literature published between 2006 and 2011 was sourced using seven databases. Twenty-nine publications met the inclusion criteria. All studies were appraised by the Scottish Intercollegiate Guidelines Network. Methodological quality was varied. Three systematic literature reviews and two randomised controlled trials were included.

Currently, head shape can be quantified by either anthropometric measurement by hand or through three dimensional imaging (3D) or photogrammetry. It is argued that 3D imaging may be a more accurate and repeatable method as there is no need to determine exact anatomical landmarks by hand. However, measurements by hand will remain a simple and in-expensive method of measurement. There is evidence that both orthotic treatment and active repositioning are successful; however when treated orthotically, the head shape asymmetry is seen to reduce at a faster rate. Research shows that there is a relationship between DP and developmental delay, particularly in the gross motor skills.

Further work is required to determine a standard measurement method and thus a standard severity scale which can be used by all clinicians to determine the mode of treatment required. The relationship between DP and developmental delay has not yet been fully established and in some cases it is thought that it is the delay in development which causes the infant to develop the head shape deformity.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Paediatrics - 3**

**Room 1.02**

Abstract Title: **Outcome Of Single Event Multilevel Lever Arm Restoration And Anti Spasticity Surgery For Cerebral Palsy**

Abstract number: **408**

Authors: **A. Sasidharan, D. Sharan, R. Ranganathan, R. Alva, M. Manikandan**

Presenter: **D. Sharan**

### **Introduction**

In Cerebral Palsy (CP), lever arm dysfunction and spasticity of non-antigravity or the body propelling muscles are the major factors which restrict gait and motor function. The aims of the study to find out the functional outcome of single event multiple lever arm restoration and anti-spasticity surgery (SEMLARASS).

### **Methods**

The study design was pre-post experimental design. 314 children with different types of cerebral palsies participated in this study. Mean age of the participants was  $9.7 \pm 4.8$  years. Distributions of children were spastic diplegia (58%), spastic quadriplegia (35%) and spastic-athetoid quadriplegia (7%). The surgical procedures were performed by a single Orthopedic Surgeon which included Intramuscular Release and Controlled Tendon Lengthening using the principles of Orthopedic Selective Spasticity Control Surgery and simultaneous restoration of lever arm dysfunctions and was followed protocol based, sequenced multidisciplinary rehabilitation for an average of 6 months. Outcome measures such as Functional Mobility Scale (FMS), Manual Ability Classification System (MACS), Pediatric Quality of Life (PQOL) were used to measure the functional status of the children following post operative rehabilitation.

### **Results & Discussion**

The Results showed a significant improvement after a 1 year post -surgical rehabilitation. Correlation studies showed median value of FMS of 3 before surgery and 5 after surgery. Before surgery the median value of Gross Motor Functional Classification System (GMFCS) was level 4 and after surgery it was level 2. Before surgery the mean value of PQOL was  $39.64 \pm 17.49$ ; after surgery the mean value was  $23.11 \pm 14.02$ . Before surgery median value of MACS was 3 and after surgery it was 1.

### **Conclusion**

A well-planned and executed SEMLARASS, followed by intensive protocol based, sequenced multidisciplinary rehabilitation provides the person with CP an excellent functional improvement.



Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Paediatrics - 3**

**Room 1.02**

Abstract Title: **A Literature Review On Paediatric Idiopathic Flat Feet**

Abstract number: **266**

Authors: **E. Figgins, M. Caldeira, K. Ross**

Presenter: **K. Ross**

Paediatric flat feet are one of the most common conditions seen in orthopaedic practice. Flat feet can alter gait, by affecting the normal foot's biomechanics which can eventually cause indirect damage and lead to pain. This global issue is a common concern to parents. However its treatment is still debated within clinicians. Although conservative treatment is known to be the most common approach for idiopathic flat feet, there is no optimal strategy for it yet.

### **Objective**

To assess current the literature on the conservative treatment of idiopathic flat feet in children.

### **Methods**

Literature was obtained by performing a search of various databases. The inclusion criteria were: children  $\geq$  18 years, normal children without any underlying pathologies other than flat feet, symptomatic and asymptomatic flat feet, conservative treatments such as physiotherapy, orthotic management and observational treatments. Surgical management was excluded. The quality of the studies was assessed using the SIGN guidelines.

### **Results**

Thirteen studies were included. The sample size ranged from 8-300. The evidence from one study suggested that asymptomatic flat feet can be improved using physiotherapy (therapeutic exercises). Besides this, it was evident that the custom-made and prefabricated orthoses show long term and immediate improvements in asymptomatic flat feet. In addition, there is also evidence suggesting that asymptomatic flexible flat feet in children slowly improve with time. For symptomatic flat feet, the evidence from one study reported a reduction in pain intensity after orthotic use.

### **Conclusions**

The evidence for the conservative treatment of idiopathic paediatric flat feet is very limited. Due to the lack of good quality studies, it is not possible to make robust Conclusions for both symptomatic or asymptomatic flat feet. It was a concern that normal children without flat feet might be treated. Future studies are therefore required which accurately diagnose flat feet.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Paediatrics - 3**

**Room 1.02**

Abstract Title: **Distribution Of Gait Abnormalities In Very Young Children With Bilateral Spastic Cp According To The Modified Amsterdam Gait Classification. Implication For Orthotic Management.**

Abstract number: **493**

Authors: **M. Bonikowski, A. Czernuszenko, M. Pawowski, J. GSior**

Presenter: **M. Bonikowski**

Gait abnormalities are present at a very early age in children with CP. Proper orthotic management is crucial part of multidisciplinary rehabilitation. Aim: To describe prevalence of different gait types according to the Modified Amsterdam Gait Classification (MAGC) in the youngest walkers with bilateral spastic CP. To deliver proper orthoses according to gait deviation.

### **Methods and Subjects**

We analysed gait using 2D video recording in 75 children (150 legs) with spastic diplegia younger than 3 years GMFCS level II-IV selected for spasticity treatment with Botulinum Toxin. Gait type was described using the MAGC:

Mid Stance abnormalities:

Type 1 - normal.

Type 2 - Knee (hyper)extension without heel rise (HR)

Type 3 - Knee (hyper)extension with HR

Type 4 - Knee flexion with HR

Type 5 - Knee flexion without HR

Swing phase abnormalities:

Type A - dropfoot in midswing

Type B - stiff knee (initial swing knee flexion < 60 degrees, or delayed)

Type C - limited knee extension in terminal swing

Type D - adduction (+ - endorotation) of the hip in terminal swing

### **Results and Discussion**

In the study group gait type 2 was represented by 17 legs (11,3%), type 3 in 90 legs (60%) and type 4 in 43 legs (28,6%). Type 1 and 5 were not observed at all. Swing phase abnormalities A, B, C and D were observed in 107 (71%), 22 (14,6%), 143 (95%) and 92 (61%) legs respectively. Orthoses for gait improvement were prescribed and manufactured for all participants. Posterior Leaf Spring AFO (PLS) for combination of types 2 and A; PLS or PLS reinforced with carbon fiber for 2 or 3 and B, or B, C; AFO for type 4 regarding swing abnormalities. Supination, medial arch support or leather shoes were added according to feet abnormalities in weight bearing.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 10**

**Room 1.03**

Abstract Title: **A Bionic Foot - Compliance Control Supports A Broad Range Of Adls In Real Time**

Abstract number: **57**

Authors: **P. Kamps, A. Harms, J. Van Vliet**

Presenter: **P. Kamps**

### **Introduction**

Prosthetic feet have to fit a range of activities of daily life (ADLs). These include walking with different speeds, on inclines and using different shoes. However, mechanical designs of prosthetic feet have to be laid out to fit particular shoes and walking speeds. Current mechatronic designs adjust to changing conditions, but they typically adapt only gradually with time. The goal of the project was to design a foot with real time compliance control during each individual step.

### **Methods**

A microprocessor controlled, hydraulic foot with a series elastic element and a multiaxial kinematic was used. The sensors include a distinguished inertial sensing system. The design was tested by patients with various amputation levels and different body weights by executing activities of daily life in a gait lab.

### **Results**

The prosthetic foot adapts its compliance in real-time throughout the gait cycle. It supports different walking speeds, changing to different inclinations, walking on stairs, stepping on obstacles and shoes of different heel heights.

### **Discussion**

For mechanical feet a trade-off has to be made when selecting the stiffness of the foot, i.e. different stiffnesses would be desirable depending on the walking speed. The plantarflexion has to be set to fit a specific heel height for level walking and standing. Introducing a variable series hydraulic element gives the possibility to adjust the foot's compliance throughout the gait cycle. The hydraulic element introduces dissipation which is in contradiction to the paradigm of maximal energy return. However this anticipated disadvantage does not report in the patients' feedback.

### **Conclusions**

A microprocessor compliance controlled, hydraulic foot can give improved support to a broader range of activities of daily life when compared to mechanical designs. By using distinguished sensorics it is possible to react in real time to the situation during each individual step.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 10**

**Room 1.03**

Abstract Title: **Performance And Satisfaction With Assistive Devices Among Amputees And Polio Patients In Sierra Leone**

Abstract number: **116**

Authors: **L. Magnusson, N. Ramstrand, E. Fransson, G. Ahlström**

Presenter: **L. Magnusson**

### **Introduction**

Polio outbreaks and violence during the Sierra Leonean civil war resulted in an increased number of patients in need of orthotics and prosthetics. The aim of this study was to investigate patients' performance and satisfaction with their lower-limb prosthetic or orthotic device and their satisfaction with service delivery in Sierra Leone. In addition, the project aimed to compare groups of patients regarding gender, type and level of devices and demographics. Method Questionnaires were used to collect self-reported data from 139 lower-limb prosthetic and orthotic patients in Sierra Leone.

### **Result**

Eighty-six per cent of the devices were in use by patients. However about half of these devices needed repair. A third of the patients experienced pain or wounds related to their device. Patients had the ability to move around in their home and rise from a chair even though many experienced difficulties in doing so. Difficulties were reported while walking on uneven ground or up and down hills. Only a few patients could not walk on stairs or get into a car or bus even though the majority experienced difficulties while performing these activities. Patients were quite satisfied with their assistive device (mean score 3.7 out of 5) and the service provided (mean score 3.7 out of 5). About half of the patients could not access rehabilitation services or pay for costs related to receiving or repairing a device. In relation to both performance and service delivery, women had poorer Results than men; orthotic patients poorer Results than prosthetic patients; and patients using above knee devices had poorer Results than patients using below knee devices.

### **Conclusion**

Overall, patients were satisfied with their assistive devices and with the services provided. Patients had difficulties accessing follow up services and repairs and this was considered to be an important issue requiring attention.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 10**

**Room 1.03**

Abstract Title: **Functional Significance Of A Biomimetic Hydraulic Ankle/Foot System**

Abstract number: **113**

Authors: **E. Iversen, H. Sears, B. Mac Williams**

Presenter: **E. Iversen**

### **Introduction**

The Motion Foot is a new foot/ankle system that offers near-normal ankle range of motion via a hydraulic ankle (ROM = 50 deg), paired with an energy-storing foot plate. This system has been developed to offer above-knee and below-knee prosthesis wearer: 1) shock absorption at heel-strike, 2) smooth adjustable resistance to roll-over in mid-stance, 3) higher toe clearance during swing phase and 4) stability standing and walking on inclines.

### **Methods**

Instrumented gait lab analysis has been performed with trans-tibial and trans-femoral wearers of the new Motion Foot. (The gait lab utilized a 10 camera Vicom MX and four AMTI force plates.) Furthermore, the Compas System that measures sagittal and transverse moments in the pylon was used to compare moments on the remnant limb when using the Motion Foot compared to the moments with previous prosthetic foot while walking up slopes, down slopes and on level ground.

### **Results**

Wearers of the Motion Foot have reported improved comfort and stability and much less concentration and effort while walking on declines with the new foot/ankle system. Gait lab Results and moments measured with the Compas system both show reduced proximal limb loading and joint power especially on declines. Furthermore, gait symmetry was improved.

### **Discussion**

The benefits of a near-normal range of ankle plantar/dorsi flexion are verified for wearers of the Motion Foot, from both high ratings in comfort and stability (compared with their earlier feet) and also from gait analysis data which indicates greater stability, lower proximal joint power and shock absorption, especially on slopes - the higher the slope, the greater difference between this foot and others.

### **Conclusion**

A foot/ankle prosthesis that offers anthropomorphic range of motion with hydraulic damping can improve comfort, stability, reduce proximal joint loadings at heel strike and improve gait symmetry.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 10**

**Room 1.03**

Abstract Title: **A Systematic And Methodical Approach For The Development Of Powered Knee Prostheses**

Abstract number: **145**

Authors: **B. Budaker**

Presenter: **B. Budaker**

### **Introduction**

In this paper a systematic and methodical approach for the development of an active knee prosthesis system is presented. The presented procedure starts with the definition of the boundary conditions and ends with a graphical description of the important parameters for the power train in powered knee prostheses. An example of a active powered knee prosthesis will be shown.

### **Methods**

Basis for dimensioning active supporting systems for humans is always data that are collected for one certain application. For dimensioning an active artificial limb, data taken from gait analysis have to be used. For the following dimensioning of the drive system it is important to structure and document all relevant boundary conditions. The presented model describes a development process of a active powered knee prosthesis.

### **Results**

An active powered knee prosthesis using an EC-Motor with a gearbox-combination is developed using a systematic and methodical approach during the development procedure. The active knee prosthesis is able to support the gait of a transfemoral amputee in an active way. Possible torque output of this knee prosthesis is about 60 Nm at the knee axis.

### **Discussion**

The most important process step in the model is the accurate transfer of medical requirements into technical parameters. Core of the suggested procedure is the definition of a generally admitted coordinate system in which the technical parameters of the biomechanical systems are described in a mathematical form. The model also contains the consideration of the mechanical properties of the prostheses or orthotics system.

### **Conclusions**

In this paper a general approach for the development of an active driven prostheses or orthoses system is discussed. A model for the development process is presented and an example is given. With the presented model the design of drive systems for a biomechanical motion-system, a active powered knee prosthesis, is realized.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 10**

**Room 1.03**

Abstract Title: **The Development Of A Knee Joint Nal-Knee, And Evaluation Of A Gait Test About Using It**

Abstract number: **289**

Authors: **M. Ninomiya, M. Gotoh**

Presenter: **M. Ninomiya**

We have developed the knee joint Named "NAL-Knee" (Natural Automatic Lock Knee) for use in trans-femoral prostheses, enabling users to ascend and descend stairs. This knee joint is 24 cm in length, and it weighs 1080g. It has a new link (referred to as a "bouncer") under the hydraulic cylinder of the knee joint.

When ascending stairs with the load on the toe, the knee is stopped from bending at an arbitrary angle, and when descending with the load on the heel, the knee performs a yielding function. This knee does not require socket or foot replacement, and does not require batteries.

We tested ascending and descending stairs, and the flat-ground gait test. 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 was effective for all three subjects. When ascending stairs, a trans-femoral amputee with good athletic ability could climb faster and easier when using NAL-Knee, as compared to the conventional step-by-step method.

Another advantage of NAL-Knee is, that the motion of the knee joint on either side when changing walking speed on level ground is almost the same (the difference in the maximum knee flexion angle on either side is small). This may be because the use of a large hydraulic cylinder decreases resistance to the flow of oil, which appears to allow smoother bending of the knee in the swing phase, so that it becomes almost symmetrical with the able side. Running also appeared to be facilitated by the cushion action of the link and the moderate oil pressure resistance.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 3**

**Room 1.05**

Abstract Title: **Aiming Technology In Developing Countries To Obtain High Quality Prostheses At Low Cost**

Abstract number: **228**

Authors: **R. Torrealba, B. Amador, C. Müller-Karger**

Presenter: **R. Torrealba**

Contrasts are common in developing countries, where on one hand most medical devices are available but costly for most of the population, and on the other there is high-tech in some R+D centers, which could be used to create high quality products with more competitive prices. This paper is aimed as a bridge between these two realities in Venezuela.

A survey was applied to 17 transfemoral amputees in order to establish the specifications of a mechanical knee prosthesis. Then, the conceptual design was defined and the device was further developed, using a solving platform which runs a genetic algorithm that proposes dimensions to each of the parameters of the mechanism. A rapid prototyping model was built to verify the mechanism's kinematics and later, two metallic prototypes were manufactured and tested on patients.

For the population polled in the survey, the most important design parameter was the stability, for which the most suitable mechanism is a polycentric one. Every mechanism proposed by the genetic algorithm was simulated in the solving platform, especially comparing the location of the instantaneous center of rotation (ICR) with respect to the ground reaction force (GRF) line during the stance phase of gait cycle. Once stability was guaranteed, the two prototypes manufactured were adapted to patients who wore them during three months, three-times a week, without claiming any discomfort. The performance of the prosthesis was assessed qualitatively through the patients' opinion, and quantitatively by observing the behavior of the ICR with respect to the GRF during the stance phase. This prosthesis represents a simple functional product available for low cost, but designed through an elaborated procedure that led to optimum dimensions. The prosthesis here introduced represents an example of the capabilities found in developing countries when technology is aimed to assist their own requirements in prosthetic field.



Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 3**

**Room 1.05**

Abstract Title: **Living With A Physical Disability In Malawi: A Prosthetic And Orthotic Patient Perspective**

Abstract number: **496**

Authors: **E. Berg Lissel, E. Fredriksson, L. Magnusson**

Presenter: **E. Berg Lissel**

### **Introduction**

Malawi is located in south-east Africa, 53% of the population live below the poverty line. Few studies have specifically investigated the situation for people with physical disabilities in Malawi. The aim of this study was to explore the opinions and feelings of how it is to live with a physical disability in Malawi from a prosthetic and orthotic patient perspective.

### **Methods**

A qualitative study using individual semi-structure interviews for data collection was performed with 16 patients, men and women with physical disabilities receiving services from the prosthetic and orthotic centre in Lilongwe, Malawi. Data were analysed using content analysis.

### **Results**

Six categories emerged from the data. People with physical disabilities felt independent and wanted to take care of themselves. They experienced mainly positive attitudes and encouragement from others. They had a positive view of life, but the disability affected their life situation. Contact with other people with physical disabilities was requested for support and experience-sharing. The major concern was work and the financial situation. Ability to work was important to meet basic needs and for the feeling of independence. Negative attitudes were a result of poor knowledge.

### **Discussion**

The study showed a clear need of creating work opportunities specifically for people with physical disabilities, since having a job was found important for many reasons. Support programs profiled to help and strengthen people with physical disabilities in Malawi would be beneficial for them to access the labour market. Spreading knowledge and information about physical disabilities and orthopedic devices is a key issue to create a better understanding and to change people's attitudes.

### **Conclusions**

Work was important for the feeling of freedom, independence and for the self-image. Negative attitudes were uncommon, but when seen they were a result of poor knowledge about causes of disability and the situation for these people.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 3**

**Room 1.05**

Abstract Title: **Assessment Of Functional Capability And Self-Esteem Of Haiti Earthquake Victims With Lower-Limb Loss**

Abstract number: **355**

Authors: **H. Alhamzah, R. Gailey, J. Kornfeld, J. Miller**

Presenter: **R. Gailey**

### **Introduction**

On January 12, 2010, the earthquake struck the poorest country in the western hemisphere, Haiti, resulting in more than 200,000 deaths. A large number of survivors sustained significant injuries resulting in approximately 2-5,000 amputations. The purpose of this study was to assess the effect of the employment and recreational activity of lower-limb amputees (n=55) two years after January 2010 catastrophe.

### **Methods**

Seventy- three patient-records of amputees were reviewed from Hospital Bernard Mevs/Project Medishare hospital's archive; interviews were completed with 55 patients (28 TFA, 25 TTA, 1 TMTA, and 1 BTTA). Data was extracted from patients' records and in-person and phone interviews were conducted to complete missing data and to confirm recorded data in the medical records. The ICF Activity and Participation Survey was used to assess functioning; and employment and recreational activity statuses were acquired through additional direct questions to participants.

### **Results**

The self-report outcome measure found that 81% ranked themselves as having a high level of functional capability with 83% indicating average or above average self-esteem. However, 53% had lost their jobs and/or learning opportunity and 34% quit participating in recreational activities after earthquake related amputation. Reasons for loss of job or educational opportunities, included: discrimination, intolerance, lost support from family or friends and lack of funding to secure employment opportunities.

### **Discussion and Conclusion**

Despite significant employment / lost learning opportunities and change in recreational activity status, post earthquake Haitian with limb loss report high level of function and have high self-esteem. Providing job opportunities, proper support and guidance would very likely result in a highly-productive amputee community in Haiti.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 3**

**Room 1.05**

Abstract Title: **The Hispaniola Island Prosthetic And Orthotic Education Program (Hipoe) – An Overview**

Abstract number: **388**

Authors: **D. Lawrence, G. Grisetti**

Presenter: **D. Lawrence, MSPT, ATC**

### **Introduction**

For over 10 years Physicians for Peace and the Walking Free project have worked in the Dominican Republic and Haiti to establish, enhance and advance prosthetic and orthotic rehabilitation providing programs to a variety of rehabilitation professionals. During this time, education for prosthetic and orthotic technicians was clinically based because of the absence of formal educational institutions in either country for training or certification. Over time Physicians for Peace determined that clinically based education, though helpful, would not produce a long-term sustainable P&O system in either county. Distance learning was viewed as a viable alternative and a program was implemented to address the need on a permanent basis.

### **Methods**

An international collaborative partnership between entities with a common goal to provide the knowledge base, administrative structure, organizational skills and resources was developed to produce a successful outcome with a distance learning program. The stakeholders included NGOs, in country rehabilitation centers, institutions of higher learning, and governmental agencies. Twelve trainees were selected from partner institutions and the training began in 2011 although plans for post earthquake Haiti changed. Participants have completed two modules of the University of Don Bosco distance education program from El Salvador.

### **Results**

Of those trainees who took the exam, 75% (n8) passed module one and 90% (n8) passed module two.

### **Discussion**

The pass rate suggests that the majority of trainees are meeting established standards.

### **Conclusion**

The success of the program continues to depend on support provided by the stakeholders at all levels including week long curriculum support missions scheduled near the end of each module as well as the provision of a mentor who spends at least 2 weeks in-county in the middle of each module. Interim and final evaluation will be performed to determine the impact of this distance learning program.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Developing Countries - 3**

**Room 1.05**

Abstract Title: **Implementing National Programmes For Clubfoot In 20 Low Income Countries: Progress Over 2 Years**

Abstract number: **468**

Authors: **M. Steenbeek, R. Owen**

Presenter: **M. Steenbeek**

### **Introduction**

Clubfoot is a congenital deformity affecting nearly 200,000 children born each year worldwide, with 80% of these in low income countries. Increasingly, the Ponseti method is being taught and utilised in these settings to prevent severe disability caused by untreated clubfoot.

### **Methods**

Following Introduction of national programmes for clubfoot using a standardised approach to capacity building and service provision programme managers in 20 low income countries were surveyed in order to collect data on clubfoot cases treated and training activities in 2009. The survey will be repeated for data from 2011 in order to compare performance over 2 years and to gain qualitative data on barriers and factors for success in implementing national programmes for clubfoot.

### **Results**

More than 6,000 babies were enrolled for treatment in sample year 2009. Introduction of programmes resulted in rapidly increased awareness and in children identified and treated. In one integrated programme involving 12 countries, 112 clubfoot clinics were established, 634 personnel trained and 7705 babies treated over 2 years. These data will be compared with outcomes for the same 20 countries for 2011.

### **Discussion**

The Ponseti method has been found to be effective in correcting the clubfoot deformity, with good long-term functional outcomes. Addressing the need for treatment in low income countries will require an approach incorporating public health principles, early intervention and building capacity through training and coordinated national or regional programmes.

### **Conclusions**

Country-wide programmes for the treatment of babies with congenital clubfoot can be successfully implemented when appropriate health systems administration is followed. The methodology was found to be applicable across continents and cultures. Standardisation of methodology facilitates integration into national plans and allows potential for global programming.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 11**

**Room 1.06**

Abstract Title: **Clinical Experiences With Temporary Socket And Modular Socket System In Patients With Lower Limb Amputation**

Abstract number: **147**

Authors: **H. Hashimoto, S. Hirabayashi, K. Hasada**

Presenter: **H. Hashimoto**

An initial lower limb prosthesis during rehabilitation period has to be fitted and delivered to achieve early discharge from hospital, while stump volume and shape are fluctuating. It also has to be considered the way to evaluate the stump for determining the socket design. Therefore, we have adopted a procedure using temporary cast socket prior to modular socket system.

Firstly, general condition is assessed to determine the patient is suitable for fitting prosthesis or not. Once general condition has assessed, one week trial of Iceross liner will be given. When a Iceross liner is usable, a temporary TSB cast socket is made with a Icross liner and Icecast at hospital. The TSB cast socket will be assembled with ideal prosthetic components, and then physiotherapist can start standing and gait training immediately. When the socket loosens, it could be renewed at the hospital. The final evaluation will be conducted during the training period whether a TSB socket is suitable or not. When TSB is usable, the modular socket system is applied and complete prosthesis will be delivered before discharge.

With this procedure 23 cases are fully succeeded. There was no failure when utilizing the modular socket system because of ill-fitting. A cast socket enables the amputee to start the training process early because it is easy to be renewed when edema is minimized or the stump shape is changed. It is also cost-effective and useful for evaluating Iceross liner with TSB socket. Complete prosthesis with modular socket system will be produced within 3-4 hours which includes casting and fabrication, so it is considered to be useful for early discharge. It is efficient to use both temporary cast socket and modular socket system for a first lower limb prosthesis during rehabilitation period.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 11**

**Room 1.06**

Abstract Title: **Stress Analysis Of Different Rigid Frame Designs Within A Flexible Transfemoral Prosthetic Socket**

Abstract number: **165**

Authors: **O. Komolafe, R. Caldwell, K. Tucker, A. Hansen, W. Chen, C. Sun, S. Fatone**

Presenter: **S. Fatone**

### **Introduction**

In vacuum suspension sockets, loss of elevated vacuum pressure is often a result of non-conformation of the socket material to changes in residual limb shape and volume. Reduced vacuum suspension may lead to increased relative movements (i.e. pistoning) of the residual limb within the socket. Fabrication of the socket from a flexible material provides a direct solution; however, to be of practical use, minimum socket rigidity for stable load transfer between the residual limb and prosthesis must be maintained. To maximize socket flexibility, we use a fenestrated rigid socket (i.e. frame) embedded within a laminated polyurethane flexible material. We present Results of a finite element (FE) analysis evaluating the effect of different frame designs on residual limb/socket interface stress distributions.

### **Methods**

Equipment: Creaform 3-D digitizer, Novel pliance system, Instron mechanical testing system Procedure: A FE model of a transfemoral sub-ischial prosthetic socket is developed and validated. The model assembly was simplified to the following components: (1) Rigid frame, (2) Flexible polyurethane layer, (3) Silicone liner and (4) Residual limb. A FE analysis was then performed in Abaqus FEA (Dassault Systemes).

### **Results**

Qualitative Results from the FE analysis showed a non-uniform stress distribution that was different for each socket. Preliminary Results indicate regions of high normal stresses around the proximal brim and regions of low normal stress values along the lateral wall of the socket. On-going work is focused on quantitative assessment of the effect of different frame geometries of various thicknesses on the stress distribution.

### **Discussion**

The sockets differed only in locations and extent of cut-outs within their rigid frames. Cut-outs in transfemoral sockets have been used to provide release areas that accommodate displaced tissues. The Results suggest this approach is useful to optimize flexible sockets capable of conforming to changing residual limbs, while achieving biomechanical load requirements.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 11**

**Room 1.06**

Abstract Title: **Assessing Gait Adaptability Longitudinally In Rehabilitation After A Transtibial Amputation.**

Abstract number: **156**

Authors: **K. Schenkeveld, M. Kerste, H. Wiggerts, O. Bosboom, T. Janssen, M. Roerdink**

Presenter: **K. Schenkeveld**

### **Introduction**

An important goal of the rehabilitation after a transtibial amputation is to increase walking ability. An important aspect of walking ability related to fall risk in community walkers is the capacity to adjust gait to environmental circumstances, such as avoiding obstacles and targeting safe foot placement locations. However, research on the course of walking ability and specifically gait adaptability during the rehabilitation program is scarce. The aim of the present study is to assess gait adaptability longitudinally in rehabilitation by exploiting an innovative instrumented treadmill (C-Mill, ForceLink) with visual context (e.g., stepping targets, obstacles) projected on the belt's surface.

### **Methods**

Longitudinal descriptive study. Six patients with a recent transtibial amputation, who were in primary amputee rehabilitation, were included in the study. They performed obstacle avoidance and visually-guided stepping tasks on the treadmill and overground three times with intervals of six weeks. Outcome measures include walking velocity, obstacle-crossing success rates and crossing strategies.

### **Results**

Soon after participants received the prosthesis, they were able to perform the C-Mill gait adaptability tasks. Preferred walking speed increased and most patients showed improvements in obstacle avoidance and visually-guided stepping tasks. The number of strategies to avoid obstacles increased over time. Patients required less stabilizing walking aids in daily life as gait adaptability improved over time.

### **Discussion**

The C-Mill can be used to evaluate walking ability in terms of gait adaptability during rehabilitation in prosthetic patients, who become community-walkers. It is important to assess gait adaptability in this group for several reasons: 1) to evaluate progress in the rehabilitation process, 2) to facilitate goal setting during the rehabilitation process, 3) to guide prosthesis fitting and 4) to assess their fall risk.

### **Conclusion**

With rehabilitation, patients with a recent transtibial amputation increase their preferred walking speed, improve gait adaptability performance and develop multiple obstacle-crossing strategies.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 11**

**Room 1.06**

Abstract Title: **The Role Of Quadratus Lumborum Muscle In Asymmetrical Loading Condition In Unilateral Transtibial Amputee**

Abstract number: **199**

Authors: **A. Vimal, S. Sharma, D. Joshi, R. Kumar**

Presenter: **A. Vimal**

### **Aim**

The purpose of this study was to investigate that the effect of quadratus lumborum contraction muscle in asymmetrical loading on energy expenditure and stride parameter of unilateral transtibial amputee. Thirty transtibial amputees subjects selected for measure the energy expenditure and stride parameter.

### **Methods**

The PCI measurement is the simple method to measure the energy cost. It is calculated by measuring the heart rate. Heart rate is calculated from pulse oximeter (CMS-50D ver.1.2) by placing on index figure. The energy expenditure measured through the difference in resting heart rate and walking heart rate with load carrying on ipsilateral and contra lateral side of prosthesis on shoulder divide by walking speed. Stride parameters were measured on the 10 meter paper walkway with 10% of body weight (BW) asymmetrical loading condition on the shoulder. The following gait characteristic stride parameters for each participant on the 10 meter walkway paper: - stride length, walking velocity.

### **Result**

The energy expenditure showed significant difference in right side amputee with two different loading conditions. Stride length and velocity were showed significant difference in the left amputee.

### **Conclusion**

Concluded that right side Quadratus Lumborum muscle contraction reduces energy expenditure by helping in right side hip elevation of right side transtibial amputee.



Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 11**

**Room 1.06**

Abstract Title: **Moisture Management Within A Prosthetic Socket**

Abstract number: **217**

Authors: **J. McCarthy, J. Ross, A. Mcdougall, L. Ritchie, A. Ward, S. Zahedi**

Presenter: **J. McCarthy**

### **Introduction**

Maintaining an intimate fit between the skin and prosthetic socket is a key factor to ensure the comfort and control of prosthetic devices. Relative movement (pistoning) causes abrasions, lack of control and extra energy expenditure leading to pain fatigue etc. Liners are usually made from visco-elastic materials such as polyurethane, silicone, or mineral gels which damp peak pressures increasing comfort. However, these liners do not “breathe”, they create an air tight seal between the residuum and the liner. The effects of amputation level and energy expenditure will be discussed.

### **Method**

A blind trial was carried out using trial liners, one of which incorporated sweat management. A questionnaire was completed after wearing each liner and the Results recorded.

### **Results**

**Results** were recorded after using each of two trial liners. There was an improvement in most cases when perforated liners were employed.

### **Discussion**

Amputees expend more energy during gait than the able bodied yet have less ability to cool due to loss of surface area. Experiments have shown that perforating a liner can have advantageous effects on moisture management including some unexpected advantages.

### **Conclusion**

Perforating liners can have advantageous effects.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Orthotics : Spinal - 1**

**Room G.06**

Abstract Title: **Use of 3D Volume Rendered CT Scans In The Design and Fabrication of TLSO**

Abstract number: **99**

Authors: **P. Ammanath, E. Wizuer, G. Shah, S. Murphy, G. Graziano**

Presenter: **P. Ammanath**

### **Introduction**

Fitting a thoracolumbosacral orthosis for patients after trauma or surgery requires a great deal of effort and expertise by an experienced orthotist. The current method of fabricating a custom TLSO begins with casting the torso of the patient which is often done while the patient is lying in a trauma unit. Obtaining a cast in this manner is challenging for the orthotist to maintain spinal stability while moving the patient into supine and prone positions increasing the risk of injury and discomfort. In this study, we used Computed Tomography scans of a patient's torso, to create a custom TLSO. The aim of the study was to compare the anthropomorphic measurements using the three-dimensional (3D) reconstruction of a torso surface model from CT scan to the traditional hand molding method for fabrication of TLSO.

### **Method**

Subjects: sixteen male subjects with pre-existing CT scans were evaluated in whom conventional TLSO fitting was performed. Procedure: Patients received CT scans utilizing "Trauma Chest Abdomen Pelvis" protocol. A 3D image in STL format was created from CT and custom mold was exported to TracerCAD. Virtual Comparison: Circumference, anterior-posterior (A-P), medial-lateral (M-L) Intervals are measured and compared for the two models generated for each subject. Data analysis: Pearson correlations and Bland-Altman tests were used to assess the relationship and agreement between the CT and conventional TLSO.

### **Results**

Sixteen male subjects mean age 53.31 and mean body mass index 27.91 kg/m<sup>2</sup> were evaluated. Correlations were high with an average correlation .72 (.71 - .93).

### **Discussion and Conclusion**

We found that 3D model measurements from CT scan and from plaster models were strongly related. This study provides preliminary support for the use of the CT method given its relation to conventional method.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Orthotics : Spinal - 1**

**Room G.06**

Abstract Title: **The Effect Of Spinal Bracing On Sitting Function In Children With Scoliosis And Neuromuscular Impairment**

Abstract number: 111

Authors: **A. Blomkvist, K. Olsson, M. Eek**

Presenter: **A. Blomkvist**

### **Introduction**

Treatment with modified custom-molded Boston brace is common in children with scoliosis and neuromuscular impairment in the western region of Sweden. The purpose of this study was to describe how sitting function is affected by the brace.

### **Methods**

A retrospective review of medical records from children fitted with scoliosis braces during 2003-10 at the Regional Rehabilitation Centre. An objective analysis of sitting on a bench was made using a pressure mapping system.

### **Results**

122 children were included; mean age 10.4 years (1.7-17.7). The most frequent diagnoses were cerebral palsy (CP)(n = 38) and myelomeningocele (MMC) (n = 19). Thirty-two children were independent walkers and 66 children could sit without support. Cobb angle was between 19° and 126°. The pressure mapping showed that symmetry was improved in 46/90 children while two deteriorated. Stability improved in 31/49 children and eight had decreased stability. Changes in sitting were also described in words, with improvement noted in 77 children and deterioration in five. These changes were categorised as: Stability, Posture, Ability to sit, Head Control, Activity, and Muscle tone.

### **Discussion**

The brace reduced the need for support in sitting. A more upright sitting position with improved head control increased the possibilities of participation. Sitting analysis with pressure mapping can identify the need for adaptations of the chair and corrections of the brace. The motivation of children and families to use the brace and the understanding of adaptations can be increased.

### **Conclusion**

This study shows that a brace has a positive impact on sitting function. The greatest effect was seen in children who could not sit without support, those with severe scoliosis and non-walkers. Children with CP seemed to gain more than children with MMC.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Orthotics : Spinal - 1**

**Room G.06**

Abstract Title: **The Application Of Asymmetric Loading For Spine Curvature Correction In Subjects With Adolescent Idiopathic Scoliosis**

Abstract number: **126**

Authors: **H. Cheng, Z. Huang, J. Cheung, Y. Zheng, D. Chow**

Presenter: **H. Cheng**

Load carriage is common in school-age children for transferring books and personal belongings. It is conventionally believed that abnormal external loading is one of the possible factors that may exacerbate spinal deformity. Thus, children are usually recommended to carry the load symmetrically over the shoulders. However, as asymmetric and side-shift exercises have been demonstrated to be effective therapeutic exercises for scoliosis management, we propose the use of properly controlled asymmetric load for postural correction and muscle conditioning in adolescents with idiopathic scoliosis (AIS). In our preliminary study of six subjects with AIS (Cobb's angle between  $10^{\circ}$  and  $21^{\circ}$ ), cross-chest single strap shoulder bags of different weights (2.5, 5, 7.5, 10 and 12.5% of subject's bodyweight) were applied to either shoulder of the subject in normal upright stance. Spine curvature, expressed in term of spinuous process angle (SPA), was assessed by manual palpation of spinuous processes and measured by photogrammetric method. SPA of the affected spinal region under different asymmetric load carriage configurations were compared to that of the unloaded situation. A preferable asymmetric loading configuration with minimum SPA was identified for each subject. The spinal curvature under the preferred loading configuration for each subject was further measured and confirmed by an ultrasound system. It was observed that scoliotic deformity could consistently be reduced by an asymmetric load positioned opposite to the apex of the major curve. Preliminary **Results** showed that an appropriate asymmetric loading configuration could help to reduce the lateral deformity of patients with mild scoliosis. Further investigations of the prolonged effects of asymmetric load carriage on spinal curvature, posture and back muscle activity in patients with AIS under dynamic situation are warranted.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Orthotics : Spinal - 1**

**Room G.06**

Abstract Title: **A Case Study Of Biomechanical Effect Of Spinal Orthosis On Scoliotic Spine Versus Time Domain**

Abstract number: **288**

Authors: **M. Li, K. Cheung, K. Wong, K. Luk, M. Wong**

Presenter: **M. Li**

### **Introduction**

The biomechanical effect of spinal orthosis on a scoliotic spine may not response immediately because of the low stiffness and viscoelastic properties of the soft tissues surrounding the spine. This study aims to apply 3D clinical ultrasound (3D CUS) method to monitor the curvature changes of a scoliotic spine at and after donning/ doffing of spinal orthosis.

### **Methods**

A female subject with adolescent idiopathic scoliosis and under orthotic treatment for a year was invited. She had right thoracic (50°) and left lumbar (30°) curves. It was a two-day study protocol. The first day was to check the doffing effect, while the second day focused on the donning effect. Before the ultrasound scanning, the subject was instructed to wear her orthosis 23 hours/day with prescribed strap tightness. On the first day, 3D CUS was used to monitor the spinal curvature changes from in-orthosis stage to immediate off-orthosis, 15-minute, 30-minute, 60-minute, 90-minute and 120-minute off-orthosis. Afterwards the orthosis was kept in the clinic. On the second day, 3D CUS was applied to monitor the spinal curvature changes from 24-hour off-orthosis stage to immediate in-orthosis, 15-minute, 30-minute, 60-minute and 90-minute in-orthosis.

### **Results**

According to the Cobb's angle estimated from US images, the immediate in-orthosis and off-orthosis effects were not obvious. By monitoring the curvature changes, both thoracic and lumbar curves increased > 5° at and after 90-minute off-orthosis, while both curves decreased > 5° at 60-minute in-orthosis.

### **Conclusions:**

This pilot study demonstrated the low stiffness and viscoelastic properties of the spine and time lag on the response of orthotic treatment. The best correction happened 60 minutes after bracing and the correction could not be maintained at and after 90 minutes off bracing. A further study with more subject number has been initiated in order to find out a solid Conclusion.

Date / Time: **Wednesday, Feb 6 / 14:30 - 15:45**

Session Name and Room: **Orthotics : Spinal - 1**

**Room G.06**

Abstract Title: **A Study Of Size Classification Using K-Means Clustering Applying To The Boston Brace In Japan**

Abstract number: **419**

Authors: **B. Masuhara, K. Kato, A. Sakamoto, T. Sakamoto**

Presenter: **B. Masuhara**

### **Introduction**

A module size of Boston brace (Allard support UK Ltd.) is selected from matching a patient's body size in each four specified points. If an order does not match prefabricated standard modules (PSM) of 30 patterns, a custom-made module (CMM) is applied. In our cases, 43% of all order belongs to a CMM. The applied condition of a PSM satisfies whether each of the measured size falls in the error range of +/- 2cm (waist) and +/- 4cm (chest, hip, ASIS (anterior superior illiac spine)). We tried to find integral four-measurement combinations for Japanese scoliosis patients by using a statistical clustering method.

### **Methods**

K-means clustering was applied on measurement data in 663 patients with CMM from Sep. 2004 to Oct 2011. The data consists of each circumference (chest, waist and hip) and distance between left and right ASIS. The first step is to divide measurement data groups into 8 classes by k-means method. The second step is to divide into 10 classes (C1-C10) by k-means method applying for classes except for lower 3 classes as outliers.

### **Results**

The top three center value of the cluster which belongs a lot of samples were as follows: [Chest-Waist-Hip-ASIS(cm):C1:69-64-82-25, C2:64-61-75-24, C3:62-54-80-24]. 49% of all of CMM belongs to the C1-C3.

### **Discussion**

In our investigation, the size combination of the most used in PSM is [S1:66-57-80-22]. Although the C1, C2 and C3 size combination exists near the S1, one size in the each combination does not fall in an allowable range. When simulated what percentage matches each C1-C10 center value of cluster, 42% of the CMM applied was covered.

### **Conclusions:**

We proposed method to find four size combinations simultaneously related to matching of Boston brace with k-means clustering and showed the validity of our proposed method in CMM applied cases.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Seating & Wheelchair - 1**

**Room 1.01**

Abstract Title: **Design And Development Of A Wheelchair Having An Integral Transfer Board.**

Abstract number: **283**

Authors: **V. Agrawal, S. Winkler, J. Sanford**

Presenter: **V. Agrawal**

### **Introduction**

People with bilateral or higher level amputations typically use a wheelchair for indoor mobility and transfer-boards for transferring to/from the wheelchair. Users who lack adequate strength, balance and coordination are at risk of experiencing a fall while using portable, standard transfer-boards (STB). The purpose of this study was to design and develop a wheelchair with an integral transfer-board (SafeSlideBoard-SSB) and to compare the SSB with STB.

### **Methods**

A new prototype of the transfer wheelchair was developed in collaboration with a manufacturer to meet all performance specifications of a mass produced product. Finite element analyses (FEA) and fatigue testing were done with the SSB model and prototype, respectively. Comparison between STB and SSB was then performed by 11 wheelchair users and 9 therapists, in terms of independence, safety and difficulty during a toilet and a tub transfer.

### **Results**

Modifications were made to the SSB design following FEA and the prototype successfully passed mechanical testing without safety concerns. There were no significant differences between the two transfer devices in either test group for independence, safety and difficulty. When toilet and bench transfers were aggregated, "Safety" was found to be significantly higher for SSB than STB.

### **Discussion**

The small sample size made achieving significant differences between SSB and STB difficult. Trends, however, demonstrated more positive outcomes with the SSB compared to the STB. Open-ended responses about the design and usability of SSB suggest that having a transfer board fixed to the wheelchair is not only safer and more secure, but also more convenient and easier to use.

### **Conclusion**

Observational and self report data from both older wheelchair users and therapists demonstrate that the attached transfer device is not only highly feasible, but has the potential to have large effects on the independence, safety and ease of transfer for older users.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Seating & Wheelchair - 1**

**Room 1.01**

Abstract Title: **The Rapid Provision Of Appropriate Wheelchairs In Emergency Situations**

Abstract number: **329**

Authors: **D. Constantine, S. Sheldon**

Presenter: **D. Constantine MBE**

### **Introduction**

Disasters result in death and injury. A significant number of people injured will need to use a wheelchair permanently or temporarily. Disabled people who lose their wheelchair are also vulnerable; they are unable to access emergency services such as food, shelter and medical aid. In an emergency response, wheelchairs are usually slow to arrive and rarely meet international standards. They are not designed for the challenging environments typical of emergencies, cannot be adapted to fit the user and often cause secondary complications.

### **Method**

The lack of appropriate wheelchairs for emergency situations hinders inclusion of disabled people in a humanitarian response. Motivation and Handicap International have collaborated to develop a wheelchair specifically for this purpose; easily transportable, quick to assemble and low-cost. The wheelchair is also adjustable, durable, and designed for rough terrain. This product is a starting point for effective rehabilitation, helping ensure that appropriate and long term wheelchair provision is planned at the onset of a humanitarian response.

### **Results**

The emergency wheelchair design has been prototyped and tested to ISO7176-8, and is currently undergoing trials. The Results of these trials will be fed back into the design. A support package to ensure it is delivered safely and effectively has also been developed and will undergo trials later this year.

### **Discussion**

This product complements existing activities in the field and will enable a shift in international practice. Wheelchair services are under-represented aftermath of a disaster, yet the P&O sector is well placed to integrate appropriate wheelchair provision into its existing activities.

### **Conclusions**

An emergency wheelchair delivered promptly in crisis situations can reduce overflow in health services; enable follow-up and facilitate mobility in successive displacement. It can also help avoid isolation; allowing disabled people to participate in relief activities; relieving the burden on families and contributing towards psychological recovery.



Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Seating & Wheelchair - 1**

**Room 1.01**

Abstract Title: **A Project On Prefabricated Special Chair**

Abstract number: **149**

Authors: **M. Kumari, S. Raju, R. Hussain, S. Govindasamy**

Presenter: **M. Kumari**

### **Introduction**

Many children with disabilities, primary Cerebral Palsy require special chair. It is observed that special chair improve child's sitting posture, engage in self-care, play activity and have a meaningful impact on child and the family. Fabrication of special chair is often tedious, requires skills and takes time. The need of hours is to find solution for the above challenges.

### **Objectives**

To design 'off the shelf product'. A prefabricated special chair with adjustable features, cost effective, is reducing the delivery time.

### **Method**

Randomized sample selection technique was used to collect data of 200 children with cerebral palsy, delayed milestone and spina bifida having poor seating balance with or without head and neck control. Individual measurements were taken in relation to segmental classification of height, width, depth and body circumference. Mean and standard deviation at baseline were derived from measurement for each part required to assemble the chair.

### **Results**

Parts for eight different sizes of prefabricated special chair have been developed. Sizes are 1(A, B), 2 (A, B), 3 (A, B) and 4 (A, B). The size varies in height and depth. Each size has two seat widths A and B ranging from 20-38 cms. Range of difference for A and B is 4 cms. Back rest (50 to 65 cm), seat depth (20 to 40 cm), foot rest position (16 to 37 cm), and length of foot plate (15 to 24 cm).

### **Discussion**

Prefabricated parts of eight sizes along with adjustable features enable us to reduce the delivery time considerably. In 2010, 44 special chairs were fabricated and delivered whereas in 2011, 203 prefabricated special chairs were fitted.

### **Conclusion**

Adjustable features allow modifying the same chair as the child grows, reducing the cost required for replacing to new piece. Introducing the prefabricated special chair significantly increased the overall fitment rate.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Seating & Wheelchair - 1**

**Room 1.01**

Abstract Title: **Design Of A Standing Wheelchair**

Abstract number: **538**

Authors: **H. Chaudhary, S. Veer, S. Srinivasan**

Presenter: **S. Veer**

### **Introduction**

A person with leg disability may have to use a wheelchair for his/her entire life. In a conventional wheelchair, the user spends most of the time seated in one position. Providing the ability to stand can help alleviate physical issues such as sore body, building of pressure points, and lowered blood circulation due to lack of movements. In addition, it can improve the quality of life for the wheelchair user by enabling eye-level interaction with other people and access to objects at elevated heights. In this work, a mechanical wheelchair with an adjustable frame that can elevate the user to a standing position has been designed for household use.

### **Methodology**

This development of the wheelchair was carried out in a sequential manner starting from understanding the user's needs, synthesizing kinematic mechanisms, evaluating various design options and selecting a design for further analysis and prototyping. Kinematic synthesis was carried out to determine suitable link lengths for the mechanism. The design was modeled using CAD and Finite Element Analysis was carried out to determine suitable cross-sections for the links for the material chosen. A wooden prototype was initially made to evaluate the proof-of-concept. Springs are used in the wheelchair to balance the weight of the person and reduce the effort of the user in getting to the standing position. Based on the experience with the wooden prototype, a metal prototype made of Aluminum has been built.

### **Results**

Able-bodied users weighing about 65 kg have tried the prototype with good success. By operating the hand levers, the user is able to lift himself up to a standing position and come back down to the seated position. The design exhibits good stability for the user in both the seated and standing positions. Improvements are being made to the design to incorporate additional safety features in the next prototype before having actual wheelchair users test the design. The design has been demonstrated at national level competitions and has won several awards. A patent application has been filed and commercialization of the design is being explored.

### **Conclusion**

A mechanical user-operable standing wheelchair has been designed in this work. The goals of a cost-effective, simple, easy-to-operate design have been met.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Orthotics : Spinal - 2**

**Room 1.02**

Abstract Title: **The Effectiveness Of Milwaukee Brace On Thoracic Hyperkyphosis In Patient Referred To The Iranian Red Crescent Society**

Abstract number: **422**

Authors: **M. Khanali, Z. Hedayati Roshan, S. Hasanpour, M. Seif, A. Daryabor**

Presenter: **M. Khanali**

### **Introduction**

Hyper kyphosis is a common spinal deformity which means an increase in the normal kyphosis angle in the sagittal plane. Its frequency assumes to be 15.3% in western countries and 13.2%[3] in Iran in those attending high school. If the deformity angle is more than 40 degrees orthotic intervention may be recommended. Thus new Methods for conservative treatment of hyperkyphosis have been suggested during the last several decades, Milwaukee brace has remained as the gold standard for managing this disorder. The aim of the study was to analysis the effect of Milwaukee brace on patient with hyperkyphosis referred to the Red Crescent society between 2009 and 2011 during seven months.

### **Methods**

304 Patients who referred to the Rehabilitation Center of Iranian Red Crescent Society between years 2009 and 2011, and were managed using Milwaukee brace, were recruited to participate in this retrospective longitudinal study (210 female and 94 male) among which 119 subjects have been referred because of hyperkyphosis. The Cobb angles were extracted out of the x-rays to the third and seventh month of using the Milwaukee brace. These angles were statistically analyzed using the statistic package SPSS version 19. After assuming normal distribution of the data, paired sample t-test was employed to compare the means.

### **Results**

The amount of hyperkyphosis between the primary angle (mean=59.57) and the secondary one after 3 and 7 months (means= 44.54 and 43.54 respectively) were compared and a significant difference was revealed (p-value= 0.007). The incidence of hyperkyphosis in this study was 38% in girls and 55% in boys.

### **Conclusion**

This study demonstrates that hyperkyphosis prevalence in boys is more than girls. The Milwaukee brace reduced the kyphosis angles in both genders equally.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Orthotics : Spinal - 2**

**Room 1.02**

Abstract Title: **The Clinical Investigation Of Wireless Posture Monitoring System In Treating Patients With Osteoporotic Vertebral Fracture**

Abstract number: **440**

Authors: **L. Wang, A. Wong, M. Wong**

Presenter: **L. Wang**

### **Introduction**

Severe osteoporosis could cause vertebral compression fracture and hyper-kyphotic deformity. Thoraco-lumbo-sacral-orthosis (TLSO) is generally applied in controlling such deformity. However, limitations such as restricted respiration, poor compliance and trunk muscle atrophy were found. A wireless posture monitoring system (WPMS) has been developed for posture training through audio-biofeedback mechanism. This study aims to compare clinical effectiveness of these two captioned interventions (TLSO and WPMS) for the patients with osteoporotic vertebral fracture (OVF).

### **Method**

Female patients (with age > 55 & OVF) were recruited for the four-week posture training programme. They were divided into a test group (8 subjects were applied with WPMS for 3 hours/day) and control group (11 patients were applied with TLSO for 3 hours/day). The assessment parameters included kyphotic angle (electronic-inclinometer), pain assessment (Roland-Morris Disability Questionnaire, RDQ) and health related quality of life (HRQOL, through Short Form -36).

### **Results**

The average kyphosis angle of the test group had a significant decrease of  $4.6^{\circ}$  ( $\pm 2.5^{\circ}$ ) at the 4th week ( $p < 0.05$ ) while the reduction of the kyphosis angle in the control group is not significant ( $p > 0.05$ ). The average RDQ scores for the test group were  $21.3 \pm 0.3$  (1st week) and  $19 \pm 1$  (4th week) while the control group were  $21.5 \pm 1.5$  (1st week) and  $20.5 \pm 0.5$  (4th week). No significant difference in HRQOL between the two groups.

### **Discussion and Conclusion**

Obvious spine extension occurred in the thoraco-lumbar region of the test group. In this ongoing study, X-rays will also be used to compare the clinical Results. A long-term assessment and posture information will be collected for further comparison of effectiveness of TLSO and WPMS.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Orthotics : Spinal - 2**

**Room 1.02**

Abstract Title: **Development Of A New Cervico Thoracic Orthoses Its Design & Pilot Evaluation**

Abstract number: **480**

Authors: **T. Hanajima, B. Masuhara, A. Sakamoto, T. Sakamoto**

Presenter: **T. Hanajima**

### **Introduction**

In a spine position, patients wearing a conventional CTO (c-CTO) often complain of pain caused by a pressure created by a posterior support surface which often fails to conform to the shape of the head. In order to decrease the pain due to the pressure, a new CTO (n-CTO) is developed with a new posterior support surface to create better pressure distribution. This study aims to compare the posterior support surfaces of c-CTO and n-CTO. The n-CTO-posterior shell has two layers with an outer-shell made of hard plastic and an inner-shell made of an elastic one. The inner-shell has a mesh shape which conforms to the shape of the head, and it hangs like a hammock within the outer-shell and fixed to the outer shell by the four pins.

### **Method**

The subjects were three healthy volunteers. Range of height and weight of subjects were 169-171cm and 61-81.6kg. A sensor sheet was used to measure the pressure of the contact area between the head and the CTOs in the spine position. Measurement was performed three times alternatively while wearing c-CTO and n-CTO. We compared contact area and mean pressure of c-CTO and n-CTO. Coefficient of Variance (COV) was used to statistically compare two sets of data. ( $COV = \text{standard deviation} / \text{mean}$ ) A COV value is lower when a degree of pressure distribution is higher.

### **Result**

Compared to c-CTO, Contact area of n-CTO increased to 18%, Mean pressure of n-CTO reduced to 30% and COV of n-CTO was 0.18point lower.

### **Discussion**

As a result n-CTO increased the contact area, hence reduced mean pressure also COV value was lower. Therefore the n-CTO suggests its effectiveness in pressure distribution compared to the c-CTO.

### **Conclusion**

The new design of n-CTO-posterior shell was successful in reducing the mean pressure with better pressure distribution than c-CTO in this study.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Orthotics : Spinal - 2**

**Room 1.02**

Abstract Title: **The Rewalk Powered Exoskeleton: A Powered Orthosis To Restore Ambulatory Function To Individuals With Thoracic-Level Motor-Complete Spinal Cord Injury**

Abstract number: **539**

Authors: **A. Esquenazi**

Presenter: **A. Esquenazi**

### **Objectives**

The aim of this presentation is to present the safety and performance of ReWalk in enabling people with paraplegia due to spinal cord injury to carry out routine ambulatory functions.

### **Our Results**

We currently have data on 16 subjects. After training, all subjects were able to independently transfer and walk, without human assistance while using the ReWalk, for at least 100 m continuously, for a period of at least 5 to 10 mins continuously and with velocities ranging from 0.1 to 0.55 m/sec (mean, 0.35 m/sec).

Some subjects reported improvements in pain, bowel and bladder function, and spasticity during the trial. All subjects had strong positive comments regarding the emotional/psychosocial benefits of the use of ReWalk.

### **Conclusions:**

ReWalk holds considerable potential as a safe ambulatory powered orthosis for motor-complete thoracic-level spinal cord injury patients. Most subjects achieved a level of walking proficiency close to that needed for limited community ambulation. Further development and application of this rehabilitation tool to other diagnoses are expected in the future.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 12**

**Room 1.03**

Abstract Title: **A Biomechanical Model For The Estimation Of Dynamic Interactions At The Transfemoral Socket Interface**

Abstract number: **136**

Authors: **J. Wojtusch, P. Beckerle, O. Von Stryk**

Presenter: **J. Wojtusch**

### **Introduction**

For the analysis of the human gait with prosthesis and the design of prosthetic devices, the knowledge of fundamental dynamic interactions at the user-prosthesis interface is required. A direct measurement of these interactions, including forces, torques, and powers, is complex and necessitates additional sensors in the prosthesis.

### **Methods**

In this work, a biomechanical model for the estimation of dynamic interactions at the transfemoral interface in sagittal plane is presented. By applying an inverse dynamic simulation, the normal force, torque and power at the interface are computed for different gait scenarios and lengths of the residual limb. The biomechanical model consists of multi-body system dynamics models of the legs and the trunk. The sound leg is modeled by three rigid bodies for thigh, shank, and foot as well as three rotatory joints representing the hip, knee, and ankle joint. The model of the leg with prosthesis is obtained by partitioning the rigid body of the thigh into a residual and a prosthetic limb and linking both partitions by virtual joints representing the transfemoral interface. The parameters of the residual limb are identified by fitting the inertial specifications to a detailed geometric model of the human thigh.

### **Results**

The simulation Results provide essential information for gait analysis and prosthesis design.

### **Discussion**

The power characteristics allow to evaluate the effort that has to be expended by the prosthesis user, while the torque characteristics show the influence of different prosthesis lengths on the loads of the residual limb. The normal force characteristics describe the impact of force peaks introduced by ground reactions and are a measure for the pressure distribution at the prosthesis stem.

### **Conclusions**

The presented biomachnical model is a first approach towards a comprehensive simulation environment for the human gait with prosthesis and will be further enhanced in accuracy and applicability.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 12**

**Room 1.03**

Abstract Title: **Analysis Of Ankle Biomechanics With An Advanced Microprocessor Controlled Ankle-Foot Prosthesis**

Abstract number: **215**

Authors: **J. McCarthy, N. Stech, A. Sykes, D. Moser, J. Ross, A. Mcdougall, S. Zahedi**

Presenter: **J. McCarthy**

### **Introduction**

The healthy limb has an amazing capability to adapt to the changing requirements of walking such as walking on varied inclined ground and at different walking speeds. An advanced microprocessor controlled ankle foot system has been developed that has the capability to alter and adjust how the foot interacts with the ground by controlling the amount of energy that is stored and released elastically by the foot in the stance phase of the gait cycle. This study aimed to develop a deeper understanding of how changing ankle foot properties automatically for different walking environment may influence biomechanical parameters at the ankle.

### **Methods**

Gait trials and measurements were conducted both outdoors on various walking inclines and speeds. For each walking scenario/task the ankle foot properties were altered in each case to determine how the ankle foot kinetics would change if a microprocessor or control foot system would adapt the ankle kinetics and kinematics.

### **Results**

The Results of the study highlighted distinct differences in ankle bending moment data which could be correlated to changes in ankle motion, walking speed and the walking task undertaken. The largest differences in the kinetic ankle moment data were shown in the first 40-50% of the stance phase. Overall the Results showed that adaptation to the viscoelastic response of the foot could produce marked changes in both ankle motion and kinetics that were independent of the walking activity being carried out.

### **Conclusions**

The Conclusion from this study supports the view that future ankle-foot systems should ideally have the capability to adjust to better optimize the gait tasks being undertaken. The consequences of pathological kinetics at the ankle we believe contribute greatly to the energetic of locomotion and the degree to which amputees have to adapt and compensate their gait.



Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 12**

**Room 1.03**

Abstract Title: **Service And Cost Of Transfemoral Osseointegrated Prostheses Compared To Socket-Suspended Prostheses**

Abstract number: **379**

Authors: **E. Häggström, K. Hagberg**

Presenter: **E. Häggström**

### **Introduction**

Transfemoral amputation (TFA) prostheses can be fitted directly to the skeleton using an osseointegrated implant (without socket). Treated patients have reported improvements in quality of life but no study has investigated prosthetic maintenance costs. The aim of this paper is to investigate differences of prosthetic service and costs of osseointegrated prostheses (OI-prostheses) as compared to socket-suspended prostheses (S-prostheses) among patients with unilateral TFA.

### **Methods**

All prosthetic costs and number of visits were noted during ~10 years and taken from one non-profit prosthetic workshop. The study included 36 patients with S-prostheses (83% male, mean age 51.3 years, cause 75% trauma, 19% tumour, 6% other) and 20 patients with OI-prostheses (55% male, mean age 56.6 years, cause 65% trauma, 25% tumour, 10% other). The mean cost of a new prosthesis, including material and working-hours, was compared in a sub-group.

### **Results**

There was statistically significantly fewer workshop-visits with OI-prostheses compared to S-prostheses (3.1 vs 7.2 visits/year,  $p < 0.0001$ ). The mean total annual cost of new prostheses, services, repairs and adjustments was 14% lower for OI-prostheses than S-prostheses (€3,149 and 3,672 respectively,  $p = 0.632$ ). The OI-group had to larger degree been supplied with more expensive knee-components. The distribution of cost of labour and cost of material was 7 and 93% for new OI-prostheses and 30 and 70% for new S-prostheses.

### **Discussion**

The main finding was not the small difference in costs between the two kinds of prostheses but the significant difference in number of visits for service. The osseointegration treatment includes other costs (e.g. surgery, implant, hospitalisation) which also needs to be investigated further.

### **Conclusions:**

Despite fewer visits for prosthetic service with OI-prostheses the overall prosthetic costs for OI-prostheses were comparable to S-prostheses. This study suggests this is due to higher costs of material used with OI-prostheses such as more expensive knee-components.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 12**

**Room 1.03**

Abstract Title: **Does A Mechanically-Demanding Task Exaggerate The Effect Of Prosthetic Alignment For Persons With Transfemoral Amputation?**

Abstract number: **226**

Authors: **S. Koehler, R. Lipschutz, R. Stine, S. Gard**

Presenter: **S. Koehler**

## **Introduction**

The extent to which prosthetic alignment influences the gait mechanics of persons with transfemoral amputation is poorly understood, particularly during mechanically-demanding tasks when knee-joint stability and voluntary control are exceedingly important. In this study, we sought to characterize the association between prosthetic alignment and the neuromechanical control options of transfemoral amputees during gait tasks that were designed to uniquely challenge stance-phase stability and controllability of the prosthetic knee joint.

## **Methods**

Twelve subjects with transfemoral amputation (age 46+/-15 years; mass 88+/-14 kg; height 176+/-7 cm) were fitted with an Otto Bock 3R95 knee (single-axis, no stance-phase control), rigid pylon, and Otto Bock 1D35 foot for testing. Gait was assessed (kinematics, kinetics, EMG) for different combinations of walking surface (level; 5-degree incline; 5-degree decline) and alignment (BASE: bench alignment; ANT: 1 or 2 cm anterior knee translation; POST: 2 cm posterior knee translation).

## **Results**

As expected, external knee extension moments increased for POST ( $p < 0.001$ ) and decreased for ANT ( $p = 0.04$ ) compared to BASE for all walking surfaces. Regarding ANT, internal hip extension moments increased at contralateral toe off for level walking ( $p = 0.05$ ) and even more so for declined walking. Subjects also exhibited persistent trunk flexion throughout stance phase ( $p = 0.01$ ) compared to BASE. Despite the expectation that POST would increase the hip flexion moment required to initiate knee flexion for swing phase, no significant changes were observed.

## **Discussion**

For all walking surfaces, anterior knee alignment significantly altered the stability of the prosthetic knee joint, as evidenced by a prominent shift in external knee extension moment during most of stance phase. Consequently, subjects increased both their internal hip extension moment and trunk flexion to prevent inadvertent knee buckling during early stance phase. To understand the underlying control mechanisms associated with this response, future work will focus on characterizing the corresponding activity of residual-limb musculature.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Lower Limb - 12**

**Room 1.03**

Abstract Title: **Biomechanical Analysis Of A New Prosthetic Suspension System For Lower Limb Amputees**

Abstract number: **287**

Authors: **A. Eshraghi, N. Abu Osman, M. Karimi, H. Gholizadeh, S. Ali, W. Wan Abas**

Presenter: **A. Eshraghi**

### **Introduction**

Suspension in lower limb prostheses is achieved through liners and attachments that link them to the rest of the prosthetic components. The purpose of this study was to perform biomechanical analysis on a newly-designed magnetic prosthetic suspension system, and to compare that with two other existing systems of locking and seal-in suspension. Our hypothesis was that the new suspension system will cause less pistoning than the locking suspension system, but higher than the seal-in suspension. We also conjured that the new system will solve the so-called problem of milking of the locking liners.

### **Methods**

A new prosthetic suspension system was designed and tested mechanically. The system was incorporated into lower limb prosthetic limbs for lower limb amputees. Each subject was provided with three prostheses fabricated with three different suspension systems including our new system. The biomechanical analyses were accomplished by the evaluation of liner-socket interface pressures and pistoning during walking and stair negotiation.

### **Results**

The statistical analysis showed significant difference in pistoning values among the three studied systems. The pistoning values for the new suspension system were significantly lower than the locking liner during one gait cycle ( $P < 0.05$ ). Mean peak pressure values (kPa) were also significantly different between the three systems in different regions of the residual limb.

### **Discussion**

The Results of the study supported our hypotheses in terms of pistoning and interface pressure. There was evidence that locking liners cause milking phenomenon at the residual limb which will lead to pain, discoloration and skin problems in amputees.

### **Conclusions:**

Clinical evaluation of a new prosthetic suspension system revealed that it could successfully retain prosthesis on the residual limb with an acceptable amount of pistoning. It may also solve the so-called problem of milking of the locking liners.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 5**

**Room 1.05**

Abstract Title: **Arm Prosthesis Control: Perception Of Cable Activation Forces And Displacements**

Abstract number: **263**

Authors: **M. Hichert, M. Valk, D. Plettenburg, G. Smit**

Presenter: **M. Hichert**

### **Introduction**

Body powered arm prostheses require too high operating forces. Prosthetic use is found tiresome or even painful. The required operating forces need to be lowered. The ideal prosthesis should be powered by cable operation forces and displacements which can be invariably perceived by the user and do not lead to pain or fatigue. Earlier research showed good perception in a force range between 20 and 30 N at fixed cable displacement. The question remains: With which cable force and displacement should a prosthesis be operated when also taking into account cable displacements?

### **Method**

A prosthesis simulator was fitted to 30 subjects without arm defect. Instead of a prehensor an interchangeable spring was placed at the end of the control cable. The cable forces were measured with a force sensor located close to the shoulder harness. Cable displacement was calculated through the known spring constant and the measured cable forces close to the spring. Cable force and displacement were fed back to a laptop running a LABVIEW programme. The subject was requested to reproduce a given force and hold it constant for 2 seconds. Visual feedback was enabled every second repetition. Nine different combinations of forces and displacements were measured.

### **Results**

The smallest replication error (reproduced minus reference force) was found between 24 and 33 N. For every spring an inverse relationship between cable displacement and replication error was found.

### **Discussion & Conclusion**

The smaller the replication error the better the perception. Since in this experiment the smallest replication error (and therefore the preferred force level for prosthesis control) was found for cable forces between 24 and 33 N, the finding of the prior research seems to be confirmed. Perception of cable displacement seems to be dependent on spring constants and is better at larger spring deformations.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 5**

**Room 1.05**

Abstract Title: **Compensatory Motions Observed When Performing Bimanual Activities Of Daily Living**

Abstract number: **274**

Authors: **A. Zinck, P. Kyberd, A. Hussaini**

Presenter: **A. Hussaini**

Patients who undergo an amputation of the upper limb experience a reduction in range of motion and several degrees of freedom. Though the number of upper limb amputations is relatively small when compared to patients with lower limb loss, the dexterity and the ability to interact with one's environment is severely compromised. Even the most advanced upper limb prostheses available today are nowhere near replicating the function of the natural upper limb. Componentry used in fingers, wrists and elbow joints of prosthetic devices do not offer sufficient range of motion and a patient is forced to compensate by twisting their trunk, lifting their shoulders and positioning themselves in unnatural stances that put them at risk of developing repetitive strain injuries.

The aim of this study was to analyze the compensatory motion of 4 patients with transradial amputation and compare these against a reference of 20 able-bodied subjects, as they perform a set of controlled exercises. The movement of the wrist was paid particular importance.

Movement data was captured with the use of the Vicon 512 motion capture system and relative changes in joint angles were calculated and analyzed. It was observed that there were identifiable compensatory motions during certain tasks for the prosthesis users. Synergies in head and trunk motion, as well as compensatory movement in the non-dominant (i.e. prosthetic) arm of patients were observed for activities related to eating, slicing bread, and stirring tasks. Increases in motion and angles were usually distributed over a number of joint which lessened the occurrence of larger compensations at any one joint. It was concluded that prosthesis users do perform compensatory movements to accommodate for their limb loss and that the wrist plays an important role in effective positioning of a hand or other terminal device when performing certain activities of daily living.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 5**

**Room 1.05**

Abstract Title: **A Comparison Of Direct Control And Pattern Recognition Control Of A Seven Degree-Of-Freedom Hand Wrist System.**

Abstract number: **346**

Authors: **L. Miller, K. Stubblefield, S. Finucane, R. Lipschutz, T. Kuiken**

Presenter: **L. Miller**

### **Introduction**

Pattern recognition (PR) has been described as a method of controlling more prosthetic arm movements than those that are possible with current commercial myoelectric devices. Work has shown that PR can also be used for transradial amputees to control a physical device with seven degrees-of-freedom.

### **Methods**

One individual has been fit with a socket and liner with six electrodes. An embedded controller was developed that could be programmed with either pattern recognition or two-site direct control. For PR control, EMG from all six electrodes was input into an LDA classifier running in real-time. For direct control (DC), two sites (over the flexors and extensors) were used as input. The subject switched between the degrees of freedom and used only the two signals for control. The two Methods were applied to a multifunction hand-wrist system with wrist pronation/supination, wrist flexion/extension, and two grasps (three-jaw chuck and key). The subject was trained and took the device home for a one month trial using each control.

### **Results**

Data (ACMC, SHAP, Jebsen-Taylor, Box-and-Blocks, Clothespin test and a custom survey) were collected using both two-site and PR control. Usage statistics were recorded as well as subjective feedback. Comparison of pre-home trial data (ACMC not yet completed) for one user shows PR out-performed in all tests, except Box-and-Blocks. It is expected that data from 5 additional users will be collected for presentation.

### **Discussion**

The subject was able to complete all testing tasks using the additional DOFs of the multifunction system. PR removed the need to switch between motors; the additional degrees of freedom could therefore be accessed more easily. The subject preferred PR control over the DC method.

### **Conclusions**

Future work will expand upon our initial home trial experiments, further examining the evaluation of PR and DC multi-function hand-wrist system home trials.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Prosthetics : Upper Limb - 5**

**Room 1.05**

Abstract Title: **Rehabilitation And Outcome Of Osseointegrated Amputation Prostheses On Upper Limbs**

Abstract number: **398**

Authors: **K. Caine-Winterberger, S. Jönsson, R. Brånemark**

Presenter: **K. Caine-Winterberger**

### **Objective**

The aim was to describe the osseointegration procedure for surgery, prosthetics and rehabilitation. A titanium fixture was implanted for first time in a thumb amputation in Sweden in 1990. The same procedure was performed at transradial amputation in 1992 and at transhumeral level in 1994. The treatment involves two surgical procedures, where a titanium fixture is operated into the skeleton and after six months a skin penetrating abutment is connected to the fixture, to enable a prosthetic attachment. Rehabilitation starts shortly after surgery following a strict protocol. The patient can be supplied with a cosmetic prosthesis after eight weeks and a myoelectric prosthesis after three months.

### **Material and Methods**

Patients selected to the treatment, were highly motivated, difficult to fit with conventional prosthesis, with adequate bone quality and no contra-indicated illness. They were operated with titanium fixtures and supplied with osseointegrated prostheses.

### **Results**

From 1990 to April 2010, totally 37 upper limb amputees were fitted with osseointegrated prostheses. Of these 10 were thumb amputees, 1 partial hand, 10 transradial- and 16 transhumeral amputees. Thirty-one were males and 6 were females. Cause of amputation was trauma in 32 cases, three with congenital deformities and 2 cases with tumour. Twenty-four were amputated on the right side and 13 on the left. Today 7 patients are non-users due to either deep infection, loosening of the implant or overload accident of the implant. Patients indicate that overall function and quality of life were improved since osseointegration, range of motion has increased and prosthetic use has improved.

### **Conclusion**

Osseointegration improves the prosthetic situation for the individual due to the stable fixation, freedom of motion and functionality.

### **References**

Jönsson S, Caine-Winterberger K, Brånemark R. Osseointegration amputation prostheses on the upper limbs: Methods, prosthetics and rehabilitation. *Prosth. Orthot. Int* 35(2), p 190-200, 2011.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Technology - 1**

**Room 1.06**

Abstract Title: **Assessing The Prosthetics Needs Of Farmers And Ranchers In The U.S.A.: Interview Results**

Abstract number: **256**

Authors: **K. Waldera, C. Heckathorne, M. Parker, S. Fatone**

Presenter: **S. Fatone**

### **Introduction**

Farming and ranching in the United States remains a hazardous occupation with the fourth highest level of fatalities and with 11% of nonfatal agricultural injuries resulting in an amputation. Although the majority of amputations involve fingers and toes, farmers with major limb amputations (at least the complete loss of a hand or foot) find that contemporary prostheses are not meeting their occupational needs. A descriptive qualitative study was undertaken from an engineering perspective to elucidate how prostheses are a help or hindrance in the work of farming and ranching.

### **Method**

Farmers with a major upper- or lower-limb amputation were interviewed. Data was gathered on current and past prosthesis use, failures of prosthetic components, and ability to complete farm tasks using a prosthesis. Additionally, interviews were conducted of prosthetists who serve farmers and ranchers to identify specific devices and practices utilized with this population.

### **Results**

Analysis of interviews with 40 farmers and 26 prosthetists identified specific themes related to prostheses. These themes included durability/utility, environment, adaptation, cost, and education. It was also found that farmers and ranchers with amputations often modified their prostheses, their farm equipment, and their daily and seasonal routines to continue farming or ranching.

### **Discussion**

All farmers with lower-limb amputations (transtibial and transfemoral) and all farmers with upper-limb amputations distal to the elbow used prostheses. All farmers experienced device failures at a higher rate of incidence than the general population of prosthesis users even when they were provided with components considered to be "heavy duty". Farmers and ranchers prefer prostheses that are mechanically simple, maintainable locally, and easy to clean of farm and ranch contaminants.

### **Conclusions:**

Design improvements are needed to achieve prosthetic systems for farmers and ranchers that are more durable, more affordable, and better adapted to the rigors of the farm and ranch environments.



Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Technology - 1**

**Room 1.06**

Abstract Title: **Charcot Arthropathy Of Hand And Knee**

Abstract number: **386**

Authors: **U. Illgner, C. Droste, H. Wetz**

Presenter: **U. Illgner**

### **Introduction**

While Charcot arthropathy (DNOAP) of the foot is well known and represent a threat to modern health systems due to the fast rising number of diabetic patients, the DNOAP of the hand and the knee is nearly unknown. Only single case reports are published, systematical studies are missing.

### **Methods**

All patient's reports suffering of DNOAP who were treated between 1998-2010 in our clinic were included and systematically searched for DNOAP of the hand and the knee. Then clinical examination, x-rays, and a standardized questionnaire were done.

### **Results**

5 Patients were included (all female, 4x diabetes type I, 1x diabetes type II, all suffering from polyneuropathy, 4 patients younger than 35y). All patients had multiple complications of the diabetes, 2 died under the age of 30. We saw 3x DNAOP of the hand, 3x DNOAP of the knee (one patient hand and knee). All patients complained about paraesthesia, loss of strength and instability without trauma over months. Finding diagnose took years in all patients. Immobilization improved the clinic similar to the treatment of DNOAP of the foot.

### **Discussion**

There is DNAOP of hand and knee as well, probably with a high number of undiagnosed patients. The course is similar to the foot and the same treatment standards showed to be effective. Type I diabetes seems to be a risk factor.

### **Conclusion**

Diabetic patients showing atypical symptoms of the hand and knee should be examined for DNAOP and treated in the same way as the foot.

### **Key words**

Charcot arthropathy, hand, knee, Diabetes type I, polyneuropathy

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Technology - 1**

**Room 1.06**

Abstract Title: **A Pilot Study Investigating The Intra And Inter-Rater Reliability Of Siliconcoach Within The Field Of Gait Analysis**

Abstract number: **473**

Authors: **E. Davidson, R. Bowers**

Presenter: **E. Davidson**

### **Introduction**

Siliconcoach P&O Clinical Movement Data is a mobile two-dimensional video analysis system designed for the Prosthetics and Orthotics clinical environment. This pilot study investigated Intra-Rater and Inter-Rater reliability of the P&O Clinical Movement Data for measuring kinematics during gait analysis.

### **Methods**

Sixteen staff and senior students from the National Centre for Prosthetics and Orthotics and the Bioengineering Department, University of Strathclyde, measured ankle, knee and hip angles at Initial Contact, Mid Stance and Terminal Stance on three analysis sessions at one week intervals. To investigate whether predefined anatomical markers improved reliability of measurements, two videos of the same volunteer were provided, one with markers. To assess Inter-Rater reliability three participants measured knee flexion at initial contact on videos of 15 different subjects using predefined anatomical markers. Significance level was set at  $p < 0.05$ , with reliability ICC 0.7 – 0.9.

### **Results**

Intra-rater reliability at the hip with markers throughout gait is excellent for Initial Contact and Mid Stance (ICC= 0.999), and for Terminal Stance (ICC=1.000). Confidence Intervals for all three were very narrow (CI = 0.998-1.000 and 0.999-1.000) and were highly statistically significant ( $p < 0.001$ ). Without markers, Intra-rater reliability at the hip whilst still statistically significant ( $p < 0.01$ ), was less reliable (ICC < 0.7). Reliable Results were recorded at all joints in terminal stance with markers, but not without. Measurement of knee angle at initial contact proved reliable when inter-rater reliability was assessed (ICC = 0.867), with a fairly narrow confidence interval (CI = 0.710-0.949) ( $P < 0.05$ ).

### **Discussion**

Results may have been adversely affected by the need to exclude measurements that were not taken according to the protocol in this relatively small sample.

### **Conclusions:**

Using predefined anatomical markers increases reliability. Results indicate that Intra-rater reliability of Siliconcoach software varies across the gait cycle and was best in terminal stance. Inter-rater reliability was high.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Technology - 1**

**Room 1.06**

Abstract Title: **A Potential Design & Manufacturing Alternative At The Service Of Individual And Functional Orthotics Production**

Abstract number: **510**

Authors: **M. Cavallaro, A. Armillotta**

Presenter: **M. Cavallaro**

The Prosthetics and Orthotics work properly when they are well designed and above all when they fit properly with the anatomic part of the body in interaction. Nowadays, many digital technologies are used to better understand the static and dynamic information which are then used to design and manufacture P&O items. Although the digital technologies are spread and used in the diagnostic context along with the biomechanical analysis, the Results are not properly integrated with the manual and traditional approaches used to manufacture prosthetics ad orthotics. The manual approach is justified by an economic point of view since it is cheaper compared to industrial and automated processes, applied here for individual production. The current manufacturing Methods make the P&O device not adequately accurate and they do not include most of the static and dynamic information acquired through diagnostic technologies and morphology scan of the body part. Additive technologies could represent a valid alternative methodology, able to involve the conceptualization of a virtual object which can be properly modified and directly manufactured thanks to the digital data flow. However, the availability of the virtual model and contour inputs, such as static and dynamic data, are not sufficient to justify the use of additive technologies, but functional requirements must be verified for technological feasibility. The consistency of Fused Deposition Modeling was investigated with an attempt to replace the traditional manufacturing processes of personalized orthotics, in details feet orthosis, through a Direct Digital Manufacturing approach. An investigation of technological opportunities was performed through a characterization of materials (physical and chemical tests) and technological process in terms of tolerances and functional validation of final product, tested by human patients in defined scenarios. At the end, different additive strategies have been performed in order to individualize the best manufacturing strategy.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Technology - 1**

**Room 1.06**

Abstract Title: **Description Of A System For Wear Time Measurement For Orthopedic Devices Based On Radio Frequency Identification (Rfid) Technology**

Abstract number: **535**

Authors:

Presenter: **M. Roller**

When it comes to treatment provided by orthopedic devices, the conversation often centers on the term 'compliance'. Almost any and all papers that discuss the use of orthopedic devices in terms of correcting, growth-guiding or mitigating measures emphasize the importance of patient compliance. This is not surprising since, in fact, especially there where there is only a small window of treatment time, for example, in the case of helmet therapy for skull asymmetry (Plagiocephaly), it is necessary to make use of this. A statement known in the field of scoliosis treatment, namely 'Only a scoliosis orthosis that is actually worn will end up being effective', has become somewhat of a truism, but it certainly is on track when putting a finger on the problems of treatment per orthosis.

The goal was to develop the most accurate and practical time monitoring system for everyday clinical and scientific activity possible. The result is a documentation system that consists of a reading device, software and a small micro-sensor. The micro-sensor is built into the orthopedic device and stores the temperature in the device every 15 min, every 24 hours. The maximum lifespan of the micro-sensor after the wireless activation is at least 18 months. With the aid of RFID technology, the memory of the micro-sensor is transmitted and read in a wireless manner. The analyzed data is displayed graphically on the computer monitor and it allows a comparison of the actual wear time with the recommended wear time specifications. The gestation period monitoring system has been made clinical use of for one year now. Reports on the initial experience with regard to the suitability for daily use of the system as well as patient acceptance are currently being submitted.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Developing Countries - 4**

**Room G.06**

Abstract Title: **Prosthetics And Orthotics Services In Afghanistan**

Abstract number: **490**

Authors: **M. Zia**

Presenter: **M. Zia**

### **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. Before the invasion of Afghanistan in 1979 by the USSR there was only limited provision of P&O services. In 1980s P&O services started in the refugee camps in Pakistan and in Afghanistan through different International organizations and NGOs. These organizations started to train Afghans as physiotherapists and P&O technicians to meet the demand from individuals requiring physical rehabilitation. Now International committee of Red Cross (ICRC), Swedish committee for Afghanistan (SCA), Handicap International (HI) and Kabul Orthopaedic Organization (KOO) have been implementing projects to extend the reach of quality physical rehabilitation in Afghanistan for several years. This includes access to prosthetics, orthotics, physiotherapy, corrective surgery across the country. Beside prosthetic/orthotic services at the centres, Swedish|committee for Afghanistan (SCA) and Handicap International (HI) are also providing CBR services using Community Based Rehabilitation workers (CBRWs).

### **Method**

The Methods used in this study were desk research, standardized questionnaires, focus group Discussions (FGDs), and field observations.

### **Results**

Sixteen Orthopaedic Workshops are currently functional throughout the country. Out of sixteen Orthopaedic Workshops only two are managed by government. According to Central Statistical Organisation (CSO), the current population of Afghanistan is 29.021 million. It is estimated that 2% – 3% , (563,000 – 844,500) are people are with disabilities. Of the wider group of people with disabilities, 1.5% (495,000) are people with physical disabilities who need some kind of orthopaedic device or mobility aid.

NDSA – 2.7% , UNDP/UNOPS – 3% , WHO estimates 0.5% of a population could need an orthopaedic device. The current production of prosthetics orthotics and mobility devices in the country is 21,7373 excluding repairs. This indicates only about 4.39% population in need of orthopaedic devices including mobility devices are presently able to receive a device where 95.6 % are deprived of it.

### **Conclusion**

There is a serious need to reduce this shortfall as much as possible by all stakeholders and service providers in the country in an effective and coordinated manner to expend the services.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Developing Countries - 4**

**Room G.06**

Abstract Title: **A Strategy To Implement The Locally Maintainable Limbs Polycentric Knee In The Developing World On A Large Scale**

Abstract number: **500**

Authors: **R. Gonzalez**

Presenter: **R. Gonzalez**

### **Introduction**

The LIMBS Knee is a 4-bar polycentric knee specifically designed for implementation in the developing world. The initial strategy for the LIMBS Knee was to fabricate and maintain the knee at the local clinic level using a jig based fabrication model. This strategy has proven successful in several clinics around the world and has produced very high quality locally repairable, polycentric knees.

### **Methods**

To promote uptake of the LIMBS Knee on a large scale, we have enhanced our initial jig based clinic fabrication strategy with a jig based mass production line in Bangladesh, partnering with a third party that is ISO 9001 and ISO 13485 certified. The jig based mass production model has allowed for higher quality control than was possible at the clinic level for both our raw materials and finished product.

### **Results**

The assembly line in Bangladesh is currently producing approximately 1000 knees per year. Scaling plans are in place as orders increase. All knees are now made from batch tested raw materials, and produced by an ISO 13485 (medical device quality) certified company.

### **Discussion**

The LIMBS Knee is a low-cost, polycentric knee unit which passes ISO 10328 testing requirements and is field maintainable. The knee has been implemented in 30 clinics in 14 different countries. In order to facilitate the implementation the LIMBS Knee on a much larger scale, LIMBS has established a jig based mass production fabrication facility to supplement our already successful jig based clinic fabrication model.

### **Conclusions**

The addition of our refined mass produced LIMBS knee to supplement our clinic fabricated knees will not only allow us to provide our current clinics with another source of high quality low cost LIMBS Knees, but it will also allow us to implement the LIMBS Knee on a much larger scale throughout the developing world.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Developing Countries - 4**

**Room G.06**

Abstract Title: **Exploring The Prosthetic And Orthotic Service And Barriers For Receiving The Service In Malawi, Based On Interviews With Patients.**

Abstract number: **524**

Authors: **G. Omarsdottir**

Presenter: **G. Omarsdottir**

### **Purpose**

To explore the Prosthetic and Orthotic (P&O) service and barriers to receiving P&O care in Malawi. Suggestions were provided to improve the P&O service.

### **Methods**

18 patient receiving services at the P&O centre in Lilongwe, Malawi, participated in semi-structured interviews. A qualitative content analysis was applied to analyzing the data.

### **Findings:**

Patients were satisfied with receiving P&O services and a P&O device but there was uncertainty about payment of treatment. The main barriers experienced to receiving P&O care were lack of awareness about available P&O services, long travel distance and finance of transportation to P&O centres. Suggestions to reduce barriers were for instances increased number of P&O centres and more highly educated P&O's.

### **Conclusion**

Elimination of the experienced barriers is needed to enable persons with physical disabilities access to P&O care which Results in increased mobility and chance to make their own living. The level of P&O care is sufficient at present; it is only needed on a greater scale.

Based on author's bachelor thesis in Prosthetics & Orthotics. Supervisor: Lina Magnusson, Certified Prosthetist and Orthotist, Master's degree in Prosthetics and Orthotics, Master's degree in International Health.

Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Developing Countries - 4**

**Room G.06**

Abstract Title: **A Descriptive Review Of Lower Limb Amputation Cases In Benazir Bhutto Hospital Rawalpindi, Pakistan Of Last Five Years**

Abstract number: **511**

Authors: **S. Muhammad, M. Ali**

Presenter: **S. Muhammad**

This is five year retrospective study (January 2007 to December 2011) on amputees of lower limb seen in Benazir Bhutto Hospital Rawalpindi. Yearly occurrence of amputation cases are noted with leading cause and level of amputation, in respect to their age and sex.

### **Material and Methods**

During the last five year (January 2007 to December 2011) retrospective study was done 401 cases were founded in surgery data record registers in orthopedic, main and causality operation theaters of Benazir Bhutto Hospital and entered on designed Performa. 401 patients (Amputees) were Included in our study, out of which of which 303 (75.6%) were male and 98 (24.4%) were female.

### **Results**

Out of total 401 patients with lower limb amputations, .Our retrospective study concluded that PVD/Diabetes is a leading cause of amputation. Which is (316 or 78.8%), trauma (44 or 11%), infection (30 or 7.5%), cancer (11 or 2.7%) has least value. Our Results of level of amputation shows that the below knee amputations has highest percentage (183 or 45.6%) and partial foot has lowest percentage. descending order of the level of the amputation is(below knee, ray, Above knee, through knee, Syme then partial foot) . The right side lower limb amputations (280 or 69.8%) are more common them left side. The age group 41-60 shown the highest ratio (182 or 45%), age 61-80 (92 or 22.9%), age 21-40 (81 or 20.0%), age 01-20 (42 or 10.5%) and least in age group 81-100 (4 or 1.0%) Yearly analysis of the amputations of the lower limb shows that more in the year 2011 (93 or 23.9%), year 2009(91 or 22.7%), year 2008(85or 21.2%) year 2010 (78 or 19.5%) and least in the year 2007 (51 or 12.7%) while the percentage of re amputation is very less (6%).



Date / Time: **Wednesday, Feb 6 / 16:15 - 17:30**

Session Name and Room: **Developing Countries - 4**

**Room G.06**

Abstract Title: **The Impact Of Training Personnel For Prosthetic And Orthotic Services In Developing Countries: An Overview**

Abstract number: **522**

Authors: **S. Sexton, D. Blocka, J. Fisk, R. Horvath, M. Stills, B. Krausse, M. Thorpe**

Presenter: **S. Sexton**

Two programs of assistance for developing countries have been administered by ISPO and funded by the US Agency for International Development (USAID). A theme of the programs has been the awarding of scholarship funds to persons from developing countries. In the last ten years, over 220 scholarship awards resulting in ISPO Category I or ISPO Category II certification were made. We were interested in determining the impact of developing these professionals in their home countries.

Seven training institutions continued to participate in the scholarship award scheme over a ten year period with the institutions themselves based in low income countries (Cambodia, Tanzania and Togo) or lower middle income countries (India, El Salvador, Pakistan and Vietnam) according to the World Bank Country Data.

A study of graduates from one or two countries suggested by each of the seven participating institution academic heads was undertaken. Investigators led a structured interview with study participants. The study was conducted in the workplace, a Named prosthetic/orthotic clinic of each participant. Participants were ISPO certified graduates who are 1, 2 or 3 year post-graduation and who have a scope of practice in lower limb prosthetics and/or lower limb orthotics patient management.

Exploratory data analysis was used to determine common areas of strength and areas for development in lower limb prosthetic/orthotic practice in terms of patient history taking, patient assessment and prosthetic and orthotic specification and prescription. The Results helped us to map out the development of services and highlighted areas for the professional development needs of personnel. The impact of training personnel for prosthetic and orthotic services can be measured in terms of access to services for persons with disabilities. It is important to map the development of personnel and the services they offer within the context of the specific country situations.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 13**

**Room 1.03**

Abstract Title: **Weight Distribution Symmetry During Sit-To-Stand And Stand-To-Sit Activities In Transfemoral Amputees**

Abstract number: **424**

Authors: **V. Agrawal, M. Stalin, C. O'Toole, R. Gailey, I. Gaunaurd, R. Gailey Ii**

Presenter: **V. Agrawal**

### **Introduction**

To determine weight distribution symmetry between lower limbs in unilateral transfemoral amputees (TFAs) and non-amputee controls during the various events of sit-to-stand and stand-to-sit activities.

### **Methods**

Ten TFAs and 12 controls performed 3-5 sit-to-stand and stand-to-sit trials using a standard height chair and test shoes. Vertical ground reaction forces (GRFs) from the chair and both feet were collected at 50 Hz using a Matscan system, as subjects performed the activities upon a verbal command. The sit-to-stand activity was divided into 5 events: Pre-Ascent; Ascent Initiation; Seat-Off; Deceleration and Standing. The 5 events of stand-to-sit activity were: Descent Initiation; Deceleration; Seat-Contact; Stabilization and Sitting. Symmetry indices (SI) between GRFs on amputated/non-dominant and intact/dominant sides were calculated for each event.

### **Results**

In TFAs, maximum asymmetry was present at the Seat-off (SI=36.8%) and Seat-Contact (SI=48%), events. The Deceleration event, which followed Seat-Off and preceded Seat-Contact events, also showed significant asymmetry in load distribution between limbs (SI=35.6% and 56.8% respectively). While sitting, weight was symmetrically distributed between the 2 sides (SI=95%) and during standing the intact leg supported greater body weight (SI=70%). Controls exhibited high symmetry for both activities.

### **Discussion**

During the course of both activities, TFAs transferred weight over to the intact limb to complete the physically demanding events of Seat-off and Seat-Contact. Sudden increase in intact limb forces could place higher stresses on the joints and may contribute to secondary conditions, as these activities are repeated multiple times per day. Non-amputees did not exhibit 100% symmetry between limbs and had a tendency to load the dominant limb more than the non-dominant limb.

### **Conclusion**

TFAs are able to successfully execute sit-to-stand and stand-to-sit activities by using the intact limb to compensate for deficits of the prosthetic limb. Clinicians could discuss various strategies to reduce limb loading asymmetry while rising and sitting down.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 13**

**Room 1.03**

Abstract Title: **Transtibial Prosthetic Gait With Backpack Loads**

Abstract number: **243**

Authors: **E. Lemaire, S. Doyle, M. Besemann, N. Dudek**

Presenter: **E. Lemaire**

### **Introduction**

An individual's ability to carry a weighted backpack is an important mobility consideration for many people. Most biomechanical studies examined changes in able-bodied gait when carrying a load; however, research is lacking on backpack loads and amputee gait.

### **Methods**

Four males with unilateral transtibial amputations walked on level ground at a self-selected pace, with and without a 24.5kg weighted backpack. A ten-camera Vicon Motion Analysis system collected DoF marker set data. Visual 3D was used to generate 3D joint and trunk kinematics.

### **Results**

At the prosthetic ankle, dorsiflexion before pushoff was consistently greater for the weighted condition. Prosthetic ankle dorsiflexion velocity was also greater with backpack use. Ankle plantarflexion angle during weight acceptance was greater on the intact side for weighted walking, but the plantar flexion angle at pushoff was lower. On the prosthetic side, knee angle during swing was consistently greater for the unweighted condition, but knee angle on the intact side was greater for backpack trials. Hip flexion angular velocity at foot strike was greater for the backpack trials, on both prosthetic and intact sides. The hip was also more adducted at pushoff for the weighted condition. Trunk angle decreased when wearing a backpack load.

### **Discussion and Conclusion**

Differences were found for transtibial prosthesis users when walking with and without a weighted backpack. Changes at the prosthetic ankle were consistent with increased device deformation under load, with prosthetic components successfully handling these forces. Trunk motion was minimized with backpack use, likely minimizing centre of gravity movement away from the base of support. In contradiction to the literature on able-bodied backpack users, no consistent increase in hip extension was found during weight acceptance and foot off. Further investigations could provide a basis for workplace backpack load carriage by transtibial prosthesis users.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 13**

**Room 1.03**

Abstract Title: **The Influence Of Polyurethane Cosmeses On The Mechanical Performance Of Transfemoral Prostheses**

Abstract number: **271**

Authors: **N. Cairns, K. Murray, S. Solomonidis**

Presenter: **N. Cairns**

Transfemoral prostheses are often covered with a flexible Polyurethane foam cosmesis to provide an aesthetic finish and protect the mechanical components. Despite its flexibility, the cosmesis is known to influence joint movement and alter amputee gait particularly in the swing phase. In fact amputees can be advised to keep the limb in full flexion for a period of time when the limb is first issued in order to stretch the cosmesis and reduce its impact on joint movement. Over time the cosmesis ruptures, typically in the knee area, due to repeated material flexure during gait. Although the cosmesis limitations are evident in clinical practice, the information is largely anecdotal; the impact of the polyurethane cosmesis on the function of the prosthesis has not been addressed in the scientific literature. The aim of this study was to determine if thecosmesis affects the mechanical performance of the prosthesis and consequently alters amputee gait.

Three transfemoral amputees were voluntarily recruited for the study conducted in the Strathclyde University Bioengineering Unitgait laboratory, using a VICON motion analysis system. Temporal gait parameters and joint angles were recorded as the subjects walked at a self-selected speed along a 12 metre level surface under two test conditions: without wearing a cosmesis and wearing a newly fitted cosmesis. Surface markers were attached to the prosthesis at standardised landmarks to allow kinematic and kinetic analysis. Differences were measured in the swing phase gait parameters with and without a cosmesis. This is likely to reduce over time as the cosmesis stretches. Consequently, ongoing swing phase adjustments may be required to accommodate for the cosmesis effect on the mechanical performance of the prosthesis. The findings pose the question: how do we design cosmeses that do not influence the performance of advanced prosthetic components optimally set up for each amputee?

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Prosthetics : Lower Limb - 13**

**Room 1.03**

Abstract Title: **Influence Of Ankle Motion In Reducing Sit-To-Stand And Stand-To-Sit Asymmetry Of Unilateral Transtibial Amputees**

Abstract number: **423**

Authors: **V. Agrawal, R. Gailey, C. O'Toole, I. Gaunaud, A. Finnieston**

Presenter: **V. Agrawal**

### **Introduction**

Sagittal and frontal plane motions of foot and ankle are vital to the successful execution of sit-to-stand and stand-to-sit activities. Unilateral transtibial amputees (TTAs) have a tendency to preferentially load the intact limb more than the prosthetic limb during these movements. The purpose of this study was to determine the influence of four prosthetic feet – which allow varying degrees of dorsiflexion/plantarflexion – on weight distribution symmetry of TTAs during sit-to-stand and stand-to-sit activities.

### **Methods**

Eleven TTAs performed 3-5 arm-rest assisted sit-stand trials on a custom built chair with adjustable height and adjustable arm-rest position. Order of the four test feet - SACH, SAFE, Talux, Proprio – was randomized and subjects received training during a 10-14 day accommodation period with each foot. Vertical ground reaction force data were collected from the chair and feet at 50 Hz with a Matscan system. Subjects performed the activities with test shoes upon hearing a verbal command. Symmetry in weight distribution between the intact and prosthetic limbs was determined at the Seat-Off and Seat-Contact events.

### **Results**

Symmetry Indices (SI) were not significantly different between feet for any activity. During sit-to-stand, Proprio had the highest symmetry (92.6%) of all test feet. For stand-to-sit, all feet had similar SIs.

### **Discussion**

The active ankle dorsiflexion of the Proprio foot during sit-to-stand may have promoted greater weight acceptance by the prosthetic limb. The lack of significant differences between feet may be related to the absence of inversion-eversion motion in all test feet. During stand-to-sit, subjects appeared to have a rapid and controlled descent to the seat, resulting in similar SIs for all feet.

### **Conclusion**

Sit-to-stand and stand-to-sit activities were not significantly influenced by the ankle motion of test feet. Combination of inversion-eversion, along with dorsiflexion-plantarflexion may result in greater inter-limb weight distribution symmetry for unilateral transtibial amputees.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Rehab Medicine & Surgery - 4**

**Room 1.05**

Abstract Title: **Ambulation And Its Support In Patients With Fibrodysplasia Ossificans Progressiva**

Abstract number: **400**

Authors: **N. Haga, Y. Nakahara, N. Ogata**

Presenter: **N. Haga**

### **Introduction**

Fibrodysplasia ossificans progressiva (FOP) is a rare genetic disorder characterized by progressive ectopic ossification in soft tissues, leading to multiple joint contractures and spinal deformities. Though ability for ambulation gradually decreases with age, ambulation and its support have not been investigated in detail.

### **Methods**

Questionnaires were sent to 28 Japanese patients. For patients who have ever visited the authors institution, support for ambulation was investigated.

### **Results**

Twenty-three patients reported their ambulatory status. At age 12, 17 out of 18 walked independently and one used wheelchair. Among seven patients aged 30 or over, two walked independently, two used crutches and/or orthoses, two used wheelchair, and one used a stretcher. Among the eight patients visiting our institution, two patients aged 34 and 39 used powered wheelchair, but could walk for a short distance with specially modified crutches. One patient experienced head injury and humeral fracture falling down on the floor. Among the other six aged <20, only one patient used wheelchair. Three patients aged 12 to 16 could walk independently without crutches or orthoses in spite of major joint contractures and/or rigid spinal deformities, though one patient needed shoe modification at age 20.

### **Discussion**

Decreased capacity for ambulation with age leads to decreased ADL and QOL in FOP, but articles regarding ambulation and its support are scarce. Levy, in 2005, described the benefits of custom-made shoes, canes, and powered wheelchairs. In the present study, most patients aged <20 could walk independently, and two patients aged >30 used powered wheelchairs. Because accidental falls may lead to severe trauma, meticulous estimation of standing balance and walking posture is necessary to promote easier locomotion and prevent falls.

### **Conclusion**

Ambulatory status worsens with age in FOP patients. Support for ambulation to promote easier locomotion and prevent falls is mandatory.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Rehab Medicine & Surgery - 4**

**Room 1.05**

Abstract Title: **Functional Outcome Of A New Surgical Approach In Severe Cerebral Palsy (Gmfcs Iv And V)**

Abstract number: **406**

Authors: **D. Sharan, A. Sasidharan, R. Ranganathan**

Presenter: **D. Sharan**

### **Introduction**

Cerebral Palsy children with gross motor classification system (GMFCS) levels of IV and V are non-ambulatory and at a greater risk of complications. Prevention of these complications required to make the patients ambulant with or without assistive devices.

### **Methods**

In this study 170 children with GMFCS V&IV were participated. Mean age of the participants was  $9.68 \pm 4.77$ . The surgical procedures were performed by a single Orthopedic Surgeon which included Intramuscular Release and Controlled Tendon Lengthening using the principles of Orthopedic Selective Spasticity Control Surgery and simultaneous restoration of lever arm dysfunctions and was followed by protocol based, sequenced multidisciplinary rehabilitation for average of 6 months. The outcome measures such as component of GMFM-88, Functional Mobility Scale (FMS), Physicians Rating Scale (PRS), Manual Ability Classification System (MACS) were used to compare the functional status of the child which followed by the rehabilitation.

### **Results & DISCUSSION:**

The Results showed a significant improvement in all GMFM-88 components and the values were Lying and Rolling (A); GMFM V:  $t-9.77$  ( $P<0.001$ ), GMFM IV  $t-8.56$  ( $P<0.001$ ), Sitting (B); GMFM V:  $t-20.01$  ( $P<0.001$ ), GMFM IV:  $t-12.61$  ( $P<0.001$ ), Crawling and Kneeling (C); GMFM V:  $t-22.26$  ( $P<0.001$ ), GMFM IV:  $t-21.01$  ( $P<0.001$ ); Standing (D); GMFM V:  $t-20.01$  ( $P<0.001$ ), GMFM IV:  $t-22.64$  ( $P<0.001$ ), Walking, Running and Jumping (E); GMFM V:  $t-12.71$  ( $P<0.001$ ), GMFM IV  $t-15.65$  ( $P<0.001$ ), and total GMFM-88; GMFM V  $t-31.55$  ( $P<0.001$ ), GMFM IV:  $t-32.86$  ( $P<0.001$ ), respectively. The result of Pre-Post PRS evaluation showed a significant improvement for both sides (Right:  $t-8.60$ , ( $P<0.001$ ); Left:  $t-9.21$ , ( $P<0.001$ )). The improvement in the MACS (Right:  $t-4.05$  ( $P<0.001$ ); Left:  $t-5.74$  ( $P<0.001$ ) and FMS ( $t-5.46$  ( $P<0.001$ )) were also significant among both GMFCS IV and V.

### **Conclusion**

A well-planned and executed SEMILARASS, followed by intensive rehabilitation, in the context of a multi-disciplinary team, provides the person with GMFCS levels IV and V a significant functional improvement.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Rehab Medicine & Surgery - 4**

**Room 1.05**

Abstract Title: **Recurrence In The Treatment Of Charcot Foot Arthropathy**

Abstract number: **432**

Authors: **G. Osterhoff, T. Boeni, M. Berli**

Presenter: **M. Berli**

### **Introduction**

The Charcot arthropathy (CA) of the foot is a chronic destructive process affecting the osseous foot's arc in patients with sensitive neuropathy. Immobilization and total contact casting (TCC) are the treatments of choice, yet, evidence-based suggestions for the very heterogeneous affected population are missing. Purpose of the present study was to evaluate patient specific risk factors in the treatment of CA.

### **Methods**

Patients with CA and a minimum follow-up of three months after definite shoe wear or orthotic treatment between 01/2005 and 01/2012 were enrolled and analyzed retrospectively. Demographic and clinical characteristics at time of diagnosis, treatment paths and duration, recurrence rates and complications were documented.

### **Results**

Forty-three patients (mean age  $59 \pm 10$  years; female 13, male 30; 48 osteoarthropathic feet) were included. Mean follow-up after definitive treatment was 48 months (range 3 – 155 months). Recurrence of osteoarthropathic activity occurred in 11 patients with 12 feet (25 %) after a mean  $69 \pm 41$  months follow-up. These patients had shorter initial immobilization ( $3 \pm 4$  months;  $p = .049$ ). Patients that did not adhere to the suggested treatment schedule had a higher chance for recurrence (OR 24, CI 5 – 127;  $p < .001$ ).

### **Discussion**

This is one of the largest series of CA patients focussing on the recurrence of the disease after an extensive treatment with off-loading until complete disappearance of the symptoms was established. Main factors for recurrence were a too short immobilization period or non-compliance of the patient.

### **Conclusion**

The mainstay in the treatment of Charcot arthropathy is early diagnosis and immediate, long-lasting off-loading. Recurrence of osteoarthropathic activity is possible even after several years. Good patient management with a close doctor-patient relationship may be the key to avoid these.



Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Rehab Medicine & Surgery - 4**

**Room 1.05**

Abstract Title: **Is There A Difference In The Characteristics Of An Amputee Population When Divided Into Outcome?**

Abstract number: **420**

Authors: **F. Smith, L. Paul**

Presenter: **F. Smith**

The aim of the study is to identify a relationship between post amputation outcome (i.e. limb fitted, non-limb fitted and died) with pre amputation key characteristics i.e. aetiology, demographics, co-morbidities, pre admission mobility and level of amputation using a National database of amputees in Scotland from 2007-2009.

### **Method**

Rehabilitation data is collected on every person undergoing a major lower limb amputation in Scotland. The database is called SPARG (Scottish Physiotherapy Amputee Rehabilitation Group). The data is inputted in Scotland and quality checked by a data management group. Quantitative statistical analysis was performed with Minitab 15. The Population cohort excluded those undergoing amputation for trauma, tumour or orthopaedic aetiologies, focussing on Peripheral arterial disease patients with or without diabetes. Levels of amputation other than trans-femoral or trans-tibial were also excluded as more likely performed for non dysvascular reasons.

### **Results**

The population based cohort of 1739 amputees in Scotland showed 41% of amputees went on to limb fit with prosthesis, 15.9% died during rehabilitation and 38.6% did not limb fit. Of those who limb fitted 73% were males with a mean age of 66.5 years. Of the limb fitted patients 53.4% were diabetics as opposed to 46.6% PAD with no diabetes. The more distal levels of amputation were fitted, 71% trans-tibial, as opposed to 16% Trans femoral amputees. Bilateral amputees accounted for 12% of the cohort limb fitted.

### **Conclusion**

Dysvascular amputations occur more commonly in men with a 1:1 ratio of those with or without diabetes. Men more frequently proceed to limb fitting with more distal amputations being limb fitted. There is no significant difference in the co-morbidity index of those who limb fit to those who do not. Those who died during the rehab process were older by approximately 6 years.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Innovations - 2**

**Room 1.06**

Abstract Title: **Locking Single-Axis Prosthetic Ankle For Stability During Standing**

Abstract number: **162**

Authors: **A. Hansen, J. Dawson, G. Lahr, N. Smith, M. Sass, D. Castle, S. Morin, E. Nickel**

Presenter: **A. Hansen**

### **Introduction**

Ankle-foot systems of able-bodied persons create effective rocker shapes that are curved during walking (radius  $\sim 1/3$  of leg length), but that are flat during standing and swaying (radius  $\sim 2$  times leg length). The purpose of this project was to develop a single-axis prosthetic ankle that could lock for standing and unlock for walking, providing biomimetic rocker shapes for these tasks.

### **Methods**

A group of mechanical engineering students from the University of Minnesota worked with engineers and technicians at the Minneapolis VA Health Care System to design and fabricate a working prototype of a locking single-axis prosthetic ankle. The prototype was tested under "pseudoprostheses" for walking (ankle unlocked) and standing/swaying (ankle locked) in a motion analysis laboratory with 8 Qualisys cameras and a Bertec instrumented treadmill to verify function.

### **Results**

The final design used a sliding mechanism to limit motion of the ankle in standing mode and allow a range of motion in walking mode. A Firgelli linear actuator was used to move the slider between the "locked" and "unlocked" states. This actuator was controlled wirelessly using a key fob. The final design fit within a College Park cosmetic foot shell. The best-fit radii of the locking ankle-foot prototype in walking and standing modes were  $1/2$  leg length and  $3/2$  leg length respectively.

### **Discussion**

Use of a locking single-axis ankle-foot prosthesis could provide enhanced stability for lower limb amputees with balance deficiencies, particularly those with above-knee and/or bilateral amputations. The system we developed could be improved by microprocessor control of the modes and by providing locking over a range of ankle angles.

### **Conclusions:**

A locking single-axis prosthetic ankle was developed and tested. Results show significantly different effective shapes for standing and walking modes. Future work is needed to assess the benefits of this device for prosthesis users.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Innovations - 2**

**Room 1.06**

Abstract Title: **Development Of A Low-Cost Dilatancy-Based Casting System For Fabrication Of Ankle-Foot Orthoses: A Preliminary Report**

Abstract number: **308**

Authors: **Y. Wu, C. Robinson, H. Casanova, J. Michael, S. Gard**

Presenter: **Y. Wu**

### **Introduction**

This paper presents the preliminary experience of a "plaster-less" orthotic fabrication technique based on the dilatancy principle investigated by WJ Mead in 1940s. This project is funded by the National Institute on Disability and Rehabilitation Research (NIDRR) of U.S. Department of Education to develop an improved system for capturing the impression of a body part in order to efficiently fabricate custom orthoses for individuals with disability.

### **Methods**

This development project involves: design of casting systems; laboratory testing on plaster models; clinical evaluation on consented able-bodied subjects and individuals with disability; review of data; demonstration for feedback, and, knowledge translation.

### **Results**

The initial trials on original plaster replicas of lower limbs for creating positive plaster models showed dilatancy-based casting consistently yielded key dimensional measurements within 0-2mm of traditional circumferential plaster-based wraps. An acceptable impression (negative polystyrene mold) can be formed easily and rapidly using the dilatancy orthotic casting system and a specially designed casting frame. Conversion of the formed negative polystyrene mold into a positive sand model requires a few special steps because of the complexity of the anatomy around the ankle joint. However, the dilatancy-based casting system not only captures shapes accurately, it also allows changes of hindfoot and forefoot position of the positive model.

### **Discussion**

To date, the dilatancy-based casting system with a casting frame appeared to be a very promising technology for fabricating ankle-foot orthoses.

### **Conclusion**

Like the previous prosthetic dilatancy casting system (Wu et al, 2009), it is expected that the orthotic dilatancy casting system could result in significant reductions in time, cost and waste materials produced as compared with conventional means. As an alternative to both plaster-based and CAD-CAM-based approaches, we believe that dilatancy-based orthotic fabrication will be attractive within both resource-limited and healthcare-cost-containment environments worldwide.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Innovations - 2**

**Room 1.06**

Abstract Title: **Osseointegration In Transfemoral Amputees. The Gothenburg Experience.**

Abstract number: **439**

Authors: **Ö. Berlin, P. Bergh, B. Gunterberg, K. Hagberg, B. Rydevik, R. Brånemark**

Presenter: **Ö. Berlin**

### **Introduction**

Transfemoral amputations due to trauma or tumor surgery often cause problems with conventional socket prostheses. In 1999 we initiated the prospective OPRA study (Osseointegrated Prosthesis for Rehabilitation of Amputees) using standardized surgery, equipment and rehabilitation program.

### **Methods**

The surgery consists of a two-stage procedure. First a titanium screw (fixture) is inserted into the remaining skeleton (S1 operation). Six months later a second implant (abutment) is inserted into the first, allowing it to penetrate the skin (S2 operation). Gradual increase of loading and activity are initiated over a 6-month period.

### **Results**

The OPRA study includes 51 patients with 55 implants (1999 – 2010). Follow up is 2 years. Four implants have been removed due to loosening (3) or infection (1). One patient was lost to follow-up, two were excluded. The implant survival was 92 % (48/52). The patients had an average of one superficial infection every two years., successfully treated conservatively in all cases. There were 6 deep infections in 4 patients. All but one were successfully treated by conservative means. Four patients had 9 mechanical complications (bent or fractured implant parts) and 3 skeletal fractures occurred. Prosthetic use, prosthetic functions and global quality of life were all significantly improved ( $p < 0.001$ ) and prosthetic problems were reduced ( $p < 0.001$ ).

### **Discussion**

The implementation of a standardized OI surgical technique and the graded rehabilitation protocol is of importance for the promising Results. The benefits are related to the removal of the socket as attachment of the prosthesis to the stump. The amputee no longer has skin ulcers, pain when loading, and problems with stump volume changes. Normal sitting comfort and normal hip range of motion can be expected.

### **Conclusion**

All these changes lead to a significantly improved quality of life for the individual with a transfemoral amputation. Most complications can be handled appropriately.

Date / Time: **Thursday, Feb 7 / 09:00 - 10:15**

Session Name and Room: **Innovations - 2**

**Room 1.06**

Abstract Title: **Utilizing Emg From Individuals With Lower Limb Amputations To Control Powered Prostheses**

Abstract number: **152**

Authors: **R. Lipschutz, L. Miller, T. Kuiken, H. Daley, A. Simon, S. Finucane, L. Hargrove**

Presenter: **L. Miller**

### **Introduction**

Technological advancements in lower limb prostheses have resulted in actuated motors in both knees and ankles. Currently, these components use “state-based” control via information measured from various electro-mechanical sensors attached to the prosthesis. It is proposed that the additional information from the user’s EMG to the intrinsic controller will enable the intent of the user to signal transitions between “states”.

### **Methods**

To extract useful control information, it is imperative that consistent and high-quality EMG data be collected from the patients. Different approaches are presented to maintain consistent electrode placements on individuals with transfemoral and transtibial amputations during 1) static, non- weight bearing conditions, and 2) during dynamic weight-bearing activities.

### **Results**

After several iterations of the electrode/skin interface, the EMG being collected has proven effective in both conditions. Performance measures: Classification Accuracy, Completion Time and Completion Rate have been obtained for individuals with transfemoral and transtibial amputations in order to determine their ability to control prostheses with 2 or 4 degrees of freedom.

### **Discussion**

Our Results show that a variety of Methods, similar to those used in upper limb fittings, may be used to collect high quality EMG data during static non-weight bearing conditions. These outcomes are presented in a real-time environment utilizing both active prostheses and virtual environments. EMG data collection during dynamic weight-bearing activities is more challenging. The type, size, shape, and placement of electrodes must be carefully chosen to maintain contact with the individual without comprising comfort when weight bearing through the socket.

### **Conclusions**

Based on our preliminary work, we feel that it is plausible to obtain and use EMG from individuals with lower limb amputations to control powered prostheses. Results of data collection and classification will be presented as we attempt to define parameters for “state-changes” within the control of powered knees and ankles.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 14**

**Room 1.03**

Abstract Title: **Improved Energy Management – A Combination Of Energy Efficient Structures And Optimised Dynamic Alignment.**

Abstract number: **219**

Authors: **J. McCarthy, G. Harris, J. Ross, A. Ward, S. Zahedi**

Presenter: **J. McCarthy**

### **Summary**

Trials have been carried out on a new prosthetic foot which combines the energy management elements of a dynamic foot system with the improved alignment capabilities of a biomimetic ankle.

### **Introduction**

Overall performance of a Prosthetic foot requires not only efficient energy return, but also an optimised alignment especially over uneven terrain and across a range of walking speeds. A new design of foot has been produced which combines highly efficient heel, toe and axial springs with a damped hydraulic ankle motion to simulate a simple spring and dashpot model of a natural foot and ankle. A series of tests, trials and clinical evaluations have been carried out to fine tune and balance the performance of the overall system.

### **Methods**

A series of gait experiments using a force platform and load cell have been carried out to compare the performance of the new foot to an existing bio-mimetic design. The effect of the various functional elements during different phases and styles of gait was analysed. Test simulations were used to show how various movements can be optimised to give a harmonised system. User response was also recorded.

### **Results / Discussion**

Kinematic data has been compared for simple dynamic feet, biomimetic feet and the new design which shows the benefits of the new system. An optimised range of movement has been identified based on energy distribution during stance and direct user feedback.

### **Conclusion**

Improved prosthetic foot function requires not only efficient energy management but also an optimised alignment for a given walking or standing situation. It is important that the elements in the system are balanced so that the amputee can enjoy a smooth, controlled gait over a range of walking speeds and terrains.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 14**

**Room 1.03**

Abstract Title: **Comparing Prosthetic Feet On Ramps And Stairs Using The Symmetry In External Work Measure**

Abstract number: **416**

Authors: **V. Agrawal, R. Gailey, C. O'Toole, I. Gaunaud, A. Finnieston, R. Tolchin**

Presenter: **V. Agrawal**

### **Introduction**

Functional activities of ramp and stair negotiation place different biomechanical demands on prosthetic feet than level walking. The purpose of this study was to investigate the design features of prosthetic feet that result in greater work symmetry during ramp and stair gait.

### **Methods**

A custom-built 24-foot long wooden ramp was used for incline/decline walking, while stair ascent/descent was done on an 11-step staircase. Eleven unilateral transtibial amputees tested four feet – SACH, SAFE, Talux and Proprio. There was a 10-14 day accommodation period with each foot. Subjects were instructed to not use hand-rails on ramps and to use them only for support on stairs. Vertical ground reaction forces were collected at 50Hz using F-scan insole sensors and symmetry in external work (SEW) between the intact and amputated limbs was calculated for each test session.

### **Results**

For decline walking, the Talux foot had 100% work symmetry between limbs; which was significantly greater than the SACH/SAFE feet. During incline walking, SEW values were not significantly different between feet. While descending stairs, all feet had low SEW values, with no significant differences between feet. For stair ascent, the Proprio foot resulted in a significantly higher symmetry than SACH/SAFE feet.

### **Discussion**

'J' shaped ankle and heel-to-toe foot plate design of Talux foot promoted greater symmetry during decline walking. Absence of active power generation by prosthetic feet likely resulted in similar SEW values between feet during incline walking. During stair ascent, swing phase dorsiflexion of Proprio foot facilitated forward center-of-mass progression resulting in higher symmetry. While descending stairs, subjects rolled-over the edge of steps with all test feet.

### **Conclusion**

Gait symmetry during functional activities can be influenced by the prosthetic foot design. Features such as "J" shaped ankle, heel-to-toe foot plate and active dorsiflexion appear to be beneficial during descending ramps and ascending stairs.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 14**

**Room 1.03**

Abstract Title: **The Effect Of Dermo And Seal-In X5 Liner On Transtibial Amputees' Satisfaction And Perceived Problems**

Abstract number: **293**

Authors: **S. Ali, N. Abu Osman, H. Gholizadeh, A. Eshraghi, L. Abdul Latif, P. Varadan, N. Abd Razak**

Presenter: **S. Ali**

### **Introduction**

Prosthetic liners have a significant effect on amputee's satisfaction and comfort. Prosthetic liners are available in different materials to provide a contented interface by adding a soft cushion between the stump and the socket. Dermo liner and Seal-In X5 liner are two new interface systems and their effect on patient satisfaction and perceived problem is unclear. The aim of this study was to investigate the effect of these two liners on patient satisfaction and perceived problems.

### **Methods**

Ten unilateral transtibial amputees have participated in this study. Two prostheses were fabricated for each amputee, one with Dermo liner and the other one with Seal-In X5 liner. Amputees use the prostheses for four weeks. After four weeks of using the prostheses, each subject filled in a Prosthetic Evaluation Questionnaire (PEQ) regarding the satisfaction and problems faced with the two liners.

### **Results**

Significant difference were found between the two liners regarding satisfaction and problems ( $p < 0.05$ ). In five out of nine questions significant difference were recorded regarding satisfaction with Dermo liner compared to the Seal-In X5 liner. Suspension score was significantly higher ( $p < 0.05$ ) for the Seal-In X5 liner compared to Dermo liner. Subject faced significantly higher problems with the Seal-In X5 liner compared to Dermo liner.

### **Discussion**

The subjects were more satisfied and had fewer problems with Dermo liner. It seems that Dermo liner provides more comfortable interface fitting in the socket comparing to the Seal-In X5 liner. However, further studies are needed with a large subject population to study which system give more comfort and the least problems for patients.

### **Conclusion**

There is a good reason to believe that the Dermo liner provide more comfortable interface between the stump and liner compared to Seal-In X5 liner. Therefore Dermo liner can be the best interface for transtibial amputees'.



Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 14**

**Room 1.03**

Abstract Title: **Empirical Support For Distinct Mobility Groups Of Prosthetic Users**

Abstract number: **299**

Authors: **D. Amtmann, R. Askew, D. Abrahamson, S. Morgan, B. Hafner**

Presenter: **D. Amtmann**

### **Introduction**

Questions about mobility were administered to a large sample of individuals with unilateral lower-limb amputations as part of development of the Prosthetic Limb Users Survey-Mobility (PLUS-M). This study investigated the presence of distinct latent classes of prosthetic limb users based on responses to a subset of candidate mobility items. Latent class analysis of cross-sectional data was used to empirically identify groups of individuals with similar patterns of association in symptoms.

### **Methods**

Lower limb prosthetic users over 18 years of age with amputation from trauma or dysvascular causes responded to a survey of mobility, health symptoms, and quality of life indicators. Latent classes were derived from participants' responses to a subset of mobility items selected for their correspondence to US Medicare Functional Classification Levels (MFCL). Model fit criteria (BIC, entropy) and class interpretability guided class selection.

### **Results**

Respondents (n=616) completed 23 mobility items. A four-class solution was selected based on statistical considerations and interpretability of classes. Class 1 (n=111, 17.8%) reported best mobility, least problems with physical and social functioning, and highest employment level (72%). Class 2 (n=197, 31.6%) reported some difficulties with mobility and physical function; nearly half (47.2%) were employed. Class 3 (n=207, 33.1%) reported moderate difficulties with mobility, physical and social function, and higher unemployment (75.4%). Class 4 (n=101, 16.2%) reported low mobility, low physical and social function, and high anxiety, depression, fatigue, and sleep disturbance. Most Class 4 respondents were unemployed (91.1%). Class 1 and 2 had higher proportions of people with below knee amputations and amputations due to trauma.

### **Discussion**

Prosthetic users with higher mobility report better functioning on all aspects of physical and psychosocial function. Better mobility and overall function appears associated with higher employment levels.

### **Conclusion**

Future studies should compare these empirically-derived classes to existing classifications of mobility.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Prosthetics : Lower Limb - 14**

**Room 1.03**

Abstract Title: **Development Of Mechanically Controlled Prosthetic Knee Unit For Stair Ascent**

Abstract number: **337**

Authors: **K. Inoue, R. Harada, T. Wada, S. Tachiwana**

Presenter: **K. Inoue**

### **Introduction**

Stair ascent is a demanding activity for transfemoral amputees because of the restricted prosthetic knee joint function. To improve prosthetic knees, development of not only motorized and microprocessor-controlled knee units but also mechanically controlled ones is required. This paper therefore proposes a transfemoral prosthetic knee joint unit with a novel mechanism for stair ascent.

### **Methods**

The proposed knee joint (link knee joint: LKJ) unit was designed to convert external force into knee flexion lock and knee extension motion. This unit has a nearly zero-friction knee joint; it also contains a linear joint that is supported by springs and is shortened by external forces such as ground reaction force. Depending on the magnitude of the external force that causes displacement of the linear joint, the link mechanism of the LKJ unit limits the maximum knee flexion angle. This maximum angle is determined by displacement of the linear joint. The LKJ unit also generates knee extension motion when the external force increases. These functions work in joint angles ranging from 90° to 150°.

### **Results and Discussion**

In stair ascent experiments performed using a simulated prosthetic leg, the LKJ unit facilitated stair ascent in a step-over-step manner without assistive devices—an impossible feat with existing mechanically controlled knee units. The knee joint angle was nearly 130° at the beginning of the stance phase of the prosthetic leg. This angle increased at a nearly constant rate to 180° through the stance phase. These Results suggest that after the knee joint angle became 150°, knee extension occurred because of inertia of the thigh and upper body.

### **Conclusions**

The proposed knee joint unit mechanically restricts the maximum knee flexion angle and generates knee extension motion depending on the external force, without requiring external power. It facilitates stair ascent in a step-over-step manner without assistive devices.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 5**

**Room 1.05**

Abstract Title: **A Comparison Of Fibreglass Casting And Functional Ankle Brace For Ankle Immobilisation**

Abstract number: **498**

Authors: **A. Ludviksdottir, M. Nicholls, T. Ingvarsson**

Presenter: **G. Omarsdottir**

### **Introduction**

Immobilisation following ankle fracture is essential whether treated conservatively or surgically. Functional ankle braces (walkers) offer advantages in terms of hygiene, wound inspection and adjustability as oedema decreases. A previous study showed that a fibreglass cast immobilised the ankle more than walkers. Since then new walkers have become available. We compared the sagittal plane ankle immobilisation provided by a fibreglass cast and six different walkers.

### **Methods**

Twenty-two healthy subjects gave informed consent and were recruited. Sagittal plane ankle x-rays were taken while the subjects attempted to maximally dorsiflex and plantarflex their ankle. Total range of motion (ROM) was measured from the x-rays assessing the angle subtended between the posterior border of the tibia and a line perpendicular to a metal plate located at the plantar surface of the foot. This was done for eight conditions: Barefoot, Fiberglass Cast, Three high-top walkers (Rebound® Air, Equalizer®, Aircast®), and three low-top walkers (Rebound® Air, Equalizer®, Aircast®). Analysis of variance was performed on the data.

### **Results**

There was no significant difference in sagittal plane ankle immobilisation between the cast and the high-top walkers. Cast immobilisation was significantly better than the low-top walker immobilisation. Barefoot ROM was significantly greater than all other conditions.

### **Conclusion**

The Results of this study indicate that high-top walkers immobilize the ankle's ROM in the sagittal plane, as well as, fiberglass casts. The cast ROM  $9.45^{\circ} \pm 4.69$  was similar to that found by Kadakia et al. ( $8.4^{\circ} \pm 4.3$ ), who performed the same study with different high-top walkers. However the high top walkers in our study restricted ROM to  $9.59^{\circ}$ - $11.82^{\circ}$  compared to  $10.7^{\circ}$ - $15.4^{\circ}$  in the study by Kadakia. In contrast to our study the difference between cast and walkers in the Kadakia study was significant. This difference could be explained by the different types of walkers used.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 5**

**Room 1.05**

Abstract Title: **A Comparison Of Fibreglass Casting And Functional Ankle Brace For Ankle Fractures**

Abstract number: **342**

Authors: **M. Nicholls, T. Ingvarsson, A. Ludviksdottir**

Presenter: **G. Omarsdottir**

## **Introduction**

Immobilisation following ankle fracture is essential whether treated conservatively or surgically. However there is evidence to suggest that early weight bearing applied during the immobilisation period may improve outcomes. The purpose of this study was to investigate whether there is a difference in pressure distribution over the sole between functional ankle braces and a cast.

## **Methods**

The study was an IRB approved, prospective, randomised controlled study. Ten healthy subjects with no recent history of lower limb injury gave informed consent and were recruited. Pressure distribution under the sole was measured while walking on an instrumented treadmill at self selected speed. This was done for five conditions: normal shoe, fibreglass cast with walking sole and three types of functional ankle braces (Rebound®, Equalizer Air Walker® and XP Walker™). Average pressure under the hind, mid and forefoot was measured. An analysis of variance was performed on the data.

## **Results**

The Rebound showed significantly less pressure under the forefoot and hindfoot ( $30.8\text{N/m}^2$ ,  $21.7\text{N/m}^2$  respectively) compared to the fibreglass cast (forefoot,  $62.3\text{N/m}^2$ ; hindfoot  $50.6\text{N/m}^2$ ), the Equalizer (forefoot,  $60.8\text{N/m}^2$ ; hindfoot  $41.3\text{N/m}^2$ ) and the XP Walker (forefoot,  $79.5\text{N/m}^2$ ; hindfoot,  $52.2\text{N/m}^2$ ). Intraclass correlation coefficients (ICC) were 0.63 and 0.6 respectively for the forefoot and hindfoot indicating the reliability of the measures. While significant differences were seen for average midfoot pressures, an ICC of 0.02 indicates poor reliability.

## **Conclusion**

Differences in average pressure on the forefoot and hind foot were seen between the conditions with the Rebound brace showing the least amount of pressure on both the forefoot and the hindfoot. To our knowledge this type of data has not previously been published. This reduced pressure could indicate that it would be more comfortable to walk in the Rebound brace and thus weight bearing exercise could take place earlier

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 5**

**Room 1.05**

Abstract Title: **Comparison Of Anterior And Posterior Afo In Foot Drop Patients Using Metabolic And Gait Analysis**

Abstract number: **532**

Authors: **H. Uppal, G. Handa, U. Singh, S. Wadhwa, S. Yadav, R. Pandey**

Presenter: **H. Uppal**

### **Introduction and aim**

Anterior AFO is a fairly recent approach but research studies are scarce. The metabolic analysis and energy efficiency aspects of Anterior AFOs are a potential topic of research. Aim is to compare the effect of anterior and posterior AFO in foot drop patients on metabolic and gait parameters.

### **Purpose**

A pilot study was done to investigate and compare the changes in terms of rate of oxygen consumption (metabolic equivalent), VO<sub>2</sub>, VCO<sub>2</sub>, VO<sub>2</sub>/Kg body weight, VCO<sub>2</sub>/Kg body weight, and various gait parameters in foot drop patients with the use of anterior and posterior AFOs.

### **Materials**

20 unilateral foot drop patients who could walk independently or with a cane. Patients with LMN paralysis or those having spasticity score of <2 as per the Modified Ashworth Scale were incorporated in the study. Methods Ethical clearance was obtained. Cross over study in which metabolic and gait analysis of the patients was carried out while wearing anterior and posterior AFOs independently. The study also incorporated a questionnaire about patient's preference.

### **Results**

Anterior AFO is more energy efficient than posterior in metabolic analysis however there is no significant difference between the two in gait analysis except in terms of double support time. Anterior AFO was preferred by 60% as compared to posterior by 40%. Further 90%, 55% and 70% patients preferred anterior AFO over posterior in terms of cosmesis, donning and doffing and ADL respectively.

### **Conclusion**

The prescriptions for foot drop orthoses should also consider anterior AFOs wherever suitable and as per the patient's preference.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 5**

**Room 1.05**

Abstract Title: **Use Of Stance Control Knee- Ankle- Foot Orthoses: A Review Of The Literature.**

Abstract number: **397**

Authors: **P. McGeachan, K. Ross**

Presenter: **P. McGeachan**

The use of stance control orthotic knee joints are becoming increasingly popular as unlike locked knee-ankle-foot orthoses, these joints allow the limb to swing freely in swing phase while providing stance phase stability, thus aiming to promote a more physiological and energy efficient gait. It is of paramount importance that all aspects of this technology is monitored and evaluated as the demand for evidence based practice and cost effective rehabilitation increases.

A robust and thorough literature review was conducted to retrieve all articles which evaluated the use of stance control orthotic knee joints. All relevant databases were searched, including The Knowledge Network, ProQuest, Web of Knowledge, RECAL Legacy, PubMed and Engineering Village. Papers were selected for review if they addressed the use and effectiveness of commercially available stance control orthotic knee joints and included participant(s) trialling the SCKAFO. A total of 11 publications were reviewed and the following questions were developed and answered according to the best available evidence:

1. The effect SCKAFO (stance control knee-ankle-foot orthoses) systems have on kinetic and kinematic gait parameters
2. The effect SCKAFO systems have on the temporal and spatial parameters of gait
3. The effect SCKAFO systems have on the cardiopulmonary and metabolic cost of walking.
4. The effect SCKAFO systems have on muscle power/generation
5. Patient's perceptions/ compliance of SCKAFO systems

Although current research is limited and lacks in methodological quality the evidence available does, on a whole, indicate a positive benefit in the use of SCKAFOs. This is with respect to increased knee flexion during swing phase resulting in sufficient ground clearance, decreased compensatory movements to facilitate swing phase clearance and improved temporal and spatial gait parameters. With the right methodological approach, the benefits of using a SCKAFO system can be evidenced and the research more effectively converted into clinical practice.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Orthotics: Lower Limb - 5**

**Room 1.05**

Abstract Title: **Orthotic Corrections Of Infantile Tibia Vara**

Abstract number: **34**

Authors: **S. Alsancak, S. Guner, H. Kinik**

Presenter: **S. Alsancak**

Several Methods have been described for orthotics treatments on infantile tibia vara. The aim of the study is to compare the effect of different type of orthoses and correction Methods on decreasing the curve in children with severe genu varum. Three different type of Knee-Ankle-Foot Orthoses (KAFOs) were applied in 35 lower extremities of 22 pediatric patients aged 19-38 months. The same design was applied to the orthosis in the corrective forces on the femur, while different designs were applied in the corrective forces on the tibia. The orthoses applied to 20 patients were evaluated for the differences among them and the effects of the orthoses on the treatment process. In addition, the Methods used in the treatment, the problems encountered, production of different type of orthoses, convenience of application of the orthoses, and the dimension of patient satisfaction are discussed in this paper.

The mean duration of treatment of the patients until completion of treatment was  $25.3 \pm 9.7$  weeks with a minimum of 9 weeks and maximum of 41 weeks. No statistically significant correlation was found between the duration of orthoses in these with successfully outcome and percentile height and percentile weight of the patients. When the relevance between the type of orthoses and duration of treatment was analyzed, significant differences were found between Type I and Type II, and Type I and Type III ( $p < 0.05$ ), while no difference was found in the duration of treatment between Type II and Type III. We found that bracing is an effective form of treatment for infantile tibia vara up through age 38 months. We conclude that full-time using and use of as a-5 force on the KAFOs which forces full length of the limb.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 3**

**Room 1.06**

Abstract Title: **Design Of Research Studies In Prosthetics**

Abstract number: **60**

Authors: **R. Lipschultz, A. Jayaraman, T. Kuiken**

Presenter: **A. Jayaraman**

### **Introduction**

Prosthetics research studies are mainly focused either on new prosthetic designs or studying the impact of these designs on the function and wellness of individuals with amputations. The field of prosthetics presents a growing area of research and thus it is important research studies conducted in this area are well designed and executed. The randomized clinical trial (RCT) is the gold standard of research designs, providing the best evidence of effect. However, RCTs are costly and time-consuming and usually require a large population. Issues of underpowered studies, sample size, and recruitment goals often plague prosthetics research. In this abstract, we will summarize strategies that prosthetics researchers may consider for study designs in which small samples sizes are expected.

### **Methods**

Design parameters that can be utilized include randomization of subjects, subjects acting as their own internal controls or using a cross-over design. Standardizing prosthesis use; example all participants are within one year post-fitting or between 2-5 years of fitting. When newly designed prosthesis are introduced a standard acclimation period needs to be utilized across compared prosthesis. If study involves prosthesis knee research, care should be taken to standardize other components foot and socket. Subjects should be grouped based on quantitative measures instead of their K-levels. Validated clinical outcome measures along with quality of life measures and quantitative measures of prosthesis usability and compliance should be included. Results Clear study objectives without trying to find the answers to all questions at one go, Results in a good design. Adding quantitative outcomes will help achieve good Results with small samples.

### **Discussion**

Given the small sample sizes in prosthetic studies, it is important that studies are carefully planned and executed.

### **Conclusion**

Researchers and funding sources will value small n studies and encourage this area of research if well-designed studies are regularly published.



Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 3**

**Room 1.06**

Abstract Title: **Intensive Training Camp For Children With A Myoelectric Prosthetic Hand**

Abstract number: **456**

Authors: **L. Hermansson, H. Lindner, L. Sjöberg**

Presenter: **L. Hermansson**

Since 1978, the Limb Deficiency and Arm Prosthetic Centre (LDAPC) at Örebro University Hospital in Sweden offers a 5-day training camp for paediatric myoelectric prosthesis users<sup>1</sup>. The aim of the camp is to support the establishment of a regular prosthesis wearing pattern, increase capacity for control of the device, and establish prosthesis use in everyday tasks. Every year in August paediatric myoelectric hand users and their parents are invited to attend this intensive training. The camp consists of around 8 hours of scheduled training each day, both in everyday tasks and outdoor play activities. A structured programme with training of fine motor skills in the mornings and gross motor skills later in the days is prepared by the occupational therapists. The aim was to evaluate the effectiveness of this training procedure on children's ability to operate the myoelectric hand.

During 8-13 August, 2010, 11 children (aged 6-9, 6 boys) with unilateral below-elbow deficiency participated in the camp. The Assessment of Capacity for Myoelectric Control (ACMC)<sup>2</sup> was used to evaluate the effectiveness of intensive training on ability to operate the hand. Every child performed an ACMC activity on the first and the last day of the camp (packing suitcase). Their performances were videotaped and scored by an ACMC rater that did not take part in training of the participants at the camp. An ability score for each child was calibrated by Winsteps program.

The average ability scores changed from 2.45 logits to 5.04 logits. Most of the children (n=8) had a big change in the ACMC items that measure timing in grasping and releasing objects. The Conclusion is that the training camp is effective in improving the children's ability to operate a myoelectric hand. The long-term effects on wearing time, skill and bimanual performance from intensive training camps need further studies.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 3**

**Room 1.06**

Abstract Title: **Improving The Quality Of Prosthetic And Orthotic Services With Process And Outcome Information**

Abstract number: **260**

Authors: **A. Heinemann, L. Ehrlich-Jones, L. Connelly, S. Fatone**

Presenter: **A. Heinemann**

### **Introduction**

Continuous Quality Improvement (CQI) seeks to improve healthcare outcomes by monitoring healthcare outcomes, maintaining a customer focus, and understanding processes of care. CQI requires the use of performance indicators that specify key desired outcomes and allows comparisons across facilities or over time within a facility. This presentation describes a quality improvement consultation project that we provided to five Midwest O&P facilities after they collected outcomes data using the Orthotics & Prosthetics User Survey (OPUS).

### **Methods**

Five ABC-accredited facilities participated. Eligibility criteria included referral for a lower limb prosthesis, age 18+, and ability to read and answer questions at a sixth grade level. OPUSs measure functional status, quality of life, satisfaction with services and satisfaction with devices. The facilities agreed to administer OPUS at the initial visit, device delivery, and 2-months later. Facilities received a report showing descriptive statistics. De-identified comparative data were shared with each facility so that they could evaluate their patient outcomes in comparison with the other four facilities.

### **Results**

Facilities encountered various challenges in collecting data routinely. The facility that tied staff performance reviews to data collection had the highest proportion of cases with completed forms. Leadership commitment to CQI was associated with consistent data collection and receptivity to consultation feedback.

### **Discussion**

This study demonstrates the feasibility of routine outcomes data collection when staff receives incentives to report data and leadership demonstrates a commitment to CQI principles. The prototype outcomes report is a valuable means of monitoring organization performance over time and across facilities. Assessment of satisfaction is also important for maintaining facility accreditation with ABC.

### **Conclusions**

CQI is enhanced by the use of a reliable and valid outcomes instrument such as OPUS. Data management and reporting services are critical to providing outcomes information to staff in a timely manner.

Date / Time: **Thursday, Feb 7 / 12:00 - 13:15**

Session Name and Room: **Evidence Based Practices - 3**

**Room 1.06**

Abstract Title: **Mobility India Gait Training Approach For Unilateral Lower Limb Amputee.**

Abstract number: **324**

Authors: **S. Moulic, R. Hussain, D. Khatanar**

Presenter: **S. Moulic**

### **Introduction**

The purpose of the data investigates the effect of Mobility India's (MI's) new approach to gait retraining for unilateral lower limb amputees. The new approach considers amputee's pre-amputation functional ability and mobility, established through the Amputee Mobility Predictor with prosthesis (AMPPRO) and Locomotor Capabilities Index-5 (LCI). Its expected this approach will better address individual needs and allow more efficient rehabilitation.

### **Method**

Efficiency of gait rehabilitation process was measured by recording the number of training sessions taken to achieve set functional tasks. 26 Service users were divided into 2 groups, a conventional and new group. Conventional group received MI's old retraining approach which is not individualized but all amputees completed a set check list of tasks in a specified order. The new group approach involves the use of the AMPPRO and LCI. Both groups received 2 hours of training daily, totaling a maximum of 45 sessions. A comparison was made between the numbers of sessions taken to achieve independence in set tasks for each group. If an individual was unable to achieve a set task, 45 sessions were attributed to that individual.

### **Results**

In the conventional group, the mean number of sessions taken to achieve independent gait outside the parallel bars was 9.90, the 10m walk was 30.90, stair climbing was 17.81 and descent to floor was 41.27. In the new group, the mean number of sessions taken to achieve the same functional tasks was 13.73, 15.4, 15.53 and 27.

### **Discussion**

This data collection indicates the new approach may have resulted in faster mean times for these Service User's to achieve independence in 3 out of 4 pre-set functional tasks. It is postulated these measures assist in guiding appropriate, individualized rehabilitation for amputees.

### **Conclusion**

This data collection highlights the importance of individualized gait retraining post unilateral amputation with prosthesis.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 6**

**Room 1.01**

Abstract Title: **Biopatrec: A Modular Research Platform For Prosthetic Control Algorithms Based On Bioelectric Pattern Recognition**

Abstract number: **460**

Authors: **M. Ortiz-Catalan, R. Brånemark**

Presenter: **M. Ortiz Catalan**

### **Introduction**

Processing and pattern recognition of bioelectric signals have been at the core of prosthetic control research for decades. Although most studies agree on reporting the accuracy of predicting movements, there is a significant amount of study-dependent variables that hinder high-resolution inter-study comparisons. As an effort to provide a common research platform for evaluation and development, BioPatRec has been released as open source.

### **Methods**

BioPatRec is a modular platform implemented in MATLAB that allows a seamless integration of a variety of algorithms in the fields of signal processing; feature selection and extraction; pattern recognition; and, real-time control. It includes all the required functions for myoelectric control; from data acquisition to real-time evaluations, including a virtual reality environment. Moreover, BioPatRec functionalities are easily available through graphical user interfaces.

### **Results**

Over 20 non-amputees and amputees have tested BioPatRec reporting offline accuracies over 90%, and successful real-time control of a virtual hand and multifunctional prosthetic devices. All the required instructions for use and development are provided in the online project hosting platform (<http://code.google.com/p/biopatrec/>), which includes issue tracking and an extensive "wiki". This transparent implementation has shown to facilitate utilization, but more importantly, collaboration. Currently, BioPatRec is used for 3 other research groups in different countries.

### **Discussion**

The modular design of BioPatRec allows researchers from different fields to seamlessly benchmark their algorithms by applying them in prosthetic control. For example, a pure artificial intelligence researcher can easily add a pattern recognition algorithm without necessarily knowing how to obtain and process bioelectric signals, or how to produce and evaluate physically meaningful outputs.

### **Conclusions**

BioPatRec is a new tool for the development of algorithms applied in prosthetic control. It is available as open source, to facilitate international collaboration and will hopefully accelerate the development of better algorithms which can improve the patient's quality of life.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 6**

**Room 1.01**

Abstract Title: **Hand Opening And Grasping Force Feedback Through Vibrotactile Stimulation For Users Of Myoelectric Forearm Prostheses**

Abstract number: **465**

Authors: **H. Witteveen, H. Rietman, P. Veltink**

Presenter: **J. Rietman**

### **Introduction**

The number of myoelectric forearm prostheses not being used by their owners remains quite high, amongst others caused by the lack of sensory information about hand opening and grasping force. In this study vibrotactile stimulation on the stump providing this information is investigated.

### **Methods**

An array of 8 small vibrotactile stimulators was placed on the stump of 10 amputees and forearm of 10 healthy subjects, providing feedback about the hand opening of a virtual hand. Feedback about grasping force and object slip was provided via a linear relation between the force or slip and the vibration amplitude of one stimulator. The subjects' task was to control a virtual hand, grasping and holding virtual objects of different sizes and weights, by scrolling a mouse wheel. The task performance was described by the time taken to grasp and hold the object and the deviations from the correct hand opening and force level. The orientation of the array (transversal or longitudinal) and the type of feedback (force or slip) were varied.

### **Results**

Compared to the non-feedback situations, the addition of both hand opening and force feedback significantly increases the performance in grasping tasks, but at the cost of a longer task duration. Equal performances were found for both array orientations and both types of feedback.

### **Discussion**

The use of a transversal oriented array is preferred for amputees, because this can be applied easily in the prosthesis. Slip feedback is preferred over force feedback, because performance Results are comparable, but no in advance information about the weight or roughness of an object is required. However, this method should be validated with real sensors and myoelectric control.

### **Conclusions**

Vibrotactile feedback about hand opening and force has the potential to increase the performance in grasping tasks, but should be validated on myoelectric controlled forearm prostheses.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 6**

**Room 1.01**

Abstract Title: **Improving Outcomes For High Level Upper Limb Amputees**

Abstract number: **120**

Authors: **J. Miguelez, D. Conyers, T. Ryan, R. Dodson**

Presenter: **J. Miguelez**

### **Introduction**

This presentation will focus on the formulation and implementation of comprehensive prosthetic rehabilitation treatment plans for patients who sustain traumatic high level upper limb loss. Secondary to the traumatic nature of the loss, co-morbidities compromising range of motion, mobility, spatial awareness, and cognitive awareness must be considered. Patients with complex presentations benefit from a comprehensive team approach to rehabilitation.

### **Methods**

The foundation for this approach begins with healthcare professionals working in partnership with the patient. Highly experienced teams mobilize quickly to manage these difficult cases in a timely and cost effective manner. This approach combined with the utilization of innovative technologies, materials and creative prosthetic options are critical.

The process begins with the prosthetic rehabilitation evaluation and collaboration with the medical team. The team incorporates patient goals into a prosthetic care plan. The team implements an expedited fitting protocol leveraging technology and materials to create an innovative prosthesis design combined with aggressive therapeutic training to meet individual patient needs.

### **Results**

The well planned expedited fitting protocol will yield a functional prosthesis within 24-48 hours. Intensive prosthetic therapy training will occur simultaneous to the expedited fitting process. The expedited fitting creates a diagnostic prosthesis to evaluate the interface design's performance in functional use during therapeutic training.

### **Discussion**

Clinical expertise in selection of appropriate technology, including innovative socket interface designs, integrated advanced materials, sophisticated components and terminal devices to maximize function for improved outcomes is essential. Simultaneous training with therapists knowledgeable in the operation of this technology provides the foundation for patient success.

### **Conclusions**

It is beneficial to enlist input from prosthetic rehabilitation resources with extensive experience in treating high level upper limb loss patients. Clinicians with advanced skills in treatment of this population can best facilitate patients in overcoming some of the unique challenges they and their healthcare providers face.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Upper Limb - 5**

**Room 1.05**

Abstract Title: **Design For Function: The Electric Terminal Device (Etd) – A 10-Year Review**

Abstract number: **291**

Authors: **H. Sears, E. Iversen**

Presenter: **H. Sears**

### **Introduction**

The ETD is a unique example of hybridization of body-powered features with electric components, i.e., hook fingers with a water-resistant motorized drive. After a 10-year clinical history, lessons gained from the ETD are found in both case studies and survey data documenting wearers' functional ratings and their specific usage.

### **Methods**

The five case studies illustrate activities performed by bilateral and unilateral wearers: ADLs, kitchen tasks, farming, welding, and nursing tasks requiring frequent water immersion. Survey Method Over the ten-year experience a subgroup of 17 wearers were surveyed. The ETD is compared to wearer's earlier TDs in functional areas, as well as documenting the extent of usage.

### **Results**

Hook gripping demonstrates fine-tip prehension, flat surfaces with high surface area, large diameter cylindrical objects, slender tips reaching into pockets, and passive functions, e.g., pushing and hook-and-pull type tasks. Electric Drive vs. Body-Power comparison shows differences in pinch force, effort, and comfort. Usage data shows hours of usage per day (average 12 hr), usage of the ETD compared to other devices (average 82%), importance level of the ETD (12/17 answer "very important), and self-rating of level of activity (12/17 answered "heavy-duty usage"). Performance data assesses speed, appearance, grasp abilities, ease of use, and overall ratings (the average rating equates to "much better")

### **Discussion & Conclusions**

Rugged work and hobby activities create functional needs beyond capabilities of hand-type TDs. Interchangeability of the ETD with Hands greatly broadens utility. Stereotypes of hand vs. hook wearers are unreliable - male/female, rural/urban, blue-collar/white-collar, unilateral/bilateral characterizations do not predict usage of a hook-type prosthesis. Aesthetics of a work-type TD remain a great opportunity. Future design innovations could broaden the population using electric hook-type TDs, improving size constraints and strength, as well as aesthetic appeal.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 2**

**Room 1.02**

Abstract Title: **Relative Activity Variations In Persons With Transfemoral Amputation**

Abstract number: **220**

Authors: **M. Waddingham, E. Halsne, B. Hafner**

Presenter: **B. Hafner**

### **Introduction**

Evidence describing the long-term mobility patterns of persons with transfemoral amputation (TFA) is limited. While it is acknowledged that TFA imposes considerable physical impairments, little empirical information is available to convey how these deficits may manifest in the free-living environment. The purpose of this study is to quantify the relative variation in step activity in persons with TFA over annual, seasonal, and monthly periods. A secondary objective was to compare variations in activity observed in persons with TFA to healthy, non-amputees described in the literature.

### **Methods**

A retrospective analysis of twelve months of daily step activity data was conducted. Subjects' step activity was recorded with an accelerometer-based step monitor and averaged over annual, seasonal, and monthly periods. Relative variations in step activity over each period were quantified with coefficient of variation (CoV).

### **Results**

Data from 17 subjects with TFA were examined for patterns of activity. Activity was generally observed to increase and decrease with warmer and colder months. Relative variation in step count observed over annual, seasonal, and monthly periods ranged widely within the sample. Annual variation in activity for the TFA sample (CoV= 0.65) was greater than that reported in healthy, non-amputees (CoV= 0.34). Seasonal and monthly variations were also significantly different between those with TFA and non-amputees ( $p=0.000$  and  $p=0.001$ , respectively).

### **Discussion**

Variations in day-to-day activity among persons with TFA may be elevated as a result of activity-related discomfort or fatigue. Prospective research and studies incorporating subjective feedback may provide additional insight into the health conditions and personal factors (e.g., motivations and opportunities) that influence activity in this population.

### **Conclusion**

Additional efforts to characterize TFA mobility, particularly in the free-living environment, are needed to better understand the functional consequences of lower limb amputation and, subsequently, the efficacy of clinical interventions intended to address them.



Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 2**

**Room 1.02**

Abstract Title: **Using Sports And Peer Mentoring To Improve Outcomes For Disabled Children In Northern Uganda**

Abstract number: **343**

Authors: **J. Browning**

Presenter: **B. Humphrey**

### **Introduction**

Disabled children in northern Uganda experience extreme discrimination, social exclusion and severe risks to their health and well-being. They are routinely barred from attending mainstream schools and excluded from community activities with no access to any sports activities. Many are hidden away inside the home, leaving them extremely isolated, and a significant number of parents have reported pressure from family members to drown a child born with a disability to avoid disgracing the family.

### **Methods**

Motivation, and our partners the Kids League and the Gulu Disabled Persons Union, set up a programme in 2011 to address these problems by using sport to empower children and change attitudes. The project established an inclusive sports league for 300 disabled children and built the capacity of a team of coaches and peer mentors to organise inclusive sports training and competitions and to lead training for children in disability rights, self-advocacy and preventative health. The programmes's goals were to improve the children's confidence, develop their self-advocacy skills and improve their social inclusion. These three outcomes were measured through surveys, focus groups and regular assessments by the peer mentors.

### **Results, Discussion and Conclusions**

The Results of the research found that participation in sport improved the children's confidence and inclusion in the community, but that significant gains in self-advocacy (for example, lobbying their parents to send them to school) were only achieved through assistance from their peer mentors. Based on these Results, we would recommend that future disability-focused sport for development projects are linked to a tangible support mechanism—for example, peer mentors attached to the local disabled people's organisation, which can provide practical training and support with real-life challenges faced by each child. In this way, the increased confidence and reduced stigma achieved through sports participation is channelled into a specific positive outcome.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 2**

**Room 1.02**

Abstract Title: **The Advent Of Sprint Prosthesis In Kenya**

Abstract number: **344**

Authors: **P. Ongubo, R. Ewoi**

Presenter: **P. Ongubo**

### **Introduction**

The area of Sports Medicine in Prosthetic sciences has not been exploited in Kenya. Being a renowned home of athletics, Kenya has never produced a leg amputee athlete for track events. The exploits of the famous South African "blade runner" Oscar Pistorius has given us an impetus to introduce this concept in Kenya. This is in tandem with rehabilitation goals of not only promoting mobility, but enhances quality of life of amputees through sports.

### **Methods**

A hands on approach was adopted and literature review for comparison was undertaken. An inaugural athlete who is a below knee amputee was identified and fitted with customized blade prosthesis. The Milan City Marathon provided an opportunity to showcase the athlete's capability and functional outcomes were measured.

### **Results**

Provisional Results saw the amputee run 2km to validate its efficiency. The athlete has since specialized in short sprint races. It is expected that by the Congress time we shall have had a sufficient number of athletes to validate the Results following a national campaign to be rolled out soon.

### **Discussions**

Following the impressive outcome, the Kenyan Paralympics Society(KPS) has welcome this new product and a national appeal is currently underway to help raise awareness and support amputees to be fitted with sprint prostheses to help them participate in track events. Our aim is to contribute to the needs of the KPS whose aim is to participate in upcoming amputee track events.

### **Conclusions**

Sports prostheses are vital in changing lives of many people with amputations. This inaugural case has been an eye opener for amputees to take part in athletics with much hope and inspiration. It is our expectation that if exploited fully; shall impact positively to the lives of amputees and others with physical disabilities, thus empowering them to participate actively in nation building.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Sports And Physical Activity - 2**

**Room 1.02**

Abstract Title: **Motivations & Barriers To Prosthesis Users Participation In Physical Activity, Exercise & Sport: A 2011 Review Of The Literature**

Abstract number: **5**

Authors: **S. Deans, D. Burns, A. McGarry, K. Murray, N. Mutrie**

Presenter: **A. McGarry**

## **Background**

The United Kingdom (UK) will host the Paralympics in 2012 and Commonwealth Games in 2014 showcasing the talents of elite athletes and aiming to inspire the population to become involved. However, low levels of physical activity are prevalent: only 40% of men and 28% of women meet the minimum UK physical activity recommendations(1). The population of people with limb absence is no exception.

## **Objectives**

To examine the current literature to determine if people with amputation are participating in physical activity and sport; whether post-amputation activity levels match pre-amputation levels; and if there are motivations and barriers to participation.

## **Methods**

A prosthetic and physical activity for health research team systematically searched for all peer reviewed and gray literature in seven bibliographic databases and the Cochrane Library.

## **Results**

Following rigorous elimination, 12 articles were finally included in the review and critically appraised. Four themes were identified: components; rehabilitation outcomes; body image; and motivations and barriers to participation.

## **Conclusions:**

People with limb absence are not participating in physical activity conducive to health benefits, and only a minority participate in exercise and sports. Participation following amputation does not mirror that of pre-amputation levels, and more barriers than motivations exist to adopting or maintaining a physically active lifestyle.

## **Clinical Relevance**

This literature review aims to inform those involved in rehabilitation and ongoing care of those with limb absence about what motivates or precludes their participation in physical activity, exercise and sport. Such knowledge could be applied to improving health and wellbeing in the amputee population.

Reference (1): NHS The Information Centre. Health Survey for England 2006: CVD and risk factors adults, obesity and risk factors children. 2006. [published 31 January 2008]. Available from <http://www.ic.nhs.uk/>

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 15**

**Room 1.03**

Abstract Title: **The Development Of The Plus-M, A New Measure Of Mobility For Prosthetic Limb Users**

Abstract number: **300**

Authors: **D. Amtmann, D. Abrahamson, S. Morgan, R. Salem, R. Askew, R. Gailey, B. Hafner**

Presenter: **D. Amtmann**

### **Introduction**

Standardized outcome measures can be used to document clients' health outcomes and facilitate treatment of those requiring prosthetic and orthotic services. The Prosthetic Limb Users Survey-Mobility (PLUS-M) was developed using modern psychometric Methods to be a brief, precise and flexible measure of mobility for persons with lower limb amputation.

### **Methods**

A candidate item bank was developed from existing instruments, input from clinical and scientific experts, and feedback from prosthetic limb users. Items were administered to a large sample of unilateral amputees. Data were used to develop scoring using Item Response Theory (IRT). Five-level response options range from "with no difficulty" to "cannot do." Unidimensionality was assessed by confirmatory factor analysis (CFA). Item fit to IRT was assessed using standard statistical criteria.

### **Results**

105 candidate items were administered to over 1000 prosthetic limb users with traumatic or dysvascular amputation etiologies. CFA Results supported unidimensionality. Items were calibrated using a two-parameter graded-response IRT model. Items with poor discrimination and those with less than optimal fit were dropped from the bank. The item and test characteristic curves documented that the PLUS-M score is reliable and precise across different levels of mobility (from low to high mobility). The calibrated item bank can be administered by Computerized Adaptive Testing (CAT). A subset of 8 items was selected for a PLUS-M Short Form to minimize respondent burden. PLUS-M score is a t-score with a mean of 50 and standard deviation of 10.

### **Discussion**

Results support validity and reliability of the PLUS-M. IRT calibration allows for PLUS-M to be administered by paper or by CAT on phones, tablets, or computers.

### **Conclusion**

The PLUS-M is a psychometrically sound, brief, and precise measure of mobility for prosthetic limb users. The full instrument and short form are freely available and ready for use in clinical care and research.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 15**

**Room 1.03**

Abstract Title: **Mathematical Analysis Of Prosthetic Shank**

Abstract number: **312**

Authors: **M. Dash, A. Patra**

Presenter: **M. Dash**

Transfemoral amputees with prosthesis walk more slowly than the normal population. They prefer a self-selected walking speeds (SSWS). This is evident both in adult and paediatric cases. It is believed that this is due to a prolonged prosthetic swing phase. When prosthetic shank is considered, the available variables are the total mass of the shank and the distribution of that mass within the system. Different modeling Methods predict conflicting **Results**. Various types of physical theories and mathematics equations have been applied. Two mathematical models are being discussed to know the cause of slow cadence and how far the mass of the shank is responsible for delayed swing.

Two theories are:

PENDULUM THEORY and DIFFERENTIAL EQUATION method

### **Conclusion**

The duration of prosthetic swing decrease is identified as time required for the shank to traverse the arc from peak knee flexion to terminal extension. If the Variables are kept constant except the distribution of shank mass 'm' or length r, then the swing time will decrease as the location of c.m. from knee center increases. Keeping length 'r' is constant but varied overall mass, then increase mass will correlate with decreased swing time

The result of two modeling theory contradicts each other. Pendulum based theory predicts that decreased value of r should less the time period of shank & the calculus based theory don't agree with it. Again Pendulum theory holds that periods will be constant regardless of the value of 'm' & the calculus based model predicts that increase in 'm' Results decreased swing periods. Therefore both theories hold good for better ambulation of transfemoral amputees with prosthesis if marginal adjustments to the values are considered, then it should affect the swing phase as much as 50%.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 15**

**Room 1.03**

Abstract Title: **Microprocessor-Controlled Prosthetic Knees – A Review Of The Literature**

Abstract number: **314**

Authors: **T. Quake, A. McGarry**

Presenter: **T. Quake**

### **Introduction**

Microprocessor-controlled prosthetic knees (MPCKs) help better replicate normal knee function, providing transfemoral amputees (TFAs) benefits compared to non-microprocessor knees. MPCKs are not widely prescribed due to issues such as high cost and a poor knowledge base. A literature review on MPCKs was performed to: 1) assess the justifications for their prescription, 2) compare different MPCKs and 3) assess the effect of (2) on prescription criteria.

### **Methods**

A literature search was performed. 6 categories were deemed pertinent to TFA rehabilitation: gait biomechanics, energy expenditure, functional activities, safety, cost-effectiveness and quality of life (QoL). Studies were grouped into one or more of these categories based on the issues addressed. SIGN50 guidelines were used to grade studies and form recommendations.

### **Results**

47 studies were reviewed. 5 studies made inter-MPCK comparisons. 5 MPCKs were studied – the C-leg, Intelligent Prosthesis, Rheo Knee, Adaptive Knee and Power Knee. Most studies were performed on otherwise healthy, unilateral TFAs. 2 case studies investigated bilateral TFAs.

### **Discussion**

MPCKs improve gait efficiency and energy expenditure but do little to reduce sound side overuse. All studies investigating mobility, stair/slope ambulation, functional level or safety-related measures noted statistically and clinically significant improvements. All 3 economic studies found the C-leg cost-effective from healthcare and social viewpoints. MPCKs significantly improved QoL for most TFAs. MPCKs benefit K2-4 unilateral TFAs. K2 TFAs, who are not normally considered MPCK candidates, may suffer underprescription. Both case studies on bilaterals showed little benefit in improving energy expenditure, safety and QoL. A lack of inter-MPCK studies and the inconsistency of Results makes it difficult to assess inter-MPCK performance.

### **Conclusion**

MPCKs provide functional benefits for unilateral TFAs and appear to be cost-effective, justifying their prescription. Clinicians should consider prescribing them more often. More research on different TFA subpopulations and inter-MPCK comparisons are needed.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 15**

**Room 1.03**

Abstract Title: **New Thermoplastic Woven Fabrics As The Material Of Prosthetic Sockets**

Abstract number: **336**

Authors: **S. Lee, G. Cha, J. Song, M. Mun**

Presenter: **S. Lee**

Various materials such as thermoplastic plastics or fiber reinforced composites(FRPs) of glass or carbon fibers have been used widely as socket materials for limb prostheses. Each materials have pros and cons. For examples, carbon or glass fiber as widely used socket materials are good in physical property and socket performance. However they may cause skin irritation and/or respiratory trouble to prosthetic workers, since the harmful debris chops of fibers tend to be made during grinding process in fabricating sockets. In this study, we attempted to make prosthetic sockets using woven fabrics of a new thermoplastic material, which can reduce skin irritation in contact, with still offering the good mechanical property and durability of sockets. The thermoplastic woven fabrics made from polyvinylalcohol(PVA) as a new socket material have been developed and successfully applied to fabricate the prosthetic sockets for lower limb. The surface treatment for PVA fibers could be conducted effectively to acquire improved adhesion and impregnation of fiber and matrix. The cured matrix of the composites maintains the good strength for the socket. Comparing PVA fiber with carbon fiber, it shows competent value as socket material in tensile strength. The PVA fibers can be impregnated with more resin of about 20% in weight than carbon fiber. The composite thus shows similar values in the flexure strength test.

To investigate the shape and size of debris particles of PVA fibers, the particles produced during grinding were collected and observed with optical microscopy. The PVA fiber chops do not separate from the matrix resin, and their scattering in the air can be reduced effectively. We could conclude that the sockets fabricated using PVA fiber and epoxy resin enable to give less harmful environment of fabrication as well as good mechanical properties and durability in limb prosthetic performance.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Prosthetics : Lower Limb - 15**

**Room 1.03**

Abstract Title: **An International Questionnaire On The Delivery Of Lower-Limb Prosthetic Treatment**

Abstract number: **362**

Authors: **J. Andrysek, D. Wyss, W. Cleghorn**

Presenter: **J. Andrysek**

A crucial component of prosthetic rehabilitation research that is often neglected in purely product-oriented research is a preliminary needs assessment of the problem. A survey was developed to gain an understanding of the unique issues and demands relating to the delivery of lower-limb prosthetic services and technologies within individual regions of the world, and also on a global perspective. The survey was anonymous, self-administered and distributed online through the networks of various healthcare professionals targeting practitioners working in any level of lower-limb prosthetic rehabilitation. Data collected included respondent demographics and information about the types of services and technologies provided under the following categories i) feet, ii) knees, iii) sockets and suspension, iv) alignment, and v) materials and

### **Methods**

Complete responses were obtained from 199 prosthetic clinicians and technicians working in 64 different countries. The average per capita expenditure on healthcare for each country was used as an indicator to investigate the different groups of respondents.

The **Results** show that the average country health spending is often significantly different between the levels of use of certain prosthetic technologies and procedures. The average healthcare spending was most often lower for the respondents identifying problems in the delivery of their prosthetic services and technologies. Examples of these include: the use of polycentric knees or energy-storing feet, achieving adequate knee flexion, foot durability, ease of alignment adjustments, and socket liner selection. Moreover, a qualitative analysis of open-ended responses identified general priority areas of concern for each of the sections of lower-limb prosthetics investigated. Developing countries with lower spending on healthcare have different demands and priorities for lower-limb prosthetic rehabilitation. The Results of this study may be used by future researchers to direct their efforts to deliver the most effective prosthetic devices and treatments to people with lower-limb amputations living around the world.



Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Quality Of Life Issues - 2**

**Room 1.05**

Abstract Title: **Resection Of Proximal Femur Improves Quality Of Life In Cerebral Palsy Patients With Painful Hip Dislocations**

Abstract number: **358**

Authors: **C. Dussa, H. Lengnick, L. Doederlein**

Presenter: **C. Dussa**

### **Introduction**

The incidence of hip dislocation in Cerebral Palsy (CP) varies from 6% - 70%. Despite increased surveillance, chronic hip dislocations are not uncommon. Deformation of femoral head makes surgical reconstruction impossible. The purpose of this study is to investigate the effect of proximal femoral resection (PFR) on the quality of life (QOL) in patients with CP.

### **Methods**

Consecutive patients between 2007 and 2011 were included in the study. Patient demographics, GMFCS score, range of movement (ROM) of hips, and complications were documented. X-rays were reviewed for type of heterotrophic ossification (HO). The QOL was assessed pre and post operative using CP caregiver Questionnaire (Version 5.0).

### **Results**

16 patients with 19 hips underwent PFR for painful hip dislocations. M:F 10: 6. All patients belonged to GMFCS V. Mean age at the time of surgery was 21 years. The average follow-up time was 3 years. 1 post-operative Hematoma needed evacuation. HO was seen in 14 hips (Type I – 9, type II – 4 and type III - 1). Hip ROM improved in all cases. One patient (1 hip) refused to participate in the study. All other patients except one showed significant improvement in positioning, transfers, mobility, comfort, emotions and social interaction. Care givers felt an improvement in general health. The perceived QOL improved from very poor/poor to good/very good.

### **Discussion**

Neglected and painful hip dislocation causes significant limitation of daily activities, leading to confinement in bed. This affects the general health. PFR improves hip ROM. Complications are low. HO occurred in 73% of patients, however did not affect ROM of hip and QOL. Comfortable positioning, painless transfers and ability to be mobile on wheel chair improve QOL in these patients.

### **Conclusions**

Proximal femoral resection is an excellent one-off operation that significantly improves the QOL. HO did not affect the QOL.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Quality Of Life Issues - 2**

**Room 1.05**

Abstract Title: **Quality Of Life Measures Differ Between Female And Male Young Adults With Lower Limb Reduction Defects**

Abstract number: **450**

Authors: **T. Kaastad, I. Holm**

Presenter: **T. Kaastad**

### **Introduction**

Lower limb reduction defects can be treated with fitting of prosthesis, but can also be corrected through callotasis surgery with elongation to obtain gait function. The aim of our study was to evaluate general health in young adults with lower limb reduction defects to see if there were differences related to choice of treatment modality.

### **Methods**

Thirty-four former patients (13 female, 21 male) between ages 18 and 35 with below knee defects, were invited to a follow up study of health-related quality of life evaluated with EuroQol (EQ-5D) and Short Form 36 (SF-36). Seventeen were lengthened in tibia and/or femur, while 17 used prosthesis.

### **Results**

There were no differences in age, height, weight, level of education, marital status, or self-esteem. The EQ-5D general health value was median 70 in both groups, and there were no differences in the eight scales of SF-36. Female patients had lower physical functioning and emotional role limitations scores compared to the general population, while male patients had lower scores for physical functioning, bodily pain, and general health perception.

### **Discussion**

Our study groups were relatively small, and the diversity within groups considerable, but the demographic data suggest they are comparable. The SF-36 has different scores for women and men in the general population. Since the Results in our groups were similar, we chose to combine them and compare all female and all male patients with the general population.

### **Conclusions**

There are no major differences in general health issues between young adults with lower limb reduction defects who have been through lengthening procedures and those who walk with a prosthesis. The whole group has lower physical functioning scores compared to the general population, while only female patients have reduced scores for emotional role limitations, and only men for bodily pain and general health perception.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Quality Of Life Issues - 2**

**Room 1.05**

Abstract Title: **Impact Of Prosthetics And Orthotics Services On The Quality Of Life (QoL) Of People With Disabilities In India.**

Abstract number: **499**

Authors: **C. Khasnabis, K. Murray, S. Deans**

Presenter: **C. Khasnabis**

### **Introduction**

The impact of prosthetics and orthotics services in enhancing the Quality of Life (QOL) of people with disabilities are not known much, especially in the developing world. Towards this, a study was carried out to evaluate the Impact of prosthetics and orthotics services on the Quality of Life (QOL) of people with disabilities in India. The major aim of the study was to evaluate thoughts and feelings of the person who received a prosthesis or orthosis and not evaluating the actual device which was prescribed and fitted.

### **Methodology**

Mobility India runs a Community-Based Rehabilitation (CBR) programme in Anekal Taluk of Bengaluru Rural District of Karnataka, India. Among their beneficiaries, 60 subjects (n=60) who were requiring an orthosis or prostheses were selected for the study. CBR workers were trained to carry interview based on WHOQOL-Bref tool (a set of 26 questionnaire to measure Quality of Life). Subjects were interviewed twice with the same questionnaire: first time before orthotics/prosthetics intervention (pre-test) and then one month after the fitment (post-test).

### **Results**

Among the subjects (n=60), 43 were male (72%) and 17 female, 46 had orthosis (77%) and 14 had prosthesis. The mean age for male was 37 and for female 28. Among 60 subjects, 43 were first time user of orthosis/prosthesis (72%). From the comparative study of the pretest and posttest data, it was evident that a higher mean score was achieved after orthotics/prosthetics intervention in relation to individual's quality of life and in all the four domains of WHO-QOL: Physical, Psychological, Social and Environmental.

### **Conclusion**

From the study, it was evident that people with disabilities living in rural areas faces significant barriers to access orthotics and prosthetics services. People with disabilities can have a better Quality of Life (QOL) with an orthosis or prosthesis, which leads to empowerment, inclusion and participation.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Quality Of Life Issues - 2**

**Room 1.05**

Abstract Title: **Skin Problems Of The Stump In Lower Limb Amputees; Influence On Functioning In Daily Life**

Abstract number: **429**

Authors: **H. Meulenbelt, J. Geertzen, M. Jonkman, P. Dijkstra**

Presenter: **H. Meulenbelt**

Aim of this study was to analyze influence on functioning in daily life of stump skin problems in lower limb amputees, since data on this topic is scarce. A cross-sectional study was performed by means of a questionnaire. It assessed influence of skin problems of the stump on functioning in daily life by 9 items. Item scores were added to calculate a sum score (scoring range 0-27). 2039 potential participants were invited to participate, resulting in 805 completed questionnaires. 507 participants reported a present skin problem. Negative influence of a skin problem was reported on household, prosthesis use, social functioning, and performing sports. Mean sum score was 5.5 (SD=4.1). It correlated significantly with number of complaints ( $r = .483$ ,  $p = .01$ ). In linear regression analysis gender ( $\hat{\alpha} = .15$ ) and number of skin complaints ( $\hat{\alpha} = .25$ ) explained 23% of the variance. This study establishes the influence of skin problems on functioning in daily life.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **General - 1**

**Room 1.06**

Abstract Title: **Birth Prevalence And Possible Risk Factors For Congenital Limb Defects In The Northern Netherlands**

Abstract number: **89**

Authors: **E. Vasluiian, C. Van Der Sluis, H. Reinders-Messelink, A. Van Essen, P. Dijkstra, H. De Walle**

Presenter: **E. Vasluiian**

### **Introduction**

Limb defects seen in childhood are mainly congenital. Reported birth prevalences of congenital limb defects (CLD) vary largely between countries: from 10.4 in France to 4.8 in Italy during 1979-1987. There is little information on the birth prevalence of CLD in the Netherlands. Smoking, alcohol, chronic diseases, obesity, not taking folic acid supplements are controversial possible risk factors affecting limb development.

### **Aim**

To describe the epidemiology of CLD in the northern Netherlands and identify potential risk factors.

### **Methods.**

In a population-based epidemiological study we investigated the prevalence of CLD for the period 1981-2010. Additionally, in a case-control study we searched for possible risk factors associated with CLD like maternal smoking, alcohol consumption, chronic diseases, maternal weight, folic acid supplementation before and during pregnancy, maternal age, education level, and fertility problems. Data on cases with CLD in the northern Netherlands were collected by EUROCAT. Logistic regression was used to analyze risk factors.

### **Results.**

The birth prevalence of all limb defects for the period 1981-2010 was 21.3 per 10,000 births. There was an overall decrease in isolated limb defects (not part of a genetic condition,  $p=0.023$ ) during 1992-2010, specifically in syndactyly ( $p<0.01$ ). Of 1061 children with CLD, 54.9% were males, 51.1% had isolated defects, 14.8% had multiple congenital defects, and 34.1% had a recognized syndrome. The upper/lower limb ratio was 2:1, and the left/right side ratio was 1.2:1. Commonly associated anomalies were of cardiovascular and musculoskeletal origin (20.2% and 14.7%, respectively). We did not find a significant association with the risk factors we studied.

### **Conclusions.**

The birth prevalence of limb defects and of syndactyly in particular, has dropped in time in the northern Netherlands. We found no association of CLD with smoking, alcohol consumption, obesity or multivitamin/folic acid supplementation, but more studies with larger sample sizes may highlight possible relationships.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **General - 1**

**Room 1.06**

Abstract Title: **Work-Related Musculoskeletal Disorders In The Prosthetics And Orthotics Profession**

Abstract number: **125**

Authors: **S. Anderson, J. Oakman**

Presenter: **S. Anderson**

### **Introduction**

Work-related musculoskeletal disorders (WMSDs) are the largest group of work injury claims both in terms of cost and numbers of compensation claims both in Australia and worldwide. Progress in reducing the numbers of claims has been limited with little reduction in injury numbers evident in the previous decade. WMSDs occur across in all areas of employment, however, certain sectors experience greater prevalence. Workers in the health sector are at high risk of developing WMSDs, due to the nature of the work undertaken. Experienced health professionals are in high demand and as such injuries due to WMSDs are problematic, with significant cost to the individual, employer and the community.

WMSDs are multifactorial in nature with a complex aetiology of interacting physical and psychosocial factors. Management strategies for WMSDs tend to be focused on single hazards, primarily physical hazard and risk factors, without appropriately addressing the complex nature of WMSD aetiology.

### **Aim**

The overall aim of this study is to determine the prevalence of WMSDs in the Prosthetics and Orthotics (P&O) profession and identify what are the key hazards and risk factors in relation to WMSDs.

### **Method**

Focus group interviews of practicing Prosthetics and Orthotic clinicians were conducted. Structured open-ended questions were utilized to provide direction for the focus group.

### **Results**

Qualitative data analysis, including thematic analysis, of the focus groups has been undertaken to determine key hazards in P&O. The Results of this analysis will be presented in this paper.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **General - 1**

**Room 1.06**

Abstract Title: **Infections In Charcot'S Arthropathy Of The Foot Due To Pseudomonas Aeruginosa - The Underestimated Threat**

Abstract number: **383**

Authors: **U. Illgner, A. Uekoetter, H. Wetz, S. Runge**

Presenter: **U. Illgner**

## **Background**

Patients with Charcot arthropathy present a high risk of ulcers with secondary bone infections or sepsis. Infections with *Pseudomonas aeruginosa* represent a severe threat to the patients. Clinical studies are missing.

## **Hypothesis**

Infections with *P. aeruginosa* cause a longer stay in hospital and more operations than infections with other bacteria.

## **Methods**

All patients who underwent surgery of Charcot arthropathy of the feet between 1996-2006 (n=205) in our clinic were included. Residence time in hospital and number of surgeries in patients with infections due to methicillin resistant *Staphylococcus aureus* (MRSA) vs. *P. aeruginosa* were compared to infections with other bacteria. All patients were scanned for MRSA and were isolated when tested positive and treated according to a defined algorithm.

## **Results**

79 intra-operative samples exhibited bacterial growth: 12 cases of MRSA, 14 cases of *P. aeruginosa* and 53 other bacteria. Patients with deep infections due to *P. aeruginosa* stayed significantly longer in hospital (52d vs. 35d,  $p<0.041$ ) and needed significantly more surgery (1.71 vs. 1.28 surgeries,  $p<0.027$ ). There was no significant difference between patients with MRSA infections to those without MRSA or *P. aeruginosa*.

## **Discussion**

Infections with *P. aeruginosa* caused significantly more operations and a longer stay in hospital. Rapid debridement is the basic treatment.

## **Conclusion**

A specific algorithm for isolation, surgical and antibiotic treatment for *P. aeruginosa* infections is proposed as a similar algorithm for MRSA showed to be successful.

Key words: *P. aeruginosa*; MRSA; Diabetic foot; Foot infection; Antibiotics

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **General - 1**

**Room 1.06**

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Key words: *P. aeruginosa*; MRSA; Diabetic foot; Foot infection; Antibiotics



Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **General - 1**

**Room 1.06**

Abstract Title: **Prevalence Of Flat Feet Among School Children'S Between 6-10 Years**

Abstract number: **513**

Authors: **M. Ali, S. Muhammad**

Presenter: **M. Ali**

Our cross sectional study (prevalence survey) has been conducted on School children among 6-10 years (class one to class fifth) in six schools of the Rawalpindi/Islamabad. Our study determined the prevalence of the flat foot (age, gender, side involvement, and type). Our study included 712 children, male (512) and female (202). A specially designed Performa (subjective, objective history) is filled after doing physical examination and special tests for flat foot. The statistical analysis concluded that that the prevalence of flat foot in school children among 6 to 10 years (from class 1 to 5) is 14.8% (106) and more common in male child then female child and bilateral (76.4%) involvement of the flat foot is more than unilateral (23.4%). The study showed that prevalence of flexible flat foot is ten times more than rigid flat foot having a ratio of 9:1 .all rigid flat foot cases are symptomatic and flexible flat foot cases are asymptomatic (showing no symptoms).the prevalence of flat foot is more in children's who are physically inactive .while physically active children have a very well developed medial longitudinal arch.

It is our **Conclusion** that people/child who are living in different countries but having similar condition like environment, social, economical, life style. They have equal chance of developing flat foot or they have same % of the prevalence of the flat foot. Our study concluded that physical activity is directly proportional to the development of the medial longitudinal arch.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 5**

**Room G.06**

Abstract Title: **Conversion Of Hip Disarticulation Into Above Knee Amputation And Prosthetic Management**

Abstract number: **486**

Authors: **B. Dhar**

Presenter: **B. Dhar**

Osteo Sarcoma such as Ewing's is common bone affliction with very common occurrence in early years. Management often **Results** in amputation at the proximal joint .For patients with Sarcoma of proximal femur , amputation is always carried out at the hip leading to hip disarticulation. Such amputations are hard to rehabilitate due to difficult prosthetic fitting and increased energy consumption. The novel surgical procedure converts a hip disarticulation surgery into an above knee amputation wherein a viable residual limb and functional hip joint is created. Modified and step wise Prosthetic fitting then helps patient ambulate as Above knee amputee with much improved outcome and acceptance.

Patient Report:

- Six Amputations performed till date at KFSH&RC between age 16 and 23 in King Faisal Hospital. Two patients ambulatory for more than six months .One patient dead due to metastasis . Three patients in process of prosthetic fitting.

Steps of amputation Procedure:

The known basic principles of transfemoral amputation in skin incision and soft tissue dissection was followed. Femur is completely removed while the soft tissue is preserved. A Prosthetic implant was installed with 4 to 6 inch long stem. The muscles were sutured to the implant and the closure of skin was performed usual way. Rehab was immediately started with muscle strengthening exercises and volume management by shrinker socks.

### **Results**

All the patients healed normal. Prosthetic management was initiated in 6 weeks' time .All patients walked with prosthesis without any pain . All the patients were fitted with ischial containment sockets and endoskeletal prosthesis. Prosthetic gait was like any above knee amputee.

### **Conclusion**

Conversion of Hip Disarticulation into above knee amputation goes long way in energy saving and better gait. Acceptance of prosthetic fitting is higher and the ambulation is much improved due to presence of Hip Joint.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 5**

**Room G.06**

Abstract Title: **Krukenberg Procedure - Revival Of A Independence For Upper Limb Amputees.**

Abstract number: **518**

Authors: **S. Chittoor**

Presenter: **S. Chittoor**

Loss of the upper limb can severely limit the function of the amputee. Rehabilitation of bilateral cases is very challenging. Prosthetics do offer a fair amount of independence, however, the amputee remains as dependent without the use of these devices. The Krukenberg procedure offers independence without use of prosthetic devices. Our centre has a vast cumulative experience of around 500 such procedures over the last 50 years.

The Krukenberg procedure, which was first carried out by German Army surgeon H Krukenberg (1917) on British Prisoners of War (POW) during 1st World War, converts non-functional below elbow stump into a highly functional and sensate organ. Absolute indication for this procedure is loss of both the hands especially if there is loss of vision as well. It is done by separating radius and ulna, and converting them into two prong / fork like sensate fingers that are capable of performing most of the functions of hand. Pronator teres, which pronates the hand, does the apposition of the radius and ulnar prongs to hold an object, while supinators open them. This procedure helps converting a helpless person into a totally independent and useful member of the society. Krukenberg offers a sensate prehension and also allows a functional or cosmetic prosthesis. Though usually advised for blind bilateral amputees, such as due to bomb blasts, in our experience the procedure offers good outcome for unilateral, sighted patients too. Suitable patients may be reluctant due to the cosmetic issues, however appropriate peer and specialist counselling may help. The author is a prosthetic surgeon in the Indian Armed Forces, working at the largest organised limb centre in India. He will elaborate on the surgical technique, and advantages and limitations of the procedure.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 5**

**Room G.06**

Abstract Title: **Geriatric Rehabilitation Of Lower Limb Amputees; A Dutch Multicenter Cohort Study**

Abstract number: **531**

Authors: **M. Spruit- Van Eijk, H. Van Der Linde, B. Buijck, A. Geurts, S. Zuidema, R. Koopmans**

Presenter: **M. Spruit- Van Eijk**

### **Purpose**

The aim of this study was to determine factors independently associated with successful rehabilitation and prosthetic use of patients with lower limb amputation in skilled nursing facilities (SNFs).

### **Methods**

All patients admitted to one of the 11 participating SNFs were eligible. Multidisciplinary teams collected the data. Successful rehabilitation was defined as discharge to an independent living situation within 1 year after admission. Functional status at discharge, as measured with the Barthel index (BI), was a secondary outcome. Finally, a prediction model for prosthetic use was made. Multivariate regression analyses were used to assess the independent contribution of each determinant to the outcome measures.

### **Results**

Mean age was 75 years. Sixty-five percent rehabilitated successfully. Multivariate analyses showed that presence of diabetes mellitus (DM) (OR 23.87, CI 2.26–252.47) and premorbid BI (OR 1.37, CI 1.10-1.70) were the most important determinants of successful rehabilitation, whereas 78% of the variance of discharge BI was explained by premorbid BI, BI on admission, and 1-leg balance. Of the thirty-eight patients that were eligible for fitting a prosthesis at the end of rehabilitation, 50% were indeed fitted prosthesis and able to functionally use it. Being able to ambulate independently, and having a transtibial amputation (rather than a higher level of amputation), without phantom pain determined prosthetic use ( $R^2=56\%$ ).

### **Conclusion**

The presence of DM and high premorbid BI were associated with discharge to an independent living situation within 1 year after admission. Premorbid BI, admission BI, and 1-leg balance were independently associated to discharge BI. Elderly patients referred to an SNF for prosthetic training have a high probability of using a prosthesis when having an independent ambulation after transtibial amputation, without phantom pain. These patients should be considered for prosthetic training.

Date / Time: **Thursday, Feb 7 / 14:30 - 15:45**

Session Name and Room: **Rehab Medicine & Surgery - 5**

**Room G.06**

Abstract Title: **Bone Anchored Prostheses In Upper Arm Amputees: Radiologic Outcomes.**

Abstract number: **178**

Authors: **G. Tsikandylakis, R. Brånemark, Ö. Berlin**

Presenter: **R. Brånemark**

### **Introduction**

Osseointegrated prostheses have been used on transhumeral amputees for the last fifteen years. This is the first radiological report on the first 18 patients.

### **Methods**

18 patients received 20 implants. Average age at implantation was 42 (19-69) and female/male ratio was 2/16. The cause of amputation was either trauma (16) or tumor (2). Their x-rays were qualitatively evaluated by one observer. An anteroposterior and a lateral view of the implant were examined for structural changes such as near bone resorption and cancellization at bone/thread interface, cortical thinning, distal bone resorption and proximal trabecular buttressing.

### **Results**

Of the 18 patients treated, 2 had implant failures. 2 implants failed in the same patient and one implant failed in another patient and was revised. Of the remaining 17 implants (in 17 patients) 2 are followed elsewhere and one is lost to follow up. 13/14 patients are using their upper limb prosthesis. Near bone resorption was observed in 7/20 implants (35%) mainly at the distal third of the fixture. Cancellization also occurred in 7/20 implants but was more common at the middle third of the fixture. Cortical thinning appeared in 5/20 implants (25%) mainly at the distal third. Distal bone resorption was less common (3/20 implants, 15%) and limited without exposing the fixture. The most common radiological change was proximal buttressing (10/20 implants, 50%).

### **Discussion**

This study reports on up to 15 years radiological follow up on transhumeral amputees with osseointegrated prostheses. Late implant loosening has not been observed clinically or radiologically. On the other hand 3 implants loosened early within two years without any signs of bone resorption on the x-rays indicating the difficulty to correlate between clinic and radiology regarding early loosening.

### **Conclusion**

The study supports that bone anchored prostheses in upper arm amputees work satisfactory with few implant failures.

