

**Association of Children's Prosthetic-Orthotic Clinics  
2008 Annual Meeting, April 9-12  
Hyatt Regency Montreal, Quebec, Canada**

**Thursday, April 10, 2008**

Scientific Session I – Upper Extremity

7:40 am / Paper #1

**ASSESSMENT OF CAPACITY FOR MYOELECTRIC CONTROL**

*Wendy Hill, BSc, OT; Liselotte Hermansson, PhD, OT  
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**Background:** Outcome measures have become very important in the health care field over the past several years. Many important decisions are made based on results from outcome measures. As clinicians, we may decide whether a child is benefitting from a particular device or treatment, we may monitor progress in a particular occupational performance area, or we may decide what future therapy goals can realistically be attained. Outcome measures are also used by third party payers in doing a cost-benefit analysis to justify provision of health care devices. Many of the tests used by clinicians in the field of upper limb prosthetics to measure function are not designed specifically for this purpose or they have questionable reliability and validity.

The Assessment of Capacity for Myoelectric Control was developed as a valid, reliable and sensitive measure of the qualitative aspects of prosthetic use. It is administered and scored by a trained occupational therapist while observing a client using a prosthesis to perform a pre-determined activity of daily living.

**Objective:** To describe the development of the *Assessment of Capacity for Myoelectric Control (ACMC)*, an observational assessment tool designed to measure prosthetic control among myoelectric hand prosthetic users.

**Design:** Longitudinal data (18 months) from a prospective study of development of capacity for myoelectric control in children and adults were used for the analysis.

**Patients:** A consecutive sample of 75 myoelectric hand prosthetic users (43 males, 32 females) was recruited between September 2000 and March 2002. They were either born with upper limb reduction deficiency or traumatic amputees. Participants' ages ranged from 2 to 57 years.

**Methods:** Outcome measure was the ACMC. Occupational therapists completed 210 assessments at an arm prosthesis center in Sweden. A two-faceted Rasch model rating scale analysis of the data was performed.

**Results:** All 30 ACMC items and 96.2 percent of participants demonstrated 'goodness-of-fit' to the Rasch rating scale model for the ACMC. This means that all the items functioned in an expected manner. Separation and *SE* values suggested adequate reliability of the item and person estimates.

**Conclusion:** The items demonstrated internal scale validity and the participants demonstrated person response validity. The difficulties of the items were well targeted at the ability of the sample and sensitive enough to detect expected change in ability.

7:55 am / CS #1

**A NEW CUSTOM ADAPTATION TO PERMIT INDEPENDANT FEEDING FOR A CHILD  
WITH SEVERE ARTHROGRYPOSIS OF UPPER EXTREMITIES**

*Cécile Lachaine, BSc erg; Claire Lastère, BSc erg; Catherine Ménard, BSc erg;  
Isabelle Morin, BSc erg  
Centre de réadaptation Marie Enfant du Centre Hospitalier Universitaire (CHU)*

*Ste Justine Montréal, Québec, Canada*

Kim is a 5 year old with severe arthrogryposis with no prehensile skills, nor functional movement of either upper extremity. Currently she is able to use commercially available adaptations for certain activities of daily living. The challenge was to achieve autonomous feeding with the upper extremities because the mother refused to see her using her lower extremities for this task. Trials of commercially available adaptations were inconclusive.

Thus, we adapted a 'ball bearing feeder' as a support for her upper extremities. Multidirectional movement was obtained by modifications to the pivot of the arm support, which was adjusted to her dimensions. Using this adapted feeder, an orthosis to stabilize the wrist and a palmar fixator to hold utensils, Kim has experienced a significant improvement in the level of autonomy in feeding herself. We will present this adaptation and solicit your suggestions for the other activities of daily living where she is limited and no compensatory adaptations have yet been found.

8:10 am / CS #2

**YES I CAN! : THE ATTITUDE OBTAINED BY A CHILD WITH BILATERAL SHOULDER DISARTICULATION AFTER ATTENDING A CHILDREN'S PROSTHETIC CAMP**

*Suzie E. Williams BS, CP*

*Wright & Filippis, Rochester Hills, MI, USA*

A 14 year old girl presents as a congenital bilateral shoulder disarticulation. Initially fit at the age of eight with prosthetic devices consisting of Vasi elbows, Otto Bock system 2000 hand on the right side, NYU hook on the left side, with touch pad operation. The patient was successful with prosthetic function by incorporating occupational therapy. At the age of 11, the patient had grown out of prosthetic devices and was in need of new prosthetics. The patient was then fit with Otto Bock ergo elbows, and sensor speed hands. The patient was able to operate terminal devices with dual site electrodes placed on the pectorals major, and supraspinatus. The patient used these muscle sites to open and close terminal devices with proportional control. Co-contraction is used to lock and unlock the elbows. Elbow flexion/extension is aided with automatic forearm balance in the ergo arms. Sockets were suspended with two posterior criss cross straps, and one anterior strap. Patient was able to successfully operate prosthetics devices by incorporating occupational therapy in school. Over time, the patient had a chief complaint of prosthetic devices being too heavy, and her mother started to discourage prosthetic use. The patient's role model consisted of a 21 year old girl who presents as a congenital bilateral shoulder disarticulation. She does not use prosthetic devices. She is fully successful by the use of her feet in every active daily living activity. The 14 year old's mother thought her daughter could be successful with her feet as well.

The patient's mother put the prosthetic devices in a box and placed it in the shed for over a year. During this time, the patient had not been as successful with her feet as her role model. Unlike her role model, she had previously incorporated prosthetic use in her active daily living activities, and did not have the same body type and flexibility. The patient's mother continued to discourage prosthetic use, and assisted the patient with all active daily living activities.

With the concern of the patient entering her teen years without having independence, the notion of Camp Yes I Can was introduced to her mother. Camp Yes I Can is a children's prosthetic camp located in Big Bay Michigan and is sponsored by the Filippis Foundation. The camp accommodates amputees from the ages of 4 to 17. Each day children reach their goals through activities such as hiking, swimming, kayaking, arts and crafts, camping, fishing, bike riding, and daily occupational and physical therapy sessions. The mother refused to allow the patient to go the first year the camp was operated. After seeing the success of other patients who attended the camp, the mother allowed the patient to attend the following year. During camp, the patient was enriched in a positive environment and established social interaction with similar peers. Through positive encouragement, peer support, occupational therapy, and the YES I CAN attitude, the patient was able to become a successful full time prosthetic user once again.

8:25 am / CS #3

## **CREATIVE ELBOW-WRIST-HAND ORTHOSIS DESIGN TO MANAGE PEDIATRIC BRACHIAL PLEXUS INJURIES**

*Marcus Cassar CPO, LPO; Auedrey Yasukawa, OTR  
Orthotic-Prosthetic Department, Children's Memorial Hospital, Chicago, IL*

This creative orthotic solution looks at utilizing a custom elbow-wrist-hand orthosis (EWHO) with an innovative static-progressive supination/pronation forearm adjustment and a dynamic elbow component to manage pediatric brachial plexus injuries. This design is being utilized at Children's Memorial Hospital in Chicago as a common solution when managing this patient population. This presentation will also include some preliminary data concerning improvements made in range-of-motion (ROM) measurements utilizing the creative upper limb EWHO.

### Symposium I

8:40 am – 9:45 am

#### **REVIEW OF FUNCTIONAL SURGICAL ALTERNATIVES FOR CHILDREN WITH CONGENITAL HAND AMPUTATIONS**

*Patricia Egerszegi, MD; Chantal Janelle, MD; Marie Laberge-Malo, MD;  
Constantin Stanciu, MD; and genetics specialist  
Centre de readaptation Marie Enfant Hospital, Montreal, Quebec, Canada*

This symposium seeks to consider surgical options to enhance function in the child with congenital hand amputations. The current pathogenetic hypotheses explaining these malformations will be presented. How do the various disorders impede function? Which function should be sought and how should surgeries be staged? Various reconstructive surgical possibilities of the hand and forearm will be presented. Included will be: radialisation, pollicisation, pinch opening (palmar abduction-opposition plasty), digit lengthening, web space opening (syndactyly release), palm reduction (metacarpal removal), free vascularized toe transfer, and the possibilities for transplantation (vascularised, homograft etc). No emphasis will be put on aesthetic surgery. A quick over-view of rehabilitation approaches in occupational therapy and physical therapy will be addressed, as well as orthotic needs and adaptations.

Following the ensuing debate, participants will share their experiences, enabling all to leave the symposium with a balanced appreciation of the benefits and disadvantages of such surgical interventions as well as possible non-surgical alternatives.

### Symposium II

10:30 am – 11:30 am

#### **UPPER LIMB EXTREMITY MOTION ANALYSIS**

*Colleen Dewis, BSc eng; Edmund Biden, PhD; Wendy Hill, BSc, OT; Greg Bush, CP(c); Peter Kyberd, PhD; Arthur Zinck, BSc eng  
Institute of Biomedical Engineering, University of New Brunswick, Fredericton, Canada*

The objectives of this symposium include:

- Outlining the differences between upper and lower extremity motion analysis;
- Encouraging the use of motion analysis as a tool for analysis of upper extremity motions;
- Sharing and discussing some of the methods that have been developed at the University of New Brunswick (UNB) to do this;
- To present some of the results of these studies.

Motion analysis has been used in different capacities for over 50 years, mostly for gait. Few studies have examined the kinematics of the arms, and even fewer have looked at the forces involved. Gait studies are made easier since the movements are cyclical whereas upper limb motions are often anything but. Trying to force cyclic movements for the arms tend to limit how well they reflect real world tasks.

There are many factors to be considered in any type of motion analysis however these are compounded when dealing with upper limbs. One of the major challenges is defining tasks that are relevant to the community being studied, going to yield useful results, and are age appropriate. When dealing with children extra thought has to be given to ensuring that the children are interested in the tasks so that they will be cooperative throughout the testing. Choosing tests is best done in consultation with an occupational therapist (OT) with experience in the population to be studied. They will have experience in the types of tasks required for specific purposes; for example is the study examining gross or fine motor skills, are the tasks going to be bi-manual?

The next consideration in motion analysis is coordinating the collection of the data. There are many things to be considered and vary slightly with different systems. Some of the major concerns include marker visibility, stability and placement on the body to give accurate definitions of limbs and joints. In this presentation several different marker setups will be discussed.

The other aspect which separates upper limb analysis from gait studies is that measuring the forces occurring in the joints can be quite challenging. In gait analysis these forces are measured, for example, by force plates in the floor, or pressure sensors in the subject's shoes throughout the task. This point of contact is not present in most arm motions, and when it is present in a task, it can be hard to quantify accurately. We present options for measuring the external forces and provide examples of gadgets to measure handgrip forces in a bike and forces applied to the ropes while swinging on a swing.

Once data has been collected the analysis must be done. There are many approaches that one can take at this point however the general progression includes adjusting markers to joint centers to define the limb segments, defining coordinate systems, angle analysis and finally forces and moments at the joints. From this data everything from postures to joint power can be examined in detail; however it is important to note that in order for a study to be statistically significant many subjects are needed. In the case of prosthetic users having a baseline comparison of "what normal is" is important, and can be achieved using normally limbed children. It is also important that this analysis be done in conjunction with the entire care team including OT, prosthetist and parents so that if there are postures that could lead to future issues they have the chance to be addressed.

At UNB currently there are several projects underway examining various aspects of upper limb extremity motion, both in children and adults. These include examining the postures, muscle activity and forces in addition to the differences between different wrist types during play activities including zippering a vest, swinging and bicycling. This is an ongoing study that had to date resulted in a database of approximately 75 normally limbed children and 15 prosthesis users. Another study will evaluate the Norwegian Revolute Wrist Device, which is a powered wrist which can be adjusted so that the axis is not aligned with the forearm. This has been tested using a series of 6 activities of daily living, and has examined 15 normally limbed users to date.

Outcomes: At the conclusion of this symposium presentation attendees should be able to:

- Understand key differences between gait analysis and analysis of upper limb motion.
- Make informed decisions in planning studies of upper limb motion using motion analysis technology.
- Understand key elements of the analysis techniques which can be applied in the upper limb.

### Feeding Issues

11:30 am – 12:30 pm

11:30 am / CCP #1

#### ***AMPUTATION AND BARIATRIC SURGERY AS MANAGEMENT OF FAILED EQUINOVARUS SURGERY IN A MORBIDLY OBESE PATIENT***

*Robin C. Crandall, MD*

*Shriners Hospital for Children, Minneapolis, Minnesota*

A case is presented concerning management of an obese adolescent spastic diplegic. The patient presented with internal rotation equinus deformity of his left lower extremity. He was managed conservatively up to age 6. A tibial derotation with anterior wedge resection osteotomy was carried out at the ankle. Chronic deep space and ultimately distal tibial osteomyelitis developed which did not respond to treatment. A stiff equinovarus foot with intermittent draining of a sinus developed consistent with osteomyelitis of the tibia. Left transtibial amputation was carried out at age 16 + 11 followed by gastric bariatric surgical procedure. At the time of his amputation, his weight was documented to be 323.4 pounds. Progressive weight loss ensued following the bariatric procedure with an excellent three-year follow-up and long-term clinical result. His body weight decreased to 224 pounds. Aspects of bariatric surgery and prosthetic use in the obese spastic diplegic adolescent will be discussed.

11:50 am / CCP #2

**FEEDING DISORDERS : WHEN CHILDREN REFUSE TO EAT**

*Christiane de Tonnancour, MP; Cécile Lachaine, BSc erg; Claire Lastère, BSc erg; Luce Lefebvre, BSc erg; Catherine Ménard, BSc erg*

*Centre de réadaptation Marie Enfant du Centre Hospitalier Universitaire (CHU) Ste Justine Montréal, Québec, Canada*

This paper is about cases of feeding disorders seen in our population of children with congenital malformations of one or several limbs. Our team follows several children who present similar patterns of feeding disorders. These include: eating abnormally slowly, lack of appetite, extreme selectivity ( type, texture, temperature, taste of foods). Contributing factors range from medical origin to sensory impairment, oral-motor difficulties, history of past bad experiences or a combination of these. These feeding difficulties can be traumatizing for the child and his parents. Issues such as anxiety concerning the child's health, parental guilt, parental competency, child's aversion behavior towards foods, and inability to progress to different food textures must be effectively addressed. While these problems could often evolve without detection, they have a potentially significant impact on family and social life.

This presentation will raise questions concerning the relationship between congenital malformations and feeding disorders. Our other questions are about the potential link between parents psychological adjustment to the congenital anomalies and feeding disorders. Presenting these cases we hope to engage you in a discussion concerning your own experience with feeding disorders in your population of children with congenital malformations.

Scientific Workshops

1:30 pm – 5:00 pm

**WORKSHOP B**

**UPPER-EXTREMITY SPECIALIST, WILL LEAD A PANEL DISCUSSION OF CREATIVE APPROACHES TO TREATMENT OF INDIVIDUALS WITH UPPER EXTREMITY AMPUTATIONS**

*Gerrald Stark, CP*

The focus of this WORKSHOP will be to review some of the "often forgotten" principles and fitting techniques, share ideas with the audience and provide a venue for discussion and brainstorming on the challenges that prosthetists and prosthetic technicians experience in the fittings and fabrication of upper limb prostheses. Topics for discussion will include: Northwestern Socket Design by John Billock, Snap Electrode Technology, "Z-Strap" Modification to a Figure of 8 Harness and more. Attendees are encouraged to bring challenges and/or creative solutions to the workshop in a digital format so that they can be presented and discussed as well. The intent of this workshop is provide attendees with a greater armamentarium of ideas for solving specialized needs of individuals with upper extremity amputations.

**Friday, April 11, 2008**

## Scientific Session II – Lower Extremity Orthotics

7:30 am / Paper #2

### **PROLONGED USE OF MBT SHOES FOR TRAINING OF POSTURAL STABILITY IN CHILDREN WITH NEUROLOGICAL DEFICITS**

*Christina Björk Andersson, PT#; Nerrolyn Ramstrand, BP&O(hons), PhD\*  
#Team Ortopedteknik Scandinavia AB; \*Jönköping University, Jönköping, Sweden*

Children with neurological deficits typically present with impaired postural control (Lin et al., 2006). This has marked effects on various aspects of balance including, reactive balance control (Shumway-Cook et al., 2003; Burtner et al., 2007), functional stability (Westcott et al, 1997) and standing or sitting balance (Rose et al., 2002).

In recent years, shoes incorporating an unstable sole construction have been released onto the market. (e.g. MBT shoes, Masai Barefoot Technologies, Switzerland; Chung Shi Shoes, Foot Solutions Inc, USA). Manufacturers of the shoes claim numerous benefits associated with regular use of the footwear including; improved posture and balance.

This study aimed to investigate if prolonged use of shoes incorporating an unstable sole construction could facilitate improvements of balance in a sample of children with neurological deficits. Ten children (6 male and 4 female) aged between 10 and 17 years participated in the study. Children were fitted with shoes incorporating an unstable sole (Masai Barefoot Technology®) and instructed to wear them for a minimum of two hours per day for 8 weeks. A within subjects repeated measures design was used. Children were tested prior to receiving the shoes, four weeks after receiving the shoes and 8 weeks after receiving the shoes. A force plate capable of rotating about a single axis (NeuroCom International, Inc, Oregon) was used to test static balance, reactive balance and directional control.

Static balance was not found to be influenced by prolonged use of the footwear ( $p>0.05$ ) however significant improvements were noted in children's reactive balance both with the shoes and barefoot ( $p<0.05$ ). Results suggest that reactive balance can be improved through the prolonged and regular use of shoes incorporating an unstable sole construction.

#### **References:**

- Burtner et al. (2007) The capacity to adapt to changing balance threats: A comparison of children with cerebral palsy and typically developing children. *Dev Neurorehabil* 10:3:249-260.
- Lin et al. 2006. Development of a quantitative assessment system for correlation analysis of footprint parameters to postural control in children. *Physiol Meas* 27:2:119-130.
- Rose et al. (2002) Postural balance in children with cerebral palsy. *Dev Med Child Neurol* 44:1:58-63.
- Shumway-Cook et al. (2003) Effect of balance training on recovery of stability in children with cerebral palsy. *Dev Med Child Neurol* 45:591-602.
- Westcott et al. (1997). Evaluation of postural stability in children: Current theories and assessment tools. *Phys Ther* 77:6:629-645.

7:45 am / Paper #3

### **WHY DO CHILDREN DISCARD SPLINTS ROLE OF SPASTICITY/DEFORMITY**

*Vipul Shah, MS; Mansi Agarwal, BPT, Ashok Navratnamal Johari, MS; Viraj Uttamrao Shingade, MS;  
Himanshu Singh Dpoe  
Orthopaedics, Staff Compound Jubilee Girls Degree College, Lucknow, India 226001*

The aversion of kids to splints is well documented in literature; research has proved beyond doubt that faulty splintage techniques/materials have a big role in this problem. We hypothesized that the aversion of children with cerebral palsy to splints may also stem from spasticity with pain due to spasticity as a cause.

**Method and Materials:** 21 children aged 3-18 years were studied (mean-9.3yrs) (5 females and 17 males) there were 3 hemiplegics, 5 quadriplegics and the rest diplegics ( average 6.7 months) follow up according a set protocol, and R<sub>1</sub>, R<sub>2</sub>, Ashworth grades, Fixed flexion deformities at the knee, ankles and hips were

measured, all measurements were done by the same paediatric orthopaedic surgeon to eliminate inter observer bias, the treatment was then started by plaster and botulinum (DYSPORT- IPSEN Inc UK), plaster and Tizanidine, or single event multilevel surgery. They were re evaluated after 6 weeks of treatment and subsequently at fortnightly intervals according to the same protocol and parents kept on documenting splintage times in diary. There were 7 patients in botulinum and plaster group, 9 patients in plaster and Tizanidine group and 5 multilevel surgery group. Parents were also independently interviewed ensure that the splintage rates were being adequately documented.

**Observation:** All patients acted as their own controls The average hours of splintage before treatment was 2.3 hours and increased to 11.6 hours post treatment.

The splintage rates correlated inversely with initial degree of deformity,  $R_1$ , less than  $45^\circ$  at the knee and below  $-15^\circ$  at the ankle. Splintage time was documented from the parents diary.

**Discussion:** All observations pointed to importance of spasticity reduction in cerebral palsy management. Often splints are advocated as the answer to spasticity but in fact children who need splints the most (Ashworth grade 3/ grade 4) are the ones that are most likely not to wear them. Grades 1 / 2 usually don't need splints and grade V are usually locked in one position of deformity hence spasticity management takes precedence over splintage. The methods of management notwithstanding the results remain in overwhelming favor of use of treatment of spasticity first followed by/concurrent splintage.

8:00 am / CS #4

**PEDIATRIC CLINICAL APPLICATIONS OF A POLYPROPYLENE REINFORCED ANKLE FOOT ORTHOSIS (RAFO) ILLUSTRATING ENERGY STORAGE AND RETURN CHARACTERISTICS IN WALKING AND RUNNING**

*Don Weber*

*Hamilton Health Sciences Hospital, Hamilton, Ontario, Canada*

The RAFO design embeds polypropylene reinforcements (up to 1/2" thickness) in the tibial and plantar surfaces of a posterior leaf AFO (polyene base material) to produce a rigid foot plate section and a dynamic posterior section capable of clinically significant energy storage and return characteristics. The plastic architecture of the posterior tibial section can be altered to create a broad range of motion resistance from minimal control (i.e. - for a child pulling to stand) to maximal resistance for sport applications (i.e. - soccer, basketball). A brief description of the structural design of the RAFO is presented followed by video case studies of the clinical applications of the RAFO to a variety of pathologies (cerebral palsy, spina bifida, Downs syndrome, spinal muscular atrophy, hemophilia, idiopathic toe walking) and activity levels (cruising, crouch gait, walking, running). Future research and design innovations are discussed.

8:15 am / CS #5

**COMPLIANCE SOLUTIONS FOR DENIS BROWNE BARS**

*Janet G. Marshall, CPO; Daniel E. Griner, CPO*

*Shriners Hospital for Children, Tampa, FL*

The protocol for the Ponseti Clubfoot Procedure requires the long term wearing of Denis Browne Bars. The challenge of compliance with infants through toddlers has required unique creativity for orthotists and parents. A review of adaptations for addressing this issue will be presented including: padding, fabrication of custom silicone socks, silicone appliques in shoes, and AFO applications when appropriate to diagnosis.

8:30 am / CS #6

**HYBRID FOOT ABDUCTION ORTHOSIS**

*Heather Russell, PT, CO*

*University of Virginia Prosthetics & Orthotics, Charlottesville, VA*

Typically clubfoot displays excess plantarflexion, varus, and inversion. To correct this, the Ponseti Method is implemented, this involves weekly manipulations and casting to gradually position the foot in excess

dorsiflexion, valgus, and eversion. Casting can take approximately 3 – 6 months. As the foot resumes a more normal appearance and function the child is placed in a Dennis Brown Bar and straight lace shoes, which is also referred to as a Foot Abduction Orthosis. The shoes on the Foot Abduction Orthosis are typically externally rotated 60-70deg on the involved side and 45 deg on the uninvolved side. It is suggested that 40% of clubfoot cases are bilateral, in such cases there are times when one foot will relapse or lag behind the other delaying the transition from casts to the bar.

Such a case recently occurred. The child's right foot had progressed and was ready for a foot abduction orthosis, unfortunately the left foot was relapsing into plantarflexion making it difficult to keep him in his shoes overnight. His involvement was bilateral and therefore treatment of the right foot needed to continue while addressing the relapse of the left foot. The Orthopedist required recasting of the left foot with the knee fixed at 90deg. Ordinarily this would require recasting the right leg until both legs were more normal in appearance and function then proceeding to the Foot Abduction Orthosis, limiting desired active motion.

Working with the treating physician a novel approach was developed to attach the cast to the bar to provide a better solution. To attach the cast to the foot abduction orthosis a Horton Click bar was used. Using this setup the angle of external rotation is set on the bar and the mounting plate is attached via a quick release to facilitate donning and doffing easing processes such as bathing and dressing. It also allowed the detachable foot plate to be attached to the bottom of the cast. While this allowed the attachment of the cast to the foot abduction orthosis it obligated his right knee to a 90deg angle. To relieve this motion constraint a wedge was placed between the cast and the mounting plate (Figure). This combination allowed for additional range of motion in the uncasted right foot while allowing the attachment of the casted left leg to the bar.



Figure, Horton Click bar and wedge just prior to attachment to cast.

8:45 am / CCP #3

### **DENNIS BROWNE BAR VERSES CLUBFOOT, KAFO**

*David G Mueller, DPT, CPO, Hanger, Flagstaff, AZ*

**The Problem:** Traditionally, the Dennis Browne bar has been prescribed for post- casting management for the clubfoot deformity. However, experience in the clinical setting has demonstrated utilization of a brace that can hinder other factors. These include decreased function of the uninvolved leg, frustration of child/parent with system rigidity, ADL issues, compliance and limitations in supporting child developmental skills.

**The Solution:** One alternative treatment has been the utilization of a custom thermoplastic clubfoot KAFO imparting and supporting the prescribed casted method. This includes the optimum angles and imparting corrective joint mobilization across combined foot, ankle and knee segments.

This KAFO case exemplifies easier optimum positioning, increased functional movement and potential decrease in wearing time, thus, eliminating many of the factors described above.

### Session III – Treatment of the Spine

10:20 am / Paper #4

#### **FLEXFOAM BRACING FOR SCOLIOSIS IN SKELETALLY IMMATURE SPINAL CORD INJURED PATIENTS**

*Joel Lerman, MD; Craig M. McDonald, MD; Greg Aaron, CO; R. Ted Abresch, MS; Munish C. Gupta, MD*

*Shriners Hospitals for Children-Northern California and University of California-Davis, Sacramento, California*

**Purpose:** Skeletally immature patients with spinal cord injury carry a high likelihood of developing scoliosis. Results of bracing for these patients have been problematic at best, due to factors which may include patient compliance and tolerance for bracing. To attempt to decrease the risk of pressure problems associated with decreased sensation in spinal cord patients braced for scoliosis, a semi-rigid bracing system was utilized.

**Methods:** Nineteen skeletally immature patients who had sustained spinal cord injuries were treated with a flexfoam thoracolumbosacral orthosis (TLSO) and were followed until skeletal maturity, surgery, or recommendation for surgery. A curve of 50 degrees or greater was considered an indication for surgery. Of the nineteen patients, one had a curve less than 20 degrees, 12 between 20 and 40 degrees, and 6 greater than 40 degrees at the time of brace fit. Whether the patient underwent or was recommended for surgery, and the time until surgery were noted. For the 12 patients with curves between 20 and 40 degrees, the likelihood of surgery was compared with historical controls from the literature, which utilized a rigid TLSO.

**Results:** Only one patient had a problem with irritation under the flexfoam brace, occurring with transfers while using the brace. However, all patients except one in our series (15 y/o male with a 33 degree curve) underwent surgery or were recommended for surgery based on a curve greater than 50 degrees. A Pearson chi square test found likelihood of undergoing surgery greater for the 12 patients in this series with curves 20-40 degrees treated with semirigid bracing, compared with the 20 rigid TLSO patients in the historical series with a similar curve range (12/20 undergoing surgery) ( $p=.042$ ). The mean time until surgery in our series for the patients with curves between 20 and 40 degrees was 4.0 years; this was similar to the mean 4.2 years until surgery in the Mehta series.

**Discussion:** In the present series of skeletally immature spinal cord injured patients treated with semirigid bracing for scoliosis, while skin irritation was not an issue, the likelihood of undergoing surgery or reaching the operative curve range was almost universal. Bracing did not appear to delay surgery.

10:35 am / CS #7

#### **THE USE OF DYNAMIC LYCRA ORTHOSES IN THE TREATMENT OF NEUROPATHIC SCOLIOSIS- A TREATMENT REVIEW**

*Martin Matthews, M.Phil, MBAPO S/R Orthotist  
Norfolk & Norwich University Hospital NHS Trust*

The use of dynamic Lycra® Orthoses have been growing in the United Kingdom over the last ten years. Initially used in the treatment of children with cerebral palsy to provide support and to initiate self development of balance and function, the concept has developed and evolved over time. The simple supportive orthoses used ten years ago provided some stability to the trunk and were particularly useful in the treatment of the dystonic child however they did not provide the corrective abilities of rigid spinal bracing.

This paper will discuss the advent of the inclusion of corrective panels which allow translation panels to be incorporated to provide a dynamic Lycra orthoses, capable of reducing the onset of structural curves in a group of children with cerebral palsy. Some studies have shown that x-rays of scoliotic curves can provide an indication of the management outcomes of this treatment (Matthews & Crawford 2006), suggesting that this mode of treatment could have an effect on a larger population. The use of these orthoses, have been

used over the last ten years in paediatric orthotic management in the UK. The results have suggested that the orthoses could provide another option in the treatment of neuropathic scoliosis. The recent designs have provided the orthotist with the possibility of designing a truly dynamic orthoses, that can counter the progression of scoliosis, if used in the formative years without prejudicing the natural maturation of the client group. The use of translation and de-rotational panels constructed within the suits provides ease of donning, toileting and ability for long term corrective positioning which could prevent long term care issues.

The use of rigid orthoses can reduce the muscle tone through misuse; leading to a reduction of muscle sarcomeres and hence a deterioration of the curve due to further muscle imbalance. The dynamic orthoses appear to provide proprioceptive feedback coupled with cylindrical stability that can influence proximal stability (Cholewicki et al 1999, Edwards et al 2004). The client appears more aware of the body symmetry leading to improved gross motor skills and function; this from a dynamic orthoses.

The outcomes identified, suggests that the orthotist will need to develop a new understanding in the need for orthotic provision in the future in an age of increasing dynamic bracing. The evidence currently suggests that there is need for detailed future research into this field but the limited evidence provides the orthotist with a great opportunity for future development.

10:55 am / CCP #4

#### **RETROSPECTIVE CASE STUDY OF TEAM APPROACH TO OMPHALOCELE ORTHOSIS FABRICATION AND IMPLEMENTATION**

*Maureen Suhr, DPT; Kim D. Ryan, PT; James R. Miller, CPO; James H. Wynne, CPO  
Children's Hospital Boston; Boston, MA, USA*

**Purpose:** The purpose of this case study is to provide health care professionals with a model of the interdisciplinary approach to orthotic intervention in neonates with giant omphalocele.

**Background:** Omphalocele is a defect of the abdominal wall in neonates. The abdominal organs protrude through the umbilicus and are contained within a sac. Giant omphaloceles, often with liver involvement, may be at risk of flopping over, compressing organs or compromising blood supply. External support is needed to protect the infant's abdominal contents.

**Methods:** An infant with a giant omphalocele was transferred to Children's Hospital, Boston's Neonatal Intensive Care Unit (NICU) for treatment. The neonatal surgeon determined a conservative approach to omphalocele management, "paint and wait," was appropriate and requested a physical therapy consult. The physical therapists met with the physician and family to discuss the patient's particular needs and the family's desires. The patient was examined by the physical therapists and an orthotist was called. Together, the mother, physical therapists, orthotist and physician discussed orthotic options. The orthotist fabricated a custom orthosis of closed-cell, vacuformable material, to support the omphalocele. The physical therapists and orthotist also collaborated to create a positioning device to allow the infant to be placed prone to promote acquisition of age appropriate milestones and development. The orthotist fabricated this from semi-rigid foam, according to patient measurements. Finally, a follow-up survey was administered two years after the child's NICU stay to assess customer satisfaction and orthosis use.

**Results:** A custom stabilizing orthosis was fabricated by the orthotist and fit to the infant with assistance from physical therapists. The omphalocele was secure, meeting physician satisfaction. The family felt confident that the omphalocele was protected during physical interaction. They were able to comfortably hold the infant and the mother successfully breastfed the child. Additionally, a prone positioning device was created. Patient tolerated donning of brace and prone position well. In a two year follow up survey, the patient's mother indicated that she was extremely satisfied with both the orthosis and the team approach to her child's care.

**Discussion:** A custom orthosis is a valuable tool to provide external support for a giant omphalocele. The orthosis was designed with three principles in mind, to support, to protect, and to provide intervention without intrusion on the omphalocele. The infant's condition placed him at high risk, due to the dimensions of the omphalocele. The orthosis was designed to minimize the risk of this omphalocele flopping over and occluding blood supply or impinging organs. It is strongly suggested that the interdisciplinary approach of physician, therapist, orthotist, and family, be used to best realize and

accommodate patient need. The orthosis and prone positioning device design may benefit many children with giant omphaloceles. It provides improved, safer interaction between family and child, promotes appropriate development, and potentially assists in unloading the abdominal cavity. Further research is needed in the physiological impact of the orthosis, the psychosocial ramifications and impact on bonding between parent and child, and the optimal technique for fabrication.

### Symposium III

1:30 – 2:00 pm

#### **EXPECTING A LIMB DEFICIENT CHILD: HOW THE INCREASE IN PRENATAL DIAGNOSIS CHANGES THE NEEDS IN COUNSELING AND SUPPORT FOR FAMILIES**

*Christiane de Tonnancour, MPs; Tatiana Kitsikis, MSW; Noella Shorgan, MA, BSc. PT  
Centre de Réadaptation Marie Enfant de l'Hôpital Sainte-Justine, Montréal, Québec, Canada*

The last decades have seen a rapid growth in the accessibility and accuracy of prenatal diagnosis for various lethal and non-lethal conditions. Most scientific articles on this topic focus on corresponding increases in elective terminations of pregnancies, possible decreases in future prevalence of certain categories of congenital deficiencies and ethical issues. Keeping these issues in mind, we will however concentrate on psychological needs of families seen at our clinic, who had discovered a limb deficiency several weeks before the birth of their otherwise healthy baby.

In the early nineties, despite the already high frequency of routine ultrasound examinations, our counselling services were mostly requested by families trying to recover from the shock related to the birth of their unexpected limb deficient children. Prenatal diagnosis for this condition was reported only occasionally. Almost twenty years later, we see a growing number of families who have experienced the shock several weeks before the birth of their children. As we offer postnatal counseling and psychosocial support, we regularly hear about different approaches in prenatal counseling, sometimes offering elective termination of pregnancy, sometimes not, for comparable degrees of severity. We also have to adjust our counseling to new patterns of mourning and guilt, which is our main concern in this presentation.

Goal: The goal of this mini-symposium is to elicit awareness and sharing of professional experiences related to the impact of prenatal diagnosis on potentially new patterns of mourning and guilt after the birth of a limb deficient child.

Objectives: By the end of this presentation, the participants will understand that the effect of prenatal diagnosis of a limb deficiency is not only to start the mourning process earlier. The mourning patterns and the content of the correlating guilt feelings are potentially modified as new challenges are raised before the birth of the "damaged" child.

The participants will also be aware of the lack of consensus and guidelines for prenatal counseling, especially for non-lethal and relatively mild foetal impairment the fact that professional confronted with the unexpected discovery of a limb deficiency in utero may not be more prepared to offer support to the family than they are when the discovery occur in the delivery room

Abstract: This presentation is not a scientific report of a formal research but rather a reflexion on the evolution of family needs in terms of psychosocial support, following the birth of a limb deficient child, in relation to the increasing availability of prenatal diagnosis. Many short excerpts of case stories will illustrate our reflexion and suggest adjustments in counseling strategies. We also wish to stimulate research in this field of interest.

### Session IV – Limb Deficiency

3:45 pm / CCP #5

#### **A SURVEY OF 25 YEARS ON DEMOGRAPHY AND FUNCTION OF CHILDREN WITH LIMB LOSS**

*Gül ener, Özlem Ülger, Semra Topuz, Kezban Bayramlar, Fatih Erbahçeci  
Hacettepe University School of Physical Therapy and Rehabilitation*

**Introduction:** Number of the child amputees increase due to both congenital and acquired reasons such as traffic, work accidents and tumors.

**Purpose:** This retrospective study was done between the years 1982-2007 to collect the basic data on demography, level and side of the amputation, involved limbs, age, gender and prosthetic functional level in children with limb loss.

**Methods:** A total of 274 children were investigated through their prosthetic records for 25 years. This survey included demographic characteristics, level of amputation, side of amputation, cause of amputation and functional level.

**Results:** The age of the children varied between 1 and 15 years with a mean age of  $10.80 \pm 2.20$  years. Results of the study revealed that the leading amp Due to results of the study, 83% of all amputations were found to be unilateral. It was also seen that right-side amputations (53%) were more common than left-side amputations (47%). The outcome of the study showed that 97% of the children with lower-limb loss reached a functional gait pattern without any aids, while the percentage of independence in activities of daily living was found to be 89% in upper-limb loss.

**Discussion:** Finally, it was found that congenital limb loss is the primary amputation cause among children as through out the world. With the increase in community education programs in Turkey, it is observed that a slight diminish is achieved in this data when compared with the recent statistics.

In the view of authors, the results attained from the study concerning the acquired amputations showed that the number of these amputations pointed out a decrease because of the improvement in medical and surgical approaches as well as the development of the safety procedures and conditions related to environment and roads.

Finally, it can be stated that the child amputees reached a functional pattern without aids and assistance in daily living activities.

4:00 pm / Paper #5

#### **ASSESSMENT OF CHILD AMPUTEES DUE TO CANCER**

Kezban Bayramlar, Özlem Ülger, Semra Topuz, Fatih Erbahçeci, Gül ener  
Hacettepe University, School of Physical Therapy and Rehabilitation, Ankara-TURKEY

**Introduction:** One of the most important reason of amputation in children is tumours such as Osteosarcoma and Ewing sarcoma. Osteosarcoma and Ewing sarcoma are the most prevalent bone tumours and forms 89% of malign bone tumours in children. Malign tumours cause high level amputation and serious functional impairments.

**Purpose:** This study was planned to determine the ratio of cancer among the child amputees and to detect the problems in their rehabilitation period.

**Methods:** This study included 29 children whose ages varied between 3-15 years. Twenty two children had lower extremity and 7 had upper extremity amputation. The age, gender, amputation level, amputation date, prosthesis use time and number of prosthesis applied before are recorded.

**Results:** Seventeen children were amputated due to (58.62%) Osteosarcoma and 12 (41.37%) were due to Ewing sarcoma. Hip disarticulation (45.45%), and shoulder disarticulation (57.14%) were the most common amputation levels. Nine lower extremity amputee children had immediate prosthetic applications. We observed that the complications of chemotherapy in child amputees extended the rehabilitation period.

**Discussion:** Amputations due to tumours cause important impairments in lower and upper extremities and high level amputations. Loss of upper extremity in the children lead to insufficiency in daily living

activities while loss of all lower extremity cause difficulty in ambulation activities and function. It can be concluded that rehabilitation and prosthetic applications of child amputees due to cancer requires regular follow-ups and efficient rehabilitation program planning in order to be more functional. Prosthetics and ambulation should be provided in earliest period to improve the quality of life.

4:15 pm / Paper #6

### **COMPARISON OF THE ENERGY CONSUMPTION BETWEEN CHILDREN WITH CONGENITAL AND ACQUIRED LIMB LOSS**

*Özlem Ülger, Semra Topuz, Kezban Bayramlar, Güllüner  
Hacettepe University School of Physical Therapy and Rehabilitation*

**Introduction:** Energy consumption is very important in the daily living activities of the child amputees with congenital or acquired limb loss.

**Purpose:** This study was planned to investigate the energy consumption in the children with congenital and acquired amputations.

**Method:** A total of 41 children whose ages varied between 8-17 years participated in this study. Prosthetic fitting, prosthetic training and rehabilitation were given to the children after general physiotherapy evaluations. After prosthetic training for 3 weeks and 6 months later the discharge, 6 minute walk test was applied to determine the energy consumption in the both groups.

**Results:** The evaluation of data between the groups showed that congenital group was more successful in 6 minute walk test in the assessment done 3 weeks post-treatment ( $p < 0.05$ ). When the groups were assessed for 6 minute walk test, congenital group received better values in physiological consumption index (PCI) than the acquired amputees who received three weeks prosthetic training ( $p < 0.05$ ). Although, there aren't any statistically important differences between the PCI values of the two groups at the end of 6 months, both groups presented diminish in energy consumption ( $p > 0.05$ ).

**Discussion:** When the energy consumption between the congenital and acquired limb loss children was compared, it is observed that energy consumption is increased in the acquired amputees. Children with congenital limb loss were found to expend lesser energy, because they tend to function with their existing extremity. Due to the authors, increasing the daily prosthetic use time, performing the daily living and ambulation activities with prosthesis lead to a decrease in energy consumption in both groups. To conclude, it can be said that active prosthetic use is a very important criteria in using the energy economically.

4:30 pm / Paper #7

### **CARE COORDINATION AND THE PROSTHETIC CLINIC**

*Rochelle Rein, BSc, PT; Kelly Thorstad, MSc(A); N; Kathleen Montpetit, MSc, BSc, OT  
Shriners Hospital for Children, Montreal, Quebec, Canada*

Care Coordination is a health care delivery model which promotes effective and efficient utilization of resources necessary to provide comprehensive services for children with special health care needs and their families. In 2002, the Shriners Hospital for Children (SHC) Canada, applied the Care Coordination model to the Prosthetic Clinic to support and educate families, promote continuity of care, maximize use of resources and improve outcomes. In 2004, an outcomes project was undertaken by the physiotherapist and nurse involved in the prosthetic clinic, to examine the impact on quality of care of the recently applied Care Coordination model.

The purpose of the project was to evaluate the impact of Care Coordination on the family and the organization and its ability to improve the clinical process. A data base was established to describe this population, its various needs, and the services required.

Two outcomes were selected: the MPOC-20 (Measure of Process of Care short form) and the work measure units of the care coordinator. The MPOC-20 is a self-report tool measuring parents' perception of the extent to which health care professionals provided family centered care. The work units are the amount of time spent in direct and indirect patient care by the Care Coordinator.

The study looked at 60 lower extremity amputees who were on active treatment at the SHC Canada between November 2004 and December 2005. The average time of Care Coordination per patient was 3 hours, although 46 of these patients required only one hour for this period. Ten patients required greater than three hours of coordination as they had either undergone surgery, had problems with their prostheses, or had a diagnosis of traumatic amputation.

Twenty three families completed the MPOC-20. The SHC Canada rated highly in three subscales including: Enabling and Partnership (5.92), Coordinated and Comprehensive Care (6.15), and Respectful and Supportive Care (5.74) (maximum possible score is 7.0). Areas for improvement included peer support, information about the medical condition, and resources.

This study enabled the SHC Canada, to better describe its prosthetic population and their needs, evaluate the impact of its Care Coordination program, and identify short and long-term goals to improve the delivery of optimal care.

4:45 pm / Paper #8

**FUNCTIONALITY, INDEPENDENCE IN DAILY ACTIVITIES AND QUALITY OF LIFE IN CHILDREN WITH PROXIMAL FOCAL FEMUR DEFICIENCY**

*A. Michielsen, I van Wijk, M. Ketelaar*

*Rehabilitation Centre De Hoogstraat Utrecht, the Netherlands; partner of Netchild, Network for Childhood Disability Research, the Netherlands.*

**Background and Purpose:** Little is known about the functional development and quality of life of children with Proximal Focal Femur Deficiency (PFFD). From clinical expertise we assume children with PFFD perform well and experience minor problems in daily life. In our study we describe the functionality, independence in daily activities and the quality of life in children (0-8 years) with PFFD in relation to peers.

**Methods:** Ten children (6 boys, 4 girls; mean age 4,7 yr.; range 1,6 – 7,6 yr) with unilateral PFFD who are known in a rehabilitation centre in The Netherlands were included. All children wear a prosthesis to compensate for limb length discrepancy. Children with bilateral PFFD or combination with arm deficiencies or any kind of syndrome were excluded. Measurements were performed on the levels of activity, participation and quality of life. All children younger than 3.5 years of age, motor skills (activity) were measured using the Bayley Scales of Infant Development (BSID II). In children four to eight years of age, the Movement Assessment Battery for Children (M-ABC) was used. Functional skills (activity) and the independence in daily activities (participation) were assessed using the Paediatric Evaluation of Disability Inventory (PEDI). The PEDI measures functional status in children (0,5 – 7,5 yrs) in 3 domains: self-care, mobility and social function. Assessment of quality of life was done with TNO-AZL Pre- school Quality of Life questionnaire (TAPQoL) for parents of children younger than 6 years of age. For parents of children above 6 years the TNO-AZL Child Quality of Life questionnaire (TACQoL) was used. All measurements provide reference values for children without disabilities which are used in the analysis.

**Results:** Motor skills are age related: 3 children up to 3,5 years of age scored a mean developmental index (DI) of 98, range 92-106 (reference value  $100 \pm 30$ ), 1 child had a  $DI < 55$  indicating a severe delay in motor development. Six children above 4 years scored a mean percentile score of 29,5, range 11-40 (reference value percentile score  $> 15$ ); 1 child scored P11, indicating border line motor problems.

Functional skills scores of all children did not differ from reference values ( $50 \pm 20$ ) in the domains 'self-care' and 'social function'; 3 children scored below average ( $> 2$  SD) in the domain 'mobility'. Scores for independence in daily activities were related to reference values for all children in all 3 domains.

Parents' perception of the quality of life of their children resulted in high scores on all subscales.

**Conclusion:** In this research group children with PFFD perform age appropriate functionality, are as independent in daily activities as their peers and their quality of life is high. Mobility is the only domain in which a few children perform less in relation to peers.

**Saturday, April 12, 2008**

### Session V – Lower Extremity Prosthetics

7:30 am / Paper #9

#### **FUNCTIONAL AND BIOMECHANICAL IMPLICATIONS OF EARLY PROSTHETIC KNEE FITTING IN AN INFANT WITH TRANSFEMORAL AMPUTATION: A CASE STUDY**

*Geil, MD<sup>1</sup>; Coulter-O'Berry, C.<sup>2</sup>; Giavedoni, B.<sup>2</sup>*

*<sup>1</sup>Georgia State University, <sup>2</sup>Children's Healthcare of Atlanta, Atlanta, Georgia, USA*

**Introduction:** Infants and toddlers with lower limb loss at the knee disarticulation level or proximal have historically been prescribed with a prosthesis with no knee unit or a knee locked into full extension. This treatment protocol is based on an assumption that prior to the age of 4-5 years, children lack adequate strength and neuromotor control of hip flexors and extensors to use a passively flexing prosthetic knee without falling. In addition, in past years, the majority of prosthetic knee units were too large for young children (Andrysek et al., 2004; Cummings et al., 1992).

Recognizing that appropriately-sized prosthetic knees have been developed and that the conventional treatment protocol has been largely untested, some centers have begun fitting children with an articulating knee component at a younger age (Wilk et al., 1999; Giavedoni et al., 2002).

Anecdotal evidence has suggested that children who receive an articulating knee in their first prosthesis develop more normal motor patterns and are better-equipped for the onset of walking. The following case study is part of a larger investigation of neuromotor development during crawling that includes: functional activities; parental perception; and details the biomechanical analysis in children with limb loss and of a single subject.

**Method:** Analysis of crawling and functional activities occurred at the Georgia State University Biomechanics Laboratory and was approved by relevant IRBs. The functional activities include: climb into and out of a small child's chair; climb up padded steps; climb up and slide down an toddler slide; and play in tall kneel position with hands free.

*Subject:* Male congenital high right side unilateral transfemoral amputee; received first prosthesis at 12 months of age.

*Procedures:* Kinematic data with a Peak Performance motion analysis capture system, parent questionnaire and video analysis of the child performing age specific gross motor tasks were collected six days after prosthesis delivery under two conditions: articulating knee locked and unlocked.

*Data Analysis:* Along with temporal and spatial parameters, kinematic data compared between conditions included contralateral knee flexion angles, hip abduction angles. Trunk counter-rotation was quantified by comparing the angle of a segment connecting the shoulder markers projected onto the global frontal plane to a similar angle of a PSIS segment. Parental responses to the questionnaire and video tape observations were converted to numerical values for data analysis.

**Results:** The parents preferred the unlocked condition stating it looked more normal. Parents thought the unlocked knee allowed their child to perform the specific motor tasks easier, felt their child would benefit from the unlocked knee in daily activities in the home and thought the unlocked knee would be easier getting their child into and out of the car seat. Video analysis showed that child incorporated the unlocked

prosthetic knee in all functional tasks. With the knee locked, the child refused to perform some of the tasks, became frustrated and cried.

As expected, locking the knee limited prosthetic knee range of motion; however, peak knee flexion in the unlocked prosthetic knee indicates the toddler's ability to operate the knee when crawling. Contralaterally, knee flexion increased by over 18° with the knee locked (Fig. 1), and hip abduction increased by 11°. Trunk counter-rotation increased when the knee was locked and crawling velocity decreased substantially, with both increased period of knee flexion cycles and higher frequency content in the signal (Fig. 2)

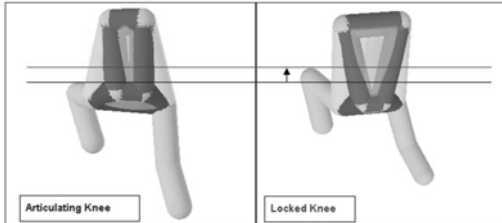


Figure 1. 3-D reconstructions of child's torso and legs during locked and unlocked conditions indicating increased contralateral knee flexion and hip abduction compensating for locked right side prosthetic knee.

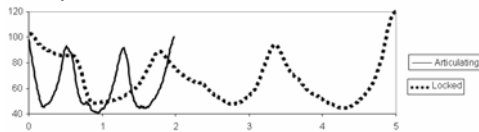


Figure 2. Knee flexion angle (deg.) vs. time (sec.) for 3 crawling cycles in locked (dotted line) and articulating (solid line) conditions.

**Discussion:** Kinematic and velocity results suggest the development of multiple compensatory adaptations for the locked knee. With only a few days' experience the child crawled successfully with an articulating knee and avoided kinematic deviations. The parents preferred the unlocked knee condition and the child also demonstrated the ability to incorporate the bending knee into selected age appropriate activities.

**References:** 1) Andrysek, J. et al. IEEE Trans. Neur. Sys. Rehab. 12, 369-78, 2004; 2) Cummings D. et al. J. Prosth. Orth. 4, 196-206, 1992; 3) Giavedoni, B. et al. AAOP J. Proceed. 2002; 4) Wilk B.S. et al. J. Prosth. Orth. 11, 69-74, 1999.

7:45 am / Paper #10

### FUNCTIONAL OUTCOMES COMPARISON BETWEEN BOYD AND SYME AMPUTEES

*Ercolano, Lisa, Lerman, Joel, Bagley, Anita*  
*UC Davis School of Medicine, Sacramento, California*

**Background:** In children treated for congenital limb length discrepancy resulting from fibular deficiency, it remains unclear if Boyd or Syme amputation confers greater functional outcomes. To assess this possible difference, the American Academy of Orthopaedic Surgeons Pediatric Outcomes Data Collection Instrument (PODCI) is employed in this study.

**Methods:** Twenty six patients who had undergone Boyd or Syme amputation were assessed. Several of the Syme amputees had been converted to below knee amputees (BKA), and were assessed separately. These children and their parents were recruited, consented and administered the PODCI. For those under age 11, the Parent Form of the PODCI was utilized, while for those ages 11 and older, the Child Form was used. Bivariate analyses with linear regression controlling for age were performed on the validated elements of the PODCI.

#### Results:

Mean scores (std.dev.) for functional outcomes in Boyd vs. Syme amputees with linear regression

analyses controlling for age.			
Functional Outcomes	Boyd	Syme	P
Upper Extremity & Physical Function	93.4 (14.76)	94.4 (10.33)	0.35
Transfer and Basic Mobility	94.2 (8.84)	94.0 (9.41)	0.41
Sports and Physical Function	87.0 (11.96)	82.5 (18.10)	0.24
Pain and Comfort	98.4 (3.58)	72.6 (25.12)	0.02
Global Function & Symptoms	92.0 (8.22)	86 (13.17)	0.06

**Conclusion:** Syme amputees had significantly lower Pain/Comfort scores than Boyd amputees, indicating more painful outcomes in these patients. The Global Function/Symptoms outcome approached significance with the Boyd patients scoring higher than Syme patients. In the other functional outcomes, both groups scored similarly. Furthermore, in a separate analysis of Syme vs. Revised Syme (BKA) patients, there were no significant differences in functional outcomes. Taken together, while the Boyd amputation is considered a more technically difficult procedure, these results indicate an advantage over Syme amputations.

8:00 am / CS #8

#### **A NEW METHOD TO PROVIDE SYME PROSTHESIS & COMPARING WITH OLD METHOD**

*Mehrab M. Karami, MSc in O&P; Neda Saeghi, O&P student*

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The surgically technique in syme amputation has several advantages for amputees. But there are some problems about making prosthesis procedure. In case of growth in children prosthetic changing may occur rapidly and it is a problem to make and adjust new prosthesis.

This new method's benefits are:

- Shaping prosthesis very fast & easy
- Adjust height of prosthesis precisely
- Adjust static & dynamic alignment
- Reduction in prosthesis weight significantly.

In this technique we use pirogof foot & plastic ingot to making a light rigid foam block. This procedure has been used for 25 patients until now, and they have a very good sense comparison with the old mode.

8:15 am / CS #9

#### **BALANCE AND WALKING ISSUES FOR QUADRAMEMBRAL AMPUTEES**

*Biden, Ed, D.Phil; Bush, Greg, BA, CP(c); Hill, Wendy, BScOT*

*Institute of Biomedical Engineering, University of New Brunswick, Fredericton, New Brunswick, Canada*

We have, over a number of years, followed a patient whose lower extremities reflect a bilateral Proximal Femoral Focal Deficiency with fibular deficiencies. These give him a leg length discrepancy of approximately 8 cm. His upper extremity limb loss is a total absence on his right side and a short trans-humeral limb on his left that is tapered and conical in shape. He is ambulatory, generally in unmodified sneakers, and has had an interest in leg extensions to make him taller.

To assess his balance we have studied him in our motion analysis laboratory with a particular view of estimating the width of his base of support and assessment of how close his net ground reaction forces come to the edge of this base. Force plate and motion analysis results suggest that he is able to keep well within his base of support in what, for him, is normal walking. Our motion analysis results show that his

residual femurs are actually quite close to horizontal and that the motion from pelvis to ankle is comprised of a combination of motions of his “hip”, and his “knee”. Estimates of the amount of elevation possible before he became at risk of tipping over suggested a maximum rise of approximately 20 cm.

He has recently been fitted with leg extensions and is currently having physio therapy at our local rehabilitation centre. The leg extensions allow correction of the leg length and rotational discrepancies and include an ultra adjustable ankle system to allow positioning of his prosthetic feet.

Observational assessment suggests that his balance continues to be very good and that he is stable during walking. We believe that his continued stability is due to the fact that the extensions compensate for his leg length and rotational anomalies.

We are waiting for completion of his training when we will reassess him the motion lab which will form part of this presentation.

The authors acknowledge the contribution making these measurements by: Colleen Dewis, John Landry, Katelynn Craig and Cindy Samaan.

8:30 am / CS #10

### **REHABILITATION OF A PATIENT WITH VANNES ROTATIONPLASTY**

*Semra Topuz; Özlem Ülger;, Kezban Bayramlar; Gül ener; Fatih Erbahçeci  
Hacettepe University School of Physical Therapy and Rehabilitation, Turkey*

**Introduction:** Distal femoral rotationplasty procedure was generally performed to increase the functional status of congenital limb loss children. Knee joint is removed and is given 180° external rotation in order to create a weight-bearing area. This operation is to be popular in 1950 by Vannes. Ankle joint is used instead of knee joint and heel of the foot is used as the patellar tendon for weight bearing.

**Case:** When the patient was 5.5 months old, he had septic arthritis of knee and hip joints. When he was 18 years old, Vannes rotationplasty was done due to 29 cm shortness of right lower limb. Following the operation he had his leg in plaster, it was taken out 4 months later. The patient is directed to Prosthetic Rehabilitation Clinic.

After the assessment of the patient, we began prosthetic training and rehabilitation program with suitable prosthesis for early mobilization.

The results of the assessment showed that there were limitations in plantar flexion, hip flexion and abduction, shortness of hip flexor and lumbar extensor muscles and especially weak muscle strength on the right lower limb. Proprioceptive Neuromuscular Facilitation Techniques, modification of prosthetic alignment and stretching and strengthening exercises were given in the treatment of limitations. Furthermore High Voltage Galvanic Stimulation was applied to plantar flexor muscles which is undertaken for the function of Knee extensors for 15 sessions. Home exercises were given and swimming was recommended.

Before the operation, the patient used extension prosthesis in which the body weight bearing was born from the tuber ischii and base of the foot. Then a modified below knee prosthesis was applied with lateral joints and thigh corset. Prosthetic training program including functional rehabilitation was given with this prosthesis. After 8 weeks training program, weight bearing on short limb, timed up & go test, functional reach, time distance characteristics of gait, ambulation activities such as ascending and descending 10 stairs and incline, crossing an obstacle were assessed. Due to visual analog scale (VAS), patient satisfaction was evaluated.

At the end of the 8 weeks prosthetic rehabilitation and physiotherapy approaches, the patient was independent with bilateral crutches outside while he used a single crutch in home. The patient was successful in the daily living activities and ambulation activities such as ascending and descending stairs,

incline and crossing an obstacle. The time distance characteristic of gait of the patient was found to be closer to normal values. The patient said that he was satisfied (VAS=7.5) with the new prosthesis. The patient was discharged from our clinic and he was invited to be evaluated again after 6 months. Results of the assessment showed that the patient was successful in all activities and functional prosthetic use.

**Result:** The case report showed that the prosthetic rehabilitation program and physiotherapy is important in the surgery of such a complex abnormality or different condition caused by amputation. Prosthetic training is thought to be very much important in reintegration of the patient to normal life. The follow-up of the patient will be done regularly in order to observe “how is he coping with the situation.”

8:45 am / Paper #11

**PRE- AND POSTOPERATIVE CASE STUDY OF SUBJECT WITH COMPLETE  
LONGITUDINAL DEFICIENCY OF THE FIBULA**

*Shane Wurdeman, MSPO; Yoshio Setoguchi, MD; Anthony Scaduto, MD; Eileen Fowler, PhD  
Shriners Hospital for Children – Los Angeles, University of California – Los Angeles*

Partial or total longitudinal deficiency of the fibula is a congenital condition that primarily affects the fibula but also has other noted symptoms. It is the most common congenital limb deficiency amongst all long bones. Current surgical intervention options include leg lengthening through callus distraction or ankle disarticulation amputation with prosthetic length restoration. There is a lack of published data documenting pre- and post surgical outcomes for patients undergoing amputation.

Amputation is generally performed on the young infant/toddler prior to walking so the child can learn to walk with the prosthesis. In contrast, leg lengthenings are typically performed in late childhood or pre-adolescence. The focus of this case report is a 12 year old male with a diagnosis of total longitudinal deficiency of the fibula who underwent Boyd type ankle disarticulation amputation.

Outcome measurements were performed in the UCLA Kameron Gait and Motion Analysis laboratory before and after surgical intervention. An Eagle 8-camera system (Motion Analysis Corporation, Santa Rosa, CA) sampling at 60 Hz was used to collect motion analysis data. Two Kistler force plates (Kistler Instrumentation Corporation, Amherst, NY) sampling at 1 kHz were concealed in the walkway to record ground reaction forces. Reflective markers were placed on the subject by a physical therapist using a modified Helen Hayes marker set. The patient was asked to walk back and forth on a 25 foot walkway until at least three force plate hits were recorded for each limb. Trials were accepted when the foot hit either force plate in isolation. Data were filtered. Gait kinematics and kinetics were calculated using Orthotrak 6.50 (Motion Analysis Corporation, Santa Rosa, CA).

A significant improvement was found in many gait outcomes following surgery. For the subject's self selected pace, there was statistically significant improvement for the affected and contralateral side for step length, stride length, forward velocity, cadence, and initial double support time. Changes were also quantified in ground reaction forces, joint moments, and joint powers.

The measures taken have quantified the significant gait improvements for this subject. The results of this case report indicate that amputation is still a viable choice in surgical intervention for the individual with hypoplasia of the fibula even if presenting at a later age.

Acknowledgments: Evan Goldberg, MSME, Marcia Greenberg, MSPT

9:00 am / CCP #6

**SUSAN'S SAGA CONTINUED: SEARCHING FOR SENSIBLE SOLUTIONS**

*Marie Claude Bastie, top; Marie Laberge-Malo, MD; Noëlla Shorgan, pht, MA  
Centre de réadaptation Marie Enfant du Centre Hospitalier Universitaire (CHU) Sainte Justine, Montréal,  
Québec, Canada*

A 16 year old riding a scooter was a victim of a motor vehicle accident, March 31, 2006. She was transferred to the intensive care unit of the Centre Hospitalier Universitaire (CHU) Ste Justine, Montreal's pediatric hospital affiliated with l'Université de Montréal. Her poly-trauma included a fractured pelvis, a massive de-gloving injury of the right lower extremity with bilateral involvement of the external popliteal nerve, an extremely short femoral amputation with a residual segment of 4 cm.

Prior to this accident, Susan had required arthrodesis for a rapidly progressive idiopathic scoliosis at age 13.

She was transferred to the centre de réadaptation Marie Enfant (CRME), the rehabilitation centre of CHU Ste Justine on June 6, 2006, approximately 2 months after extubation and cessation of tube feeding.

At the time of transfer the challenges included weakness and de-conditioning, significant excess weight, badly traumatised and grafted skin with open areas, and a very short left femoral amputation with invaginated crevices. Toward the end of her inpatient rehabilitation she began weekend visits home and was eventually discharged to continue her rehabilitation in her region. On visits home, she would visit the driver of the vehicle that hit her 'to cheer him up'. Often she remarks, "Look at what I survived!"

At the time of discharge from the URFI (our inpatient rehabilitation unit) her evaluation showed limitations of joint range, muscle weakness and poor endurance. Little change was noted in the residual stump's shape or condition which continued to show much excess loose flesh and adherences to the femur.

As she worked on these areas, she continued visiting our prosthetist. Finally in June 2007, all her wounds had closed. A final, third silicone liner was custom made and was ready for prosthetic fitting in late September.

How would you fit this young lady? She is currently 16 years old.. She weighs 89.3 kg (195 lbs) and measures 164.4 cm (64.5"). Her hip musculature is 4/5. She lives in the country. She has a manual ultra-light rigid wheelchair, drives her own van which has been adapted. She will be finishing her high school education in the adult education program requiring credits from grade 8 to 11 level in different subjects. She is articulate and engaging. She is quite comfortable sitting and is seeking a prosthesis to be able to go where the wheelchair can not access.

What is her prognosis of being a community ambulator, a household ambulator? What are the factors which will most likely cause her to abandon walking?

## Session VI – Lower Extremity Deficiency

10:05 am / CCP #7

### **ANGULAR DIFFORMITY IN A CHILD WITH BILATERAL TIBIAL AMPUTATION FOLLOWING MENINGOCOCCEMIA**

Marie Laberge-Malo, MD, Carolyn Plourde, top; Noëlla Shorgan, MA, BScPT  
Centre de réadaptation Marie Enfant du Centre Hospitalier Universitaire (CHU) Sainte Justine, Montréal, Québec, Canada

On May 17, 2005, at the age of 2 years 3 months, Mélanie arrived at the centre de réadaptation Marie Enfant (CRME) following her treatment begun on March 5<sup>th</sup> for septic shock and meningococemia type C (vaccine failure) at Centre Hospitalier Universitaire (CHU) Ste Justine. She presented with short bilateral tibial amputations (right: March 24<sup>th</sup>, left: March 30<sup>th</sup>), phalangeal amputations of both hands and significant skin lesions involving all extremities and the trunk. There were significant difficulties fitting a compressive garment. It was delivered June 29<sup>th</sup> and she received her first prostheses July 8<sup>th</sup>.

She had a revision of both tibial amputations on October 24, 2005, to eliminate bony overgrowth and spikes. In December, 2005 her right residual limb measured 12 cm from the knee joint line, the left measured 10 cm. New prosthesis were measured, fabricated and delivered in February. Skin breakdown

was an on-going problem into the spring, especially over her patella where her skin continued to be fragile, however her gait had improved and her regular care was transferred to the local rehabilitation centre.

Initial prosthetic fitting required a pelvic belt due to the condition of the skin which precluded other means of suspension and the very short limbs. In addition it gave her confidence to begin gait training. Silicone was required as an interface in the socket. This minimized injury and facilitated prosthetic use. However the belt brought her limbs into external rotation at the hips and flexion of the knees. Silicone sleeves were added over the sockets.

With growth, the varus deformities became more apparent. At the clinic visit of August 25, 2006, the varus at the knees was measured clinically as 20° on the right, 10° on the left. On weight-bearing, the varus increased to 25-30° on the right. By May, the varus had increased on the right to 40°. Radiographs indicated injury to the medial epiphyses especially of the right knee. An orthotic solution was required while she awaited surgery.

What surgical procedure would you have recommend and when ought it to be have been done? How would you have handled Mélanie conservatively?

We opted for an orthotic-prosthetic approach. The metal uprights crossing the lateral aspect of the knee served to align the limb without impeding flexion nor extension. Mélanie used a prosthetic sock and a silicon liner in her socket which attached with freely articulating joints to her thigh corsets. This was used as she awaited disepiphysiodesis.

10:25 am / CCP #8

#### **REHABILITATION CHALLENGES IN A 7 YEAR-OLD BOY WITH BILATERAL TIBIAL AMPUTATIONS AS A RESULT OF MENINGOCOCCEMIA**

*Stephanie Gould, BSc, PT; Francois Fassier, MD; Carlo Berretta, CPO  
Shriners Hospital for Children, Montreal, Quebec, Canada*

**The Problem:** T. was 7 years old when he underwent bilateral tibial amputations as a complication of severe meningococemia. Prior to amputation, there was already a history of significant psychosocial issues that had required treatment. In addition to the amputation of his lower limbs, T's systemic illness resulted in renal failure, the need for gavage feeding, partial finger amputations, and severe skin damage necessitating grafting. Once stabilized, T. was transferred to the Montreal Children's Hospital for further orthopedic interventions, dialysis, and convalescence. He developed severe fixed flexion contractures of his knees, partly due to his refusal to move, to be positioned or to allow health care providers to touch his lower extremities. Subsequently, he underwent surgery to apply Ilizarov-type external fixators to his residual limbs to correct the contractures. Upon removal of the frames, T. persisted in his refusal to participate in therapy and the contractures started to recur. T. showed distrust toward all medical and paramedical professionals and acted out aggressively. It became increasingly difficult to approach T., both in terms of physical proximity and on an emotional level. Ten months after the onset of the disease, T. was discharged home and out-patient rehabilitation services were transferred to the Shriners Hospital. Not long after, a period of respite care was required by the family, and T. was readmitted to the MCH for 2 weeks. During this time, T. slept and received his peritoneal dialysis there, but was transported to the Shriners each day for physiotherapy, school, and child life activities.

Progress in rehabilitation was limited by pain, global weakness, fear and resistance to treatment, the difficult shape of the residual limbs and the poor condition of the skin covering them. Prior to being able to mold sockets for prostheses, the recurrent knee flexion contractures needed to be addressed, the frequent ulcers on the skin healed, and the damaged skin desensitized. All this in a patient who did not want to be approached and who refused to speak to hospital staff. Furthermore, continued tibial growth, combined with the irregular shape of the distal end of the bone and the thin skin covering it, resulted in periods of open wounds that halted progress in prosthetic training and also risked delaying the necessary kidney transplant.

**The Solution:** Addressing T.'s complex needs has required interdisciplinary teamwork (with input from physicians, nurses, prosthetists, physical and occupational therapists, social workers, child life workers, and psychologists), inter-establishment partnerships (among various hospitals, prosthetists, and community health care providers), and creative problem solving (with respect to rehabilitation techniques and prosthesis fitting). The story is ongoing, but is becoming one of success.

10:45 am / CCP #9

**REHABILITATION OF AN ABOVE-KNEE AMPUTEE WITH AN UNDERLYING  
NEUROLOGICAL PATHOLOGY**

*Johanne Bégin, BScPT; Céline Goyette, OP; Marie Laberge-Malo, MD; Nadia Miscio, BScPT; Noëlla Shorgan, MA, BScPT*

*Centre de réadaptation Marie Enfant du Centre Hospitalier Universitaire (CHU) Ste Justine, Montréal, Québec, Canada*

Derek is a 16 year old teenager diagnosed with sensory neuropathy at approximately 3 years of age. Derek has a long history of multiple injuries of the distal extremities and consequently underwent multiple surgical procedures and consultations for distal fractures, wound infections, and skin closure. These were mostly due to his lack of sensation and inability to perceive injuries.

Derek had developed a progressive valgus deformity of the left lower extremity and a bony deformation of the right ankle. Derek's walking abilities progressively deteriorated as his deformities worsened. At approximately 12 years of age he became wheelchair dependent while retaining the ability to transfer in standing.

Derek and his family were unhappy with this situation. He strongly expressed his desire to walk again at any cost. After multiple medical consultations, Derek underwent a left femoral amputation and a triple arthrodesis of the right ankle at the age of 15, in November 2006. The ultimate goal of this surgery was to enable Derek to have some form of short distance ambulation.

The problem: How to fit and gait train someone with a prosthesis with a sensory neuropathy and an ankle arthrodesis of the contralateral lower extremity? Many factors contributed to the problem including: no pain sensation and incomplete light touch, deep touch, hot and cold sensation of the lower extremities, restricted weight-bearing on the contralateral lower extremity, compliance with daily stump inspection, patient and family comprehension with wound care and hygiene and the ability to carry out the recommendations given to avoid pressure points.

How we approached the problem: He received intensive physiotherapy treatment with restricted and scheduled progressive wear of the prosthesis. Nursing staff was present at the PT appointments for wound and bandage inspection. Gradual training and transfer of responsibility to the client for his care, with community follow-up permitted Derek to resume his activities in the summer with his friends.

11:05 am / CCP #10

**ON THE GO – FITTING A PEDIATRIC BILATERAL TRANSFEMORAL AMPUTEE WITH  
HIGH ACTIVITY LEVEL**

*Tricia Mahoney, PT, MHS\*; Tammie McElhinny, CP\*\**

*\*Shriners Hospitals for Children, \*\*Green Prosthetics & Orthotics, Erie, PA*

**The Problem:** The patient is an eight year-old boy with diagnosis of meningococemia resulting in bilateral transfemoral amputations. The original diagnosis and resultant amputations occurred when he was eighteen months old. The patient was originally placed in non-articulating AK prostheses at the age of two and articulating prostheses at the age of four. His first articulating set of prostheses utilized OSSUR Total Jr knees and College Park TruPer feet. The durability of the Total Jr knee was warranted due to the high activity level of the patient, however it resulted in a very audible and distracting terminal impact 'clunk' whenever his cadence was increased. The TruPer foot was chosen for its energy storing multi-axial functions for the pediatric client. Unfortunately, due to the patient being an aggressive walker he tends to

wear out the bumpers prematurely. Adult size feet would be much heavier and impact the energy demands of the patient's activities. Even if we were to utilize an adult foot, there are no cross-over components that allow use of a pediatric knee with adult foot or vice versa.

The family recently decided they would be open to utilizing adult parts for more componentry options. The Otto Bock Trias energy storing foot and Otto Bock 3R95=1 single axis knee with hydraulic unit were utilized for the patient's next set of prosthetics. These were worn for approximately two weeks before the seals on the hydraulic unit were damaged. He destroyed the second replacement set within a matter of weeks. Otto Bock was contacted and reported that the knees would not hold up in the environment that the client was exposing them to such as dirt from the baseball field and sand. Representatives from Seattle Systems also stated the same. We did attempt to place covers on the prosthetics to keep the dirt out but the covers do not last long due to the level and intensity of his activities. So, what options are there for an active 8 year old weighing 54 pounds (with current prosthetics on)?

### Symposium IV

11:25 am – 12:25 pm

#### **CHILDREN DECIDING ON AMPUTATIONS TO ENHANCE FUNCTION**

*Colleen Coulter-O'Berry, PT; Brian Giavedoni, CP; Michael Schmitz, MD; Jorge Fabregas, MD  
Children's Healthcare of Atlanta, Atlanta, Georgia, USA*

**The Problem:** Recently, over a month's period of time, 4 young males and their families treated at Children's Healthcare of Atlanta elected to have amputations following limb sparing/salvage procedures. Each of these children has a unique story about the initial injury and reasons for wanting an amputation.

This presentation will describe the initial presenting diagnosis and treatment and reasons for subsequent elective amputations. The boys have common threads:

- The amputations were their own decision
- Their families supported their decisions
- Pain was present in their involved lower limb
- A primary reason was to improve function and self esteem.
- They met with other amputees well ahead of the amputations
- Received education about pre and post operative management
- Stated specific activities and interests to be accomplished with an amputation that they could not perform in their current situation.

**The Solution:** Optimal outcomes were dependent on appropriate education centered on anticipated functional gains that matched the children's lifestyles. Education played a vital role in each of the children's decision for amputation that included:

- Peer mentoring and support
- Appointments scheduled with other children and adults with similar amputation levels.
- Knowledge about prosthetic technology and how the technology enhances function
- Discussion about the surgery and post-operative course
- Discussion about pain management and phantom sensations
- Listing specific interests and activities wanting to accomplish following amputation
- Realistic expectations about prosthetic fit and function

A suggestion from Mike Schmitz is to submit this case study/topic as a symposium to include in depth description of the pre surgery conditions and outcomes for each child. Then each case could be discussed. "As a symposium, more in depth and could offer common factors that lead to good outcomes – preamp pain, preamp functional limitation that can be overcome, patient buy in, family buy-in, appropriate pre-amp prosthetic planning" (MLS).

### **Poster Abstracts**

## **Poster #1**

### **TEN EXERCISES DESIGNED TO MAXIMIZE PROSTHETIC FOOT PERFORMANCE**

*Anushree Tulsian*

*Pandit Deen Dayal Upadhyay, Institute For Physically Handicapped ITO, Delhi, INDIA*

Prosthetic developments over the past decade have offered lower extremity amputees numerous advantages in both function and comfort. Manufacturers can now offer lighter, more durable prosthetic components fabricated from exceptionally dynamic materials that have the capacity to better mimic human walking. Moreover, manufacturers have also created a range of prosthetic components designed to compliment the functional abilities of amputees.

Matching the functional level of the amputee and the prosthetic components that will most assist them in reaching their full potential is the ultimate goal of manufactures and prosthetists alike. Unfortunately, all too often, people fitted with specially designed prosthetic components don't take full advantage of the functional capabilities their prosthesis has to offer.

Exercises are designed to educate the amputee in coordinating the functional dynamics of the prosthetic foot with the strength and power of the residual limb, the ability to optimize performance will be realized.

These exercises, such as side-to-side balance; braiding; toe box jumps; resisted walking, etc., are designed to be performed as a progression. As prosthetic ability improves and higher functional levels of prosthesis are prescribed, the amputee should attempt to master more and more of the exercises. Mastery of all the exercises would assure the amputee has the ability to fully exploit the functional potential of the prosthetic foot.

## **Poster #2**

### **DESIGN AND FITTING OF CUSTOM PROTECTIVE HELMETS FOR CHILDREN WITH COCHLEAR IMPLANTS**

*John Kooy CO(c)*

*Bloorview Kids Rehab, Orthotic Services – Clinical Technology, Toronto, Ontario, Canada*

Children with cochlear implants may have other disabilities (i.e. Epilepsy, Autism) that require the prescription for a protective helmet.

Due to the size and placement of the external headpiece transmitter standard off the shelf helmets cannot be fit effectively without interference.

The solution was to make a custom helmet that is easily donned and doffed so as not to interfere with the headpiece and permit unobstructed sound transmission while providing effective protection in the case of falls and/or trauma to the head.

Following the taking of a negative mould of the Childs head a positive model is made. The model is shaped and smoothed and used as a base to vacuum several materials to produce a foam inner liner surrounded by a hard outer shell.

The presentation is intended to follow the steps from casting to fitting and present for discussion challenges that have occurred along the way.

## **Poster #3**

### **DURAFLEX INNER BOOTS**

*Heather Russell, PT, CO*

*University of Virginia Prosthetics & Orthotics, Charlottesville, VA*

Pediatric patients present with a variety of boney prominences, foot deformities, or skin grafts from burns and accidents. Typically these patients are put in ankle foot orthotics (AFO) that are heavily padded

around the bony prominences or grafted skin. This creates a bulky brace which is difficult to purchase a shoe wide enough to fit over the AFO as well as aesthetically unpleasing, resulting in reluctance to wear. In addition, with bony prominences the trim lines of the orthosis must be flared out and/or trimmed back to allow for donning and doffing without scraping the ankle bones, resulting in suboptimal fit and decreased resistance to brace failure.

The introduction of 3 and 5 mm DuraFlex (Guard Industries) has facilitated the fabrication of soft molded inner boots for AFO's that are more resistant to failure than previously used materials (i.e. copoly, polyethylene). It is a high temperature plastic that is soft and malleable making it almost indestructible. An additional benefit of DuraFlex, it is also a non-toxic, non porous material and that does not absorb sweat and can be washed when it becomes soiled.

A specific example of the application of a DuraFlex inner liner involved a patient with Spastic Cerebral Palsy. An independent ambulator with a part time job that requires prolonged standing and walking making his skin prone to breakdown because of his thin stature, prominent malleoli, and navicular. Previously, bulky AFO's with 1/4" padding and anterior shells had been used in an attempt to prevent skin breakdown. Despite previous efforts he still developed redness and soreness that at times became painful enough to prevent him from working. Previous orthoses were tight and difficult to don and doff over his prominent malleoli causing skin abrasions and could not be contoured enough to prevent pronation within the orthosis and still be wide enough to accommodate his malleoli for donning

Oct 2006 new orthoses were initiated, the decision was made to fabricate an AFO with a molded inner boot made of DuraFlex. The soft inner DuraFlex boot protected the skin as it was slid into the harder AFO shell, and represented additional skin protection during ambulation. Although initially skeptical, the patient has done remarkably well wearing the orthoses for almost a year. The new inner liner has allowed the patient to continue working without missing work due to skin breakdown or follow-up appointments to repair torn padding or to heat and flare for sore places.

## **Poster #4**

### **DESIGN MODIFICATION OF A CONVENTIONAL STANDING FRAME**

*Michael Ceder, Prosthetist/Orthotist  
Team Ortopedteknik AB, Sweden.*

Standing frames are frequently used in Sweden for children with delayed motor development, muscle weakness or contractures. They are typically prescribed with the sole function of facilitating a stable upright vertical posture and have been associated with numerous physiological benefits including an increase in bone density, improved systemic function and a decrease in abnormal muscle tone [1].

The aim of this paper is to present a design modification for a conventional standing frame that permits the user to assume both standing and seated positions while maintaining stretch on the hamstring musculature.

A case will be presented of a twelve year old vision impaired male with hemiplegic cerebral palsy, autism and severe hamstrings contractures which forced him into a crouched position. To facilitate function and attempt to reduce the contracture, an existing standing frame was modified to include a hip joint together with a posteriorly mounted support arm that was attached to the torso section of the frame and served as a prop to allow the child to assume a semi seated position with the legs extended (see figure 1). While in the semi seated position, the spine was supported in a posterior leaning position by the proximal shell of the orthosis. Importantly, the design utilizes the patient's own body weight to facilitate stretching of the hamstrings and the patient is not forced to sit in a static position, which in this case was considered crucial.

Results of prolonged use of the modified standing shell have been very good and the child has been using the design since 2002. Positive results have been achieved in relation to stretching out the difficult hamstring contracture.



Chad KE, Bailey DA, McKay HA, Zello GA, Snyder RE. The effect of a weight-bearing physical activity program on bone mineral content and estimated volumetric density in children with spastic cerebral palsy. *J Pediatr.* 1999;135:115-117.