

8:10 am / CCP #1

**RECONSTRUCTION OF CONGENITALLY UNSTABLE,  
LIGAMENT DEFICIENT KNEES - REPORT OF 3 CASES**

*J. Ivan Krajbich, MD, FRCS(C); Sabrina Jakobson-Huston, CPO; Shannon Kelly, MPT; Kelly Alexander, RN; Shriners Hospitals for Children, Portland, OR*

**Goal:** Report on our experience in reconstructing, congenitally unstable knee and delineating basic principles of such undertaking, including rehabilitation and brace support.

**Methods:** 3 patients with congenitally very abnormal knees were treated by combination of bony osteotomies, soft tissue release, soft tissue reconstruction including ligament reconstruction. The underlying diagnosis were TAR syndrome, (slipped ep) and multiple congenital limb deficiency.

**Results:** All patients obtained significant improvement in their function. One with the longest follow-up, (13 years) was able to participate in high school sports without need for external support and normally functioning knees. The other two (follow-up 1 year and 6 months) have stable, well aligned knee but presently still use an external orthosis for protection.

8:30 am / Paper #2

## THE UTILITY OF GAIT ANALYSIS TO ENHANCE CLINICAL RECOMMENDATIONS IN A PATIENT WITH A HEMIPELVECTOMY

*Grasso M, Kanas J, Hutchinson D*

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**Background:** Gait analysis is an effective tool for evaluation of prosthetic use post amputation. Hemipelvectomy amputees constitute only a small percentage of amputees and may benefit from instrumented gait analysis to aide in prosthetic adjustments and in therapeutic recommendations. The purpose of this case report is to discuss findings and recommendations following an instrumented gait analysis in a patient with a hemipelvectomy and a recently prescribed prosthesis.

**Methods:** The patient is a young 8 year old girl who had a crush injury to her pelvis which required an emergent bowel diversion and a left hemipelvectomy. Two years after her injury, the patient was fitted for a hip disarticulating prosthesis and began gait training with physical therapy. At the time of her gait analysis, the patient had been utilizing her new prosthesis for approximately 8 days. Clinical examination, three-dimensional gait analysis (Vicon™), and surface EMG testing to the lower extremity was performed. The analysis was completed at a self-selected walking speed during walker-assisted ambulation using a left hip disarticulation prosthesis with a knee extension-assist mechanism. Reflective markers were placed to track bony movement about the pelvis, hip, knee, and ankle joints while surface electromyography examined phasic activation in key lower limb muscles.

**Results:** Clinical findings revealed bony passive limitation into right hip adduction, extension and internal rotation. The right hip also had evidence of hip adductor weakness. Kinematic findings on the prosthetic limb revealed compensatory movements about the pelvis and trunk (visual) along with knee flexion/extension motion during swing. Changes in trunk/pelvic motion appeared to result in increased left hip adduction. Overall, the position of the prosthesis in space coincided with typical values except for a slight increase in hip extension and ankle dorsiflexion values. Right-sided findings revealed abduction and external rotation posturing of the hip. There was a lack of a smooth forward progression within the sagittal plane values. This was observed at the right hip, knee, and ankle with frequent fluctuations or adjustments in the movement pattern. The right foot assumed a more external position with an increase in dorsiflexion during terminal stance.

**Conclusion:** Following the gait analysis recommendations were made by the team for prosthetic adjustments, rehabilitation approaches, and further orthopedic workup. Prosthetic adjustments consisted of moving the weight line of the prosthetic limb posterior to allow increased flexion of the knee joint in late stance, examining the fit of the prosthesis to enhance coronal trunk and pelvic control, and adjustment of the ankle positioning. Rehabilitation recommendations focused on continued training to improve gait progression in the sagittal plane. Orthopedic workup of the right hip included examining the bony pelvic structures and options for muscle transfers. The gait analysis and review by the team in this case enhanced our understanding of the patient. There is a need for further study in this area, particularly with pediatric patients with hemipelvectomy, to optimize prosthetic fit and functional outcomes in this patient population.

8:45 am / CCP #2

**THE CHALLENGES OF DESIGNING AND FITTING A TRI-LATERAL AMPUTEE  
WITH A LOW PROFILE HIP DISARTICULATION PROSTHESIS AND A VERY  
SHORT TRANS-FEMORAL PROSTHESIS**

*Daniel Griner, CPO; Bryan Sinnott, CPO; Pam Versage, PT; Carmen Aranda, OT  
Shriners Hospitals for Children, Tampa, FL*

This is a case study of a nine year old young lady who happens to be a tri-lateral amputee. This study will discuss and demonstrate how our prosthetics department was able to successfully fit her with a state of the art right low profile hip disarticulation prosthesis, using Lock it Socket technology ; as well as, a left ischial containment trans- femoral prosthesis for a very short femur. We will also discuss her fitting of a left wrist disarticulation prosthesis, which was used very effectively for donning / doffing and transfers.

8:55 am / CCP #3

**A MULTIDISCIPLINARY APPROACH TO MEET THE NEEDS  
OF A PATIENT FROM RURAL PERU**

*Pam Versage PT, Carmen Aranda OTR, Brian Sinnott CPO, Danny Griner CPO  
Shriners Hospitals for Children, Tampa, Florida*

This challenging case study will focus on a female with multiple amputations who received her first prostheses at age ten. Besides providing upper and lower extremity prosthetic training sessions, the team also focused on modifying wheelchair and mobility related assistive devices; identifying adaptive equipment to promote independence with activities of daily living, and adjusting the physical components of her prostheses in relation to her home environment. Unique adaptations and protocols were required in order to promote independence once she reintegrated to her home and school in rural Peru. Consultations also included nutritional and translation services to ensure development of a culturally sensitive home program for follow through by the patient and family upon discharge.

9:10 am / Research Award #1

**PARENT AND SELF-REPORTED PARTICIPATION AND HEALTH RELATED  
QUALITY OF LIFE IN DUTCH CHILDREN AND ADOLESCENTS WITH  
CONGENITAL LOWER LIMB DEFICIENCIES**

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*Rehabilitation Centre De Hoogstraat, Centre of Excellence for Rehabilitation Medicine,  
Utrecht, The Netherlands*

**Objective:** This study describes the participation and health-related quality of life (HRQoL) in Dutch children and adolescents with congenital LLD, and compares the results with the participation and the HRQoL of the general Dutch population. Differences between parent and self reports were explored.

**Design:** Cross-sectional study

**Methods:** This study assessed participation with the Children's Assessment of Participation and Enjoyment (CAPE) and HRQoL using KIDSCREEN-52 questionnaires through self reports and parent proxy reports of 64 children and adolescents with congenital LLD aged 8-18 years. Dutch reference data from a representative national sample were used.

**Results:** Findings indicate a broad range of diversity and intensity of participation as reported by children and adolescents with LLD and their parents. Significant differences in diversity and intensity of skill based and social activities were found in adolescents with LLD in comparison with the reference group. Parents reported lower intensity of physical and self improvement activities in their children aged 12-18 years in comparison with the children's self report.

HRQoL as reported by the children and adolescents with LLD and their parents was comparable with the Dutch reference group. Significant differences in comparing parent and self reported HRQoL were found in the domains "physical well being" ( $p=0.045$ ), "moods and emotions" ( $p=0.006$ ) and "self perception" ( $p=0.001$ ).

**Conclusion:** Dutch children and adolescents with LLD participate in diverse activities and perceive their HRQoL similar to their healthy peers. Parents' perception of the participation and HRQoL is largely in accordance with the perception of their children.

11:00 am / Research Award #2

**ORTHOTIC TREATMENT OF PECTUS CARINATUM:  
A SECONDARY RETROSPECTIVE ANALYSIS**

*Anne Fecko, OTR/L, MSE.d., BEO*

*Connecticut Children's Medical Center, Hartford, Connecticut*

**Abstract:** Determining the effectiveness of bracing for the treatment of pectus carinatum (PC) using quantitative methods has been a challenge in the field of orthotics. The purpose of this study is to draw intra- and inter- subject comparisons related to patient outcomes and factors that influence change through the use of quantitative data collected from the Insignia scanner and surveys. Seventy-six patients (males = 66; females = 10) ages 9-18 were prescribed dynamic chest compression (DCC) orthoses for the treatment of PC. Paired t-tests were used to determine that the most significant change occurred in the PC during the first three months of treatment. An Analysis of Variance (ANOVA) was used to determine that both age at initiation of bracing, and wear time significantly influenced the amount of correction achieved. Participant responses to a structured questionnaire indicated that they were generally satisfied and rated their PCs as less severe, both during and after treatment with the brace, and. Results of this study may be used to guide orthotic prescription and protocol for potential patients, and to serve as a basis for future studies on similar topics.

**Introduction:** Pectus carinatum (PC), commonly known as “pigeon chest,” is a chest wall anomaly that is characterized by an anterior protrusion from the chest wall caused by an overgrowth of the costal cartilages of the rib cage as a result of damaged growth plates in the costochondral junction (Mavanur & Hight, 1993; Meilke & Winter, 1993; Haje & Bowen, 1992).

Since the initiation of bracing pectus carinatum in Brazil by Haje and colleagues, in the 1990s, questions regarding the effectiveness of treatment and the factors that influence positive outcomes have been examined by a handful of researchers (Banever et al., 2006; Egan et al., 2000, Frey et al., 2006; Haje & Bowen, 1992; Mavanur & Hight, 2008; Meilke & Winter, 1993; Stephenson & Dubois, 2008). Across the available literature, the general consensus is that bracing is an effective and minimally invasive treatment for pectus carinatum (Banever et al., 2006; Egan et al., 2000, Frey et al., 2006; Haje & Bowen, 1992; Mavanur & Hight, 2008; Meilke & Winter, 1993; Stephenson & Dubois, 2008). However, the methodologies, outcome measures, and results are varied. As a result, it is difficult to compare results across studies.

Measuring objective outcomes with this population is a challenge because of patient growth and postural change throughout the course of treatment. While an anterior-posterior measurement of the pectus at its most prominent point to the middle of the back provides a quantitative measure for a snapshot in time, it is not effective for tracking change long term. In addition to brace effects, several factors may influence this measurement and must be considered when investigating the efficacy of this treatment approach (e.g. weight gain/loss, typical child growth and development, building muscle mass). The subjective accounts of change and qualitative data collected from patients in previous studies are helpful in justifying the effectiveness of bracing pectus carinatum. However, quantitative scientific and measurable outcomes combined with these methods will better serve to substantiate the use of this treatment for individuals with PC.

11:25 am / Symposium I

**REHABILITATION OF CHILDREN WITH BRACHIAL PLEXUS INJURY**

*Joshua Ratner, MD; Allan Peljovich, MD, MPH; Colleen O'Berry, PT, DPT, MS, PCS  
The Pediatric Hand & Upper Extremity Center of Georgia,  
Childrens Healthcare of Atlanta; Atlanta, Georgia*

Pediatric brachial plexus injuries account for some of the most profound and difficult to treat of all upper extremity injuries, often leading to impairment and disability. Optimizing function for these children involves the judicious and timely initiation of various treatment strategies including surgery, therapy, and bracing. Orthotic and prosthetic interventions are employed throughout the course of treatment to assist in mobilizing joints and improving the performance of necessary activities. The best treatment plan is tailored to the particular needs of the child and takes into consideration input from the patient and family, physicians, therapists and O&P professionals, among others.

Trauma remains the primary cause of brachial plexopathy in children. Birth related trauma and traumatic traction injuries are the most frequent mechanisms of injury. A well coordinated treatment plan must begin with a thorough understanding of the patient's history, specifically the time that has passed since the injury- which impacts the timing and potential for application of treatment modalities.

The initial assessment is aimed at understanding the particular child's pattern and nature of injury. This occurs by careful physical examination, and in some cases imaging studies. With an understanding of the "natural history" of a particular pattern of injury, care is focused on maximizing function by maintaining mobility and controlling pain. Early interventions are applied when it seems clear that the natural history of the injury can be modified; for example: early surgical repair or reconstruction, nerve transfers, and temporary chemical denervation of muscles to control spasticity as nerves recover. Orthotics are employed to assist in preventing contractures, controlling pain and maintaining joint alignment while therapeutic treatments focus on mobility and joint stability.

Later, continuing care for these patients is focused on maintenance and improvement of function. Surgery may include tendon transfers and joint stabilization to enhance the child's abilities. Orthotics and adaptive devices are of great help in furthering the child's ability to interact with their environment. In the rare circumstance of chronic severe impairment, amputation may be considered- making prosthetic application a vital segment of the plan of care.

This symposium will review the fundamental anatomy and pathophysiology of the most common patterns of brachial plexus injuries in children. The authors represent various members of the brachial plexus team, and will discuss the expert management of these children through their various phases of care.

**Goals & Objectives:**

1. Understand the consequence of brachial plexus injuries on children.
2. Understand the importance of the natural history of brachial plexus injuries in reference to the various treatment modalities available.
3. Gain appreciation for the management of brachial plexus injuries in children from the perspective of time.
4. Appreciate the critical role of rehabilitation, prosthetics and orthotics in the management of children with brachial plexus injury.

2:30 pm / Workshop A – Physicians' Case Study Forum

**PFFD PATIENT AMBULATING WITH A BELOW KNEE PROSTHESIS:  
FUTURE SURGICAL & PROSTHETIC STRATEGIES TO IMPROVE  
FUNCTION: CHALLENGING CASE STUDY**

Jennifer Jenkins, P.T.; Janet G. Marshall CPO

York Hospital, York, Pennsylvania; Shriners Hospital for Children, Tampa, Florida

This case presentation involves a 7 year 2 month old female with a diagnosis of left PFFD Aitken classification A-B. She underwent a Symes amputation at 8.5 months, and fitted with a below-knee prosthesis at 12 months. She began ambulating independently at 17 months.

On clinical exam, patient presents with good strength throughout bilateral lower extremities with minimal strength differences noted between right and left sides. She does not present with significant passive range of motion limitations throughout left lower extremity. Subject demonstrates an approximate 11 centimeter difference between knee centers. A knee evaluation noted increased laxity with the left medial collateral ligament, and a positive left anterior drawer test. A deficient anterior cruciate ligament is suspected.

Functionally, subject demonstrates independent ambulation with appropriate heel-toe strike bilaterally and no significant gait deviations. She runs independently, and ascends/descends stairs reciprocally with one hand support.

Limitations include difficulties riding a bike independently and sitting in a chair without accommodation. As subject continues to grow and mature, predicted challenges include sitting positions while driving a car and sitting in various environments such as a seat on an airplane.

A full clinical evaluation, radiographs and gait data will be presented. Future surgical and prosthetic strategies will be discussed with audience comments solicited.

1. Westberry DE, Davids JR. Proximal focal femoral deficiency (PFFD): management options and controversies. *Hip Int* 2009; 19:s18-s25. 2. Epps CH. Proximal femoral focal deficiency. *J. Bone and Joint Surg* 1983; 65-A:867-70.

2:30 pm / Workshop A

**SURGICAL TECHNIQUE: CORRECTION OF TIBIAL BOW IN PATIENTS WITH FIBULAR HEMIMELIA**

*Jorge A. Fabregas, MD, Michael Schmitz, MD*

The anterior medial bowing of the tibia is a common problem in patients with fibular hemimelia. This deformity can vary from absent to very severe. This eventually leads to many prosthetic complications. It has been proposed that correction at the time of a symes amputation would avoid further complications. Fixation methods have been proposed with k-wire or Steinmann pin. On the older patients, a Williams rod has been used. At our institutions, our preferred method of fixation of the osteotomy is a lag screw. This correction is performed at the time of the amputation. This way the two deformities are addressed at once and hopefully will prevent further surgical interventions. We present our experience and results of this variation in surgical techniques.

**COXA VARA IN PATIENTS WITH PROXIMAL FEMORAL FOCAL DEFICIENCY: A VALGUS OSTEOTOMY**

*Jorge A. Fabregas, MD; Michael Schmitz, MD; Children's Healthcare of Atlanta, GA*

Patients with proximal femoral focal deficiency will sometimes develop a coxa vara. In our institution, we have adopted a valgus producing osteotomy typically used for congenital coxa vara and coxa vara in patients with osteogenesis imperfecta as treatment of choice. The indications for valgus producing osteotomy include femoral neck angle of 100 degrees or less, H-E angle of 60 degrees or greater, trendelenburg gait, and pain. This osteotomy provides good bony contact and stability. It is accomplished by performing an oblique subtrochanteric osteotomy and insertion of a blade plate or hip screw. Patients gain a very reliable union of the osteotomy site, pain relief, and improvement of their gait.

**USE OF UPSIDE DOWN DISTAL TIBIA FOR BK-LIKE AMPUTATION IN SALVAGE OF FAILED LIMB SPARING SURGERY**

*J. Ivan Krajbich, MD, FRCS (C); Sabrina Jakobson-Huston, CPO;  
Shannon Kelly, MPT; Kelly Alexander, RN*

**Goal:** Demonstration of surgical technique, prosthetic fitting and rehabilitation of upside down tibia below-knee amputation reconstruction used as a salvage procedure after failed primary reconstruction for malignant tumors of proximal tibia.

**Methods:** Two patients with failed allograft reconstruction for osteosarcoma of the proximal tibia were treated by upside down distal tibia technique to provide them with functional below-knee amputation.

**Results:** Both patients obtained solid BK amputation stump. One is a successful long-term survivor BG prosthetic user. The second one died of metastatic disease within a year of the index surgery.

2:30 pm / Workshop B

**A FUNCTIONAL TREATMENT APPROACH FOR THE CHILD WITH A LOWER EXTREMITY AMPUTATION**

*Pamela Versage, PT; Shriners Hospitals for Children, Tampa, Florida*

This workshop will focus on age appropriate prosthetic training using a motor learning and problem solving approach. The impact of developmental, environmental, and cultural factors for children of various learning styles will be considered. Ideas for parental supervised gross motor play activities or skills will be provided to encourage acceptance of the first prosthesis.

The objectives of the workshop are follows:

- ◆ to promote new developmental skills through analysis of specific components of movement required to learn to use the prosthesis
- ◆ to identify the impact of contributory impairments such as deconditioning and comorbidities which affect postural alignment, timing issues, and lack of mobility, balance, and/or strength on prosthetic gait
- ◆ to apply core conditioning principles using Pilates/yoga ball, music, or fitness approach
- ◆ to practice strategies for weight acceptance, weight shifting, gait training, curb and stair training and balance activities

The workshop will be divided into training activities for the first prosthesis (with and without a knee component), multiple amputee child and teenager, and traumatic amputee.

Lab sessions will also promote functional motor patterns by using manual skills to allow practice with other participants in the course.

Course time suggestion is 2 to 2 1/2 hours. Lab session will be in between PowerPoint format to reinforce topics discussed. The instructor is requesting a Thursday or Friday. Participants should bring a ball which they can sit on at a ninety degree hip and knee position if a ball core control session is to be included in this course. Other equipment to promote timing and coordination activities and motor learning to go up and down curbs will be brought by the instructors.

1:30 / Workshop C

**TECHNIQUES AND PROCEDURES IN THE CORRECTION OF SCOLIOSIS, USING A RISSER CASTING FRAME TO PRODUCE A WILMINGTON SPINAL ORTHOSIS**

*Daniel Griner CPO, LPO; Shriners Hospitals for Children, Tampa, FL*

This workshop will implement the orthotic management of scoliosis through the exclusive use of the Risser casting frame to produce a corrected Wilmington orthosis. The Wilmington orthosis has been reintroduced and used very successfully at our hospital for several years. The workshop will review radiographs of several curve types and the corresponding procedures on the Risser frame used to maximally correct the magnitudes of those curves with respect to the central sacral line management. All attendees will participate in these set ups. There will also be demonstrations of the actual molding and positive model modifications, as well as demonstration models of the finished Wilmington orthosis.

*7:45 am / Workshop D*

**PARTIAL FOOT FABRICATION: A COMBINED WORKSHOP SYMPOSIUM**

Jeff Boardman, RTP; Matt Morel, CPO; Robin C. Crandall, MD

Shriners Hospitals for Children, Minneapolis, Minnesota

Fitting partial foot and Chopart level amputees can be some of the most difficult problems for prosthetic practitioners. These amputation levels are relatively common through the world, in particular, with trauma and land mine injuries. A specific fabrication technique combining a custom silicone socket with a prefabricated, injected, molded foot will be presented. This system has been used at the Twin Cities Shriners Hospital for Children long term since May 1995. The system produces a prosthesis with excellent cosmesis, simple suspension and low overall cost in long-term follow-up. Cost analysis will be presented. A complete workshop will be presented including all steps needed to fabricate the prosthesis. The system emphasizes casting with weight-bearing, supplies needed, and part numbers necessary so that the system can be exported to any other clinical setting.

7:45 am / Paper #4

**ALIGNMENT & FINE TUNING OF AFOs,  
UTILIZING THE STRATHCLYDE APPROACH**

*Davin Heyd, CO; Mike Watt, CO; Bracemasters International, New Berlin, WI & Children's  
Care Hospital School, Sioux Falls, SD*

Over the past two years we have been utilizing the Alignment techniques and fine tuning process developed at Strathclyde University, Scotland UK. We have found that achieving quality gait characteristics has greatly improved and we have discovered that as per their statements that ROM changes can be positively affected with Solid ankle AFOs. Incidence of fitting issues has decreased as well as noted standing balance and stability are better. It also came to light during this time that current methodology may not be appropriate and in fact may be causing increased tone and potential deformity of the foot and ankle structure. The approach at Strathclyde is one of the first documented and studied alignment and fine tuning process in the Orthotic industry. The goal of this presentation is to explain this process in a simplified fashion and to demonstrate via Case presentations of the success of utilizing this process.

CV: Davin T. Heyd, CO, received his bachelor's degree at Concordia College in Moorhead, MN. He received his orthotic training at Century College in White Bear Lake, MN. He attended an accredited Orthotic Residency program at the University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, and was certified by the American Board for Certification in orthotics. He designed and developed the O.U. Ankle Joint and Motion Control Limiter, two orthotic lower limb devices. He received a Quality Service Award from the governor of Minnesota in 1994, and was awarded Most Outstanding Student at Century College, for 1995-96. He is an Examiner for the Clinical Patient Management Exam through the American Board for Certification in Orthotics and Prosthetics. Mr. Heyd also formerly served as President of the Minnesota Chapter of the Academy for Orthotics and Prosthetics, Chairman for the Technical Exam Committee through the American Board for Certification in Orthotics and Prosthetics, and Chairman for the Lower Limb Orthotic Society for the Academy for Orthotics and Prosthetics. Mr. Heyd has worked for twenty-two years as a technician and orthotist, Prior to coming to work at Rehabilitation Medical Supply Mr. Heyd was the Central Fabrication Manager with Orthomerica Products, Inc. where he was responsible for the manufacture and development of numerous orthotic devices including the line of cranial remolding orthoses.

7:55 am / CS #1

## **MANAGING PEDIATRIC CROUCH WITH ADJUSTABLE DYNAMIC RESPONSE KAFOS**

*Amanda Kim, PT, MPT; Jeff Brooks, CPO  
HSC Pediatric Center, Washington, DC*

Pediatric patients with neuromuscular involvement, demonstrating a crouch gait pattern due to a combination of weakness and tightness, can present challenging opportunities to the clinicians working with them. This creative solution, case presentation, focuses on a 4 year old girl with a diagnosis of hypertonicity with a diplegic-type distribution. Due to weakness and loss of motion at both her knees and ankles, the patient presents with internal rotation of the hips bilaterally, knee flexion and ankle plantarflexion during gait and relies upon the assistance of a posterior rolling walker for ambulation. Previous attempts have been made with traditional AFOs to improve the patients gait pattern with limited success.

This case will demonstrate how a comprehensive orthotic management program was developed to address the patient's loss of motion with therapeutic stretching orthoses as well as adjustable dynamic response (ADR) KAFOs for daytime, functional use. This is the first case of single lateral upright, ADR KAFOs, for pediatric use, being reported on to the authors' knowledge.

The unique ADR KAFO design with a single lateral upright bilaterally, allowed the patient to be fit with orthoses that were relatively low profile and lightweight. The ADR components allowed for increased adjustability of range allowances as well as the ability to dampen range of motion at both the knee and ankle without having to stop it completely.

Upon fitting the ADR KAFOs the patient demonstrated improved posture, decreased internal rotation, decreased knee flexion and an improved base of support bilaterally. In addition, the dampening of motion allowed the patient to have a functional, weightbearing stretch during gait. As the patient makes improvements in range and strength, adjustments to the knee and ankle settings can be adjusted accordingly. This single case presentation demonstrates how a unique orthotic design and a team approach worked to make a significant improvement in a child with a difficult crouch gait presentation.

**Acknowledgments:** We would like to thank the patient involved in this case presentation as well as her parents for their willingness to participate.

8:15 am / Paper #5

**AN INNOVATIVE CONVERTIBLE KAFO DESIGN ALLOWS IMPROVED MOBILITY  
IN A 2 YEAR OLD WITH SPINA BIFIDA**

*Jane Anne Emerson, MD; Lynne Snyder, CO*

*University of Missouri Health Care, Dept. of PM&R, Columbia, MO*

Knee Ankle Foot Orthosis (KAFOs) are traditionally used in patients with knee instability secondary to neuromuscular problems. Traditional KAFO application in young children remains difficult because of their small limb size and the considerable amount of time they spend in floor based activities. The thigh and knee components limit mobility and prohibit independent transition to standing necessitating a delay in KAFO introduction, or requiring two separate sets of braces.

We present a 27 month old patient with mid lumbar myelomeningocele and inability to ambulate. Previous orthotic options had been limited to Ankle Foot Orthosis (AFOs) prohibiting progression of ambulation. Consideration of his size in addition to his growth, development, and mobility needs, prompted development of a convertible KAFO with a disconnect mechanism utilizing a plastic pin system. This design allowed for easy removal of the knee/thigh portion promoting quick conversion from a KAFO to an AFO. This eliminated the need for two sets of braces and allowed earlier KAFO application in a cost effective manner. This application resulted in ambulation with a reverse walker in 2-3 weeks. Further investigation is warranted to determine application for even younger patients.

*10:30 am / Presidential Guest Speaker*

**AMPUTATION, PROSTHETICS AND REHABILITATION IN CHILDREN**

*Rene F. Baumgartner, MD; Emeritus Professor of Orthopaedic Surgery, Department of  
Prosthetics, Orthotics and Related Surgery, University of Munster/ Germany*

The management of the child amputee, in many respects, is quite different than that for adults. Regardless of the patient's age, amputation surgery has to preserve a maximum of length and still create a stump free from pain and one that can be fitted with prosthesis. This principal also holds for children with congenital limb deficiencies, of which, we hesitate to remove additional tissues than those that are already missing.

Modern techniques provide excellent function and cosmesis even for the odd-shaped, deformed limbs. Amputation is not indicated to make prosthetic fitting easier.

The epiphysis growth area must be preserved whenever possible. One has to remember that the slightest shortening of a limb has a negative effect on growth. Further, in lower extremity amputations, the end of the stump must be able to carry the full body weight. This stimulates growth and improves proprioception and comfort. Plugging the fibular head into the tibia and capping the humerus will prevent bony perforations of the skin.

During the growth period, surgical corrections of axial deviations may also become necessary. Special procedures can make prosthetic fitting easier, or they can improve basic functions, such as the Krukenberg hand.

Prosthetic fitting is only indicated if it offers advantages to the child. In the lower extremity, it starts when the baby intends to stand. In the upper extremity, the onset depends on the amputee's needs and the prosthetic technology available. Technical aids for ADL have to be evaluated and ordered if the patient can benefit from them.

Occupational therapy and Physical therapy treatments must be coordinated and adapted to the child's age and development. The child should attend regular school classes. Sports and musical activities are extremely important. Vocational training must be offered by specialists who are familiar with the needs and expectations of the amputees.

Late results, some of which are cases, 50 years post-surgery will be presented, with discussion.

11:25 am / Workshop E

## **MEIDCALLY BASED EVIDENCE RELATING TO SUBTALAR NEUTRAL POSTURE FOR PEDIATRIC AFOS**

*Robert Meier, CO, BOCO; David Ruthastz, CPO*

**Introduction:** Subtalar neutral has long been believed to be the posture of greatest stability in design considerations for Ankle Foot Orthoses (AFOs). The application of this concept is seen in everything from pediatric SMOs to adult AFOs. However for anyone who has ever walked in ski boots, we can appreciate that distal immobilization may, in fact, lead to proximal instabilities.

**Methods:** A literature review was initiated to determine the level of support for the “subtalar neutral is stable” concept. A search was conducted in PubMed involving key words or phrases including AFO subtalar neutral, stability in AFO, AFO gait outcomes, and AFO functional outcomes.

**Results:** Medline searches led to finding no published data to support the concept. All references stating STN as the posture did so without justification for that posture. There is reference to the need for studies. There are multiple data sources however to suggest that a “controlled motion” environment may enhance joint modeling and neuromuscular development and at the same time minimize disuse atrophy secondary to immobilization. Trials were done using a “controlled motion” vs. subtalar neutral AFO environments. Examples of these trials will be presented demonstrating functional outcomes.

**Discussion:** Managing soft tissue injuries or dysfunction through immobilization was discredited 20 years ago when managing grade II ankle sprains was accomplished through plaster immobilization. Conceptually a “controlled stress” orthotic environment might be more appropriate to avoid the atrophy secondary to immobilization and to encourage joint modeling and neuromuscular function during the developmental process. Trials were conducted to test the concept with function during gait as the determinant of validating the concept.

**Goals and Objectives:** 1) The objective of this course is to discuss the concept of subtalar neutral in view of medical evidence, and compare that to the medical evidence supporting a “controlled motion” orthotic environment. Upon completion of the course, attendees will be able to; 2) Describe the effects of static immobilization on the structural and neuromuscular components in the locomotor system; 3) Predict the gait and functional outcomes in patients managed in an immobilizing orthosis; 4) Describe the effects of a controlled motion orthotic environment on structural and neuromuscular components of the locomotor system; 5) Predict the functional and postural outcomes in patients managed within a controlled motion orthotic environment.

**Conclusions:** Although the effects of immobilization are widely recognized, immobilizing subtalar neutral AFOs are commonly used in managing the pediatric foot/ankle complex. While there are no data to support this practice, there are data to support a “controlled motion” AFO environment might work to enhance joint modeling, neuromuscular development, and enhance functional outcomes during gait. Early trials seem to suggest that a controlled motion AFO environment yields enhanced functional stability during gait.

**References:**

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*11:25 am / Research Award #3*

**DEVELOPING AND IMPLEMENTING FORCE TRANSDUCERS IN GROSS MOTOR TASKS AS A MEANS OF QUANTITATIVE ASSESSMENT**

*Katelynn Craig, Carly Genn, Dr Edmund Biden, Dr Victoria Chester, Wendy Hill (BSc OT)  
Institute of Biomedical Engineering, Fredericton, New Brunswick, Canada*

Force transducers have been created and are currently being used to investigate joint loading in children aged four to fourteen through the use of gross motor tasks. Joint loading will be examined by combining data captured in by a motion capture system regarding the orientation of the child while bicycling or swinging and the data captured by the force transducers during the task.

The force transducers have been implemented on a swing and on a bicycle. On the swing, force transducers were located at hand-grip height along the chains, while on the bicycle, the hand grips were instrumented. The swing transducers provide grip and shear force (the amount of “down force” that is being applied to the chains), independently, on each side. On the bicycle, the transducers measure grip, force and torque independently, on each side.

Fifteen normally limbed children and five children using a prosthesis have been tested; the prosthesis users have performed the protocol while wearing their prosthesis, and again without it. The results have shown that the force transducers are fully functional, and significant data can be collected through the tasks.

When examining positional and force data, certain trends for prosthesis users appear. These trends can be compared against the data obtained from the normal population. Since a small number of children using a prosthesis have been tested, each child will be treated as a case and compared individually against the normal database. As this number increases, it may become possible to compare population.

11:50 am / Paper #6

**FINDINGS OF THE UPPER LIMB PROSTHETIC OUTCOME  
MEASURES (ULPOM) WORKING GROUP**

Wendy Hill, OT(c); Institute of Biomedical Engineering.  
University of New Brunswick, Fredericton, NB, Canada

**Background:** Advances in the design, control, application and provision of upper limb prostheses have combined with pressure on resources to require objective justification of the fitting of an arm prosthesis. This has increased interest in objective measures of performance and use, covering the entire cycle of prosthetic development from initial design, to use of a prosthesis in the home and community. At each stage, the measurement of the factors influencing use and performance are key to the decisions made concerning the design, development, treatment or provision of the devices. Thus it is clear that objective measures are central to this process. These measures are important to the therapists and clinicians involved in fitting devices. They are equally important to the engineers designing components or methods of controlling a prosthesis. Having a standard approach to outcome measurement using appropriate, valid measures would allow the comparison of findings between centres and countries.

**Evolution of an Approach:** It became apparent to many that there was a need to achieve greater knowledge and understanding of outcomes tools by practitioners and engineers who are engaged in this field of upper limb deficiency. A series of meetings were held in Canada and Norway from 2005 [1]. At the World Congress of ISPO in August 2007, a broad working group, known as the Upper Limb Prosthetic Outcome Measures (ULPOM) Group, was formed. The group's aim was to produce recommendations in order to create a standardised approach and to engage a consensus within the professions.

Based on the World Health Organization's International Classification of Functioning, Disability and Health (WHO-ICF), the existing assessments available to assess each domain have been identified. Many have the potential to be used, but have not been validated for this application.

**Recommendations:** This presentation will describe the results of the work completed in the last five years towards a consensus in the area of outcome measures for upper limb prosthetics. The recommended assessments will be identified and the work required to further develop other potential assessment tools will be reviewed.

**Acknowledgements:** The work being presented is the work of an international team of clinicians and researchers, who contributed equally in this effort. The team also includes Kristen Gulick, OTR/L, Peter Kyberd, PhD, Liselotte Norling Hermansson, PhD, Sheila Hubbard, Dip P&OT, BSc(PT), Øyvind Stavadahl, PhD, and Shawn Swanson, OTR/L.

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12:05 pm / Paper #7

## SHOULDER DISARTICULATION INTERFACE DESIGNS

*Gerald Stark, CPO/L, FAAOP*

*The Fillauer Companies, Inc., Chattanooga, Tennessee*

A prosthetist creating a shoulder disarticulation interface design faces a greater number of challenges due to the proximal position of the prosthesis. These include less anatomic prominences for suspension and indexing, greater skin coverage, triaxial dynamic loading changes, amputation variability, increased weight, motion for control options, and cosmetic concerns due to shoulder placement and functional scoliosis. These challenges are compounded by the fewer numbers of shoulder disarticulation patients (only 1,341 patients from 1988-1996).<sup>2</sup> As a consequence the average prosthetist may not be as familiar with socket design alternatives that can be utilized to lessen these negative residual affects.

Shoulder disarticulation also faces a higher rejection rate estimated to be more than 39%-65% for acquired and congenital deficiency respectively.<sup>1</sup> Some of the main factors have been linked to: insecure interface, level of amputation, lack of function, discomfort, gadget tolerance, heat dissipation, and cosmetic quality.<sup>1</sup>

The interface should provided loading comfort that provides relief for the bony prominences of the clavicle, spine of scapula, and acromium while loading the soft tissue of the suprascapular, subscapular, thoracic, and deltopectoral areas to maintain stability. This is in lieu of the fact that amputations at this level vary. It must be realized that the stability needs and loading change as the shoulder and elbow is flexed, abducted, or extended. The method of control is also affected by the loading when using body or external power especially when using myoelectric sensors. The interface can increase heat dissipation by exposing the superior shoulder and removing inferior windows using a strut system. Conversely overall rigidity of these must be increased with structural corrugations and composite lamination techniques. At times the shoulder mobility is used to operate touch sensors or cable control. In this case the tip of the acromium is allowed to move while the rigidity is provided by a proximal collar around the shoulder.

Many strut type interface variations have evolved to replace the conventional methods to answer these needs. William Sauter of Toronto was one of the first to suggest the use of aluminum frame construction in the 1970's.<sup>1</sup> Ring first suggested the use of a carbon composite frame in 1971.<sup>1</sup> In the Mid-1980's Tom Andrew of Salt Lake City applied a compact fram with his A-P compression techniques in the "mini frame" design. Craig Heckathorne and Jack Uellendahl reported on frame technique in 1992 that allowed control motion for hybrid designs.<sup>1</sup> Used since the mid to late 90's, John Miguez wrote a paper in 2003 on the "micro-frame" that advocated stabilization for myoelectric control.<sup>3</sup> With common origins, Randy Alley developed the "X-frame" construction method that employed suprascapular compression to augment suspension.<sup>4</sup> In 2008 Farnsworth et al further modified the frame technique to utilize with remnant limbs or brachial plexus injury with an external cage and strut design.<sup>1</sup> Regardless of the interface strategy, they all seek the common interface goals and raise functionality. This is done by minimizing skin coverage by providing rigidity only where necessary. Working in-conjunction with the control method to index myosites and cable attachments.

With these basic goals in mind, the impression technique should seek to simulate the load and suspension areas required for optimal performance. Conventional interface design replicated the simple shape of the upper torso. Successive splinting panels were simply applied and smoothed to the shape of the limb. Although the characteristic limb shape may have been captured, the increased weight of the limb and the dynamic positioning caused a large amount of interface gapping when the prosthesis was created. Splinting techniques advocated by Andrew, Uellendahl, Miguelez, and Alley seek to simulate more localized loading that establishes greater stability in dynamic loading. Andrew advocated the A-P pressure from the subscapular area to the deltopectoral area found in his transhumeral technique. Miguelez recommended volumetric cast using splints sandwiched with cellophane and ace wrap to create compression about the thoracic area. Most methods use inferior thoracic outriggers to control lateral migration. At times these may cause impingement and are removed for greater comfort. One of the common errors is to begin the splinting process superior and work inferior with successive inferior splints. This results in the proximal superior wall gapping from the upper anatomy as the thoracic section is loaded. To correct this issue the thoracic splint can be placed and loaded until the splint becomes moderately rigid. The successive splints can then be added to the proximal area where the subscapular and the deltopectoral region may be further defined.

Often the shoulder joint is mounted in the axilla to eliminate additional M-L bulk. Although this does not approximate normal anatomic shoulder positioning, it is permitted since the shoulder is only periodically used for dressing and gross positioning.

#### I) Challenges

- ~Not many Amputees
- ~Not many prominences for indexing
- ~Greater Skin coverage
  - Too Hot
  - Encumbering
- ~Functional Scoliosis
  - Take Tracing
- ~Myo Placement
- ~Changing Load Area
  - Extension-Flexion
  - Control Operation
- ~Triaxial Loading
- ~Myo and Body Power
  - Myo's weigh more
  - Greater range with Body
- Power
  - Fewer Control Options
- ~Shoulder Placement
- ~Multiple Anatomical Presentations

#### II) Interface Goals

- ~Loading Comfort

- ~Relief for Prominences
- ~Structural Rigidity in ROM
- ~Allow Control Motion
- ~Easy Donning & Doffing
  - Repeatable

#### III) Socket Types

- ~Traditional Bulkhead
- ~Sauter Reinforced
- ~Alley X-Frame
- ~Miguelez-Microframe

#### IV) Impression Taking

- ~Cover Limb
- ~A-P Pressure
- ~Thoracic Loading
  - \*Push Both Sides
- ~Start Inferior; to Proximal
  - Otherwise will have

#### Gapping

- ~Suprascapular Area~Randy Alley
- ~Plaster & Ace Wrap Method
- ~Take Tracing

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12:20 pm / CS #2

### **RIDING A TRICYCLE WITHOUT ARMS**

*Lynn White, OTR/L, ATP; Natasha Casimir, MSPT;  
Shriners Hospitals for Children, Tampa, Florida*

Victor is a 9 year old male from Peru, diagnosed with bilateral upper extremity Amelia and right Proximal Focal Femoral Deficiency status post Symes amputation in May 2003. He also has a diagnosis of 42° scoliosis managed by a night TLSO as daytime use interfered with ambulation. He uses his left foot for functional skills such as feeding himself, writing and assisting with dressing and hygiene purposes.

In addition to his orthotic management, through the years Victor has also graduated through different prostheses and presently uses an above knee prosthesis with a four bar knee, a self suspending socket and a Seattle light foot. Because of his poor trunk control, scoliosis and lack of any upper extremity development he has not been considered a good candidate for upper extremity prostheses. For other mobility, he also independently propels a manual wheelchair with his left leg.

In therapy, treatment has concentrated on improving trunk control, gait patterns and addressing activities of daily living. One of his goals during his multiple admissions to our facility was to be able to ride a tricycle that he saw in the therapy department. Without arms our challenge was to come up with a low cost, transportable solution which would allow him to steer a tricycle safely.

The trials which led to the final product design which allowed Victor to ride independently as well as how this was implemented in his home environment will be shared.

12:30 pm / CCP #3

### **5-YEAR-OLD UNILATERAL SHOULDER DISARTICULATION**

*Nicole T. Soltys, CP; Rehabilitation Institute of Chicago, Chicago, IL*

The patient is a now 7-year-old child who sustained a Right shoulder disarticulation amputation secondary to high-voltage electrical injury at the age of 5, on 8/13/07. He is the youngest of three children and lives at home with both parents. In addition to amputation, he had extensive burns and scarring on his Left torso, axilla, hand, toes, and scalp. He underwent inpatient rehabilitation for wound management and therapies, focusing on range of motion, strengthening, balance, self-care, and psychological support for the patient and family. Prior to discharge, consultation was provided to the family regarding options and rationale for prosthetic fitting. Consultation was provided by several different individuals within the rehabilitation hospital, with differing points of view. The family was very supportive and realistic regarding prosthetic outcomes, and made the decision to proceed with fitting a unilateral shoulder disarticulation prosthesis once his wounds were sufficiently healed, beginning in December 2007. We will present the design and results of our fitting progression so far, opening the discussion: "Would you fit this child?" and "If so, what would you fit him with?"

2:00 pm / Workshop F

**IPSILATERAL SCAPULAR CUTANEOUS ANCHOR:  
APPLICATION IN CONSUMER USE**

*Latour, Debra, M.Ed., OTR/L*

*Shriners Hospitals for Children, Springfield, MA*

**Introduction:** Traditionally, a body-powered prosthesis is activated by a harness system, using the contralateral shoulder as the power source. Many users complain of discomfort from the harness in the axilla and at the O-ring, upper body asymmetry, pain in the contralateral shoulder, difficulty performing bilateral tasks and diminished cosmesis.

For these reasons, many individuals reject use of prostheses. Occupational therapists like me help clients develop skills to live with maximal independence and to improve their quality of life. I have invented an alternative method to capture body power without use of a traditional harness that may provide a solution to these complaints.

The Shriners Anchor system derives its primary source of control from the scapula on the same side of the limb deficiency. It requires a self-suspending socket and consists of a plastic patch attached to the body via medical grade adhesive. The cable interfaces with the patch via a metal button. The terminal device is operated by the ipsilateral shoulder. Because the harness is eliminated, the benefits have the technology have been reported to include more symmetrical bilateral upper extremity development, increased function, greater comfort and improved cosmesis. This technology is in patent-pending status with the US Patent Office.

The Anchor has been used in patient treatment since August 2006. Pediatric patients appear to derive benefit, satisfaction and improved function of their unilateral upper extremity prosthesis using this device.

**Method**

*Subjects:* Currently over 35 consumers; ages 3-21 years with congenital or acquired unilateral upper limb deficiency most with experience as active users of a body-powered prosthesis, with either a voluntary opening or voluntary closing terminal device have chosen to use the Anchor.

*Apparatus:* The Anchor attached to the scapula ipsilateral to the limb deficiency.

*Procedures:* Each patient is evaluated in a multi-disciplinary clinic; screening and interview conducted to identify candidates. Upon MD prescription, prosthetist fabricates a new prosthesis with a self-suspended socket. Prosthetist and occupational therapist fit patient with the Anchor. Prosthetic training is provided including application, use, skin hygiene and care of the technology. Baseline testing includes PSI, video-taped U-BET and clinical observations. The patient uses the Anchor for three months and returns for re-evaluation using the same tools.

*Data Analyses:* Data continues to be collected for a retrospective chart review including functional abilities and quality of life measures.

**Results:** Initial reports include ease in application, continued success with prosthetic use, increased use, improved cosmesis and patient/caregiver satisfaction.

**Discussion:** The Anchor features simplicity, durability, availability and affordability. The potential benefits may result in increased prosthetic wear and use including tolerance, frequency and spontaneity since it allows for improved comfort, cosmesis and intuitive movement during functional activity including bilateral tasks. It has been used with trans-humeral patients to operate elbow and terminal device mechanisms via a “double button” design. Implications for use may extend to a “hybrid” system and to dynamize a prosthesis. It is hoped that future studies will examine this potential.

**Conclusion:** This technology appears to enable individuals with unilateral upper extremity limb deficiency to achieve greater levels of functional independence and improved quality of life.

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**Objectives:**

The attendee will demonstrate understanding of:

1. benefits of the Ipsilateral Scapular Cutaneous Anchor (“Anchor”);
2. implications for use of the Anchor;
3. need for opportunity for choices and availability of technology to consumers;
4. ease of fitting and training;
5. implications of cosmesis and intuitive movement upon quality of life of the user.

2:00 pm / Paper #8

**LONG-TERM RETROSPECTIVE FUNCTIONAL OUT-COMES IN SMO DYNAMIC AFO WEAR IN MODERATE TO SEVERE CEREBRAL PALSY**

*Nancy M. Hylton , PT, LO; Children's Therapy Center of Kent, Kent, WA*

Children's Therapy Center of Kent and Dynamic Orthotic Systems have a 25+ year history with the use of ultra flexible, custom molded, supra-malleolar Dynamic AFOs with persons who have a range of severe to mild spasticity and tone control d. For this paper, we are most interested in sharing medium and long term out-comes in children with moderate to severe spasticity or hypertonus and Cerebral Palsy of all distributions.

We are collecting preliminary retrospective data via questionnaires from persons and their families who have worn this type of precise supra-malleolar orthoses for more than 5 year; some as long as 20 to 25 years. We are primarily interested in long-term functional out-comes of persons beginning this type of orthotic wear before the age of 3 years, including primary mode of mobility (including but not limited to free community ambulator, in house, assisted ambulatory, manual or power wheelchair mobility), any orthopedic or other surgical procedures which they have had during the period of wear, functional activities impacted by orthotic wear, perceived functional differences with orthoses on versus without, what the person likes about their orthoses, and what they dislike, and why do you continue to wear orthoses?

Few, long term retrospective studies have been done associated with functional out-comes and satisfaction/ dissatisfaction perimeters. Subjective input offered by families and disabled individuals has helped us to refine both the flexibility and intimate fit of these orthoses. The fact that these orthoses contain ankle foot movement around an active balancing and stability point while permitting 5-10 degrees of motion into both plantarflexion and dorsiflexion , seems to increase compliance and minimize disturbance of typical biomechanics during functional activities, especially, but not limited to up-right.

2:10 am / Paper #9

**A COMPARISON OF CONSTRAINT INDUCED MOVEMENT THERAPY TO  
INTENSIVE CONVENTIONAL THERAPY PROVIDED TO PEDIATRIC PATIENTS  
WITH HEMIPLEGIC CEREBRAL PALSY**

*Lynn White, OTR/L ATP; Alfred Hess, MD; Adrienne Karol, OTR; Pam Versage, PT; Natasha  
Casimir, MSPT; April Luedecke, MPT; Lisa Green, RN  
Shriners Hospitals for Children, Tampa, Florida*

The purpose of this prospective research study was to identify if Constraint Induced Movement Therapy (CIMT) resulted in greater improvements of hand and arm function as compared to intensive conventional therapy. Selected participants between age 5 and 12 were admitted to the hospital for 2 weeks and received treatment Monday through Friday. They were randomly placed in the CIMT group where the patient's non-affected arm and hand was constrained with a cast and provided intense therapy (4 hours per day for 10 days) or the intense therapy only group.

After completion of the inpatient phase each subject was retested then returned for post testing day at 6-months as an outpatient. The evaluation tools used included the Box and Block Test and the Shriners Hospital Upper Extremity Evaluation (SHUEE). Over the course of three years, 15 patients were enrolled, however, one was lost to follow up and data from five of the patients was corrupted. Descriptive analysis of the results of the nine who participated will be shared.

*2:30 pm / Symposium III*

**CEREBAL PALSY: PEDIATRIC TO ADULT TRANSITION**

**Laura Tosi, MD; Mindy Aisen, MD; Kevin Murphy, MD; Steven Koop, MD**

Most children born today with cerebral palsy (CP) will survive well into adulthood; in fact, their life span will closely track that of the general population. Unfortunately, this news, while heartening, poses new challenges for the health care community. Although CP is considered non-progressive, many adults with CP note the development of musculoskeletal and neurologic symptoms, such as severe pain, chronic fatigue, and a premature decline in mobility and function, as they age. This symposium will review the current knowledge on the medical and musculoskeletal complications of aging faced by adults with CP with an emphasis on musculoskeletal impairments. Particular emphasis will be paid to strategies to prevent or reduce the impact of these impairments. In addition the team will look at the challenges faced by individuals with cerebral palsy as they transition from pediatric to adult care.

8:00 am / Workshop G

## **ADVANCED THERAPEUTIC ORTHOTIC MANAGEMENT TECHNIQUES FOR THE CHILD WITH SPASTIC CEREBRAL PALSY**

*J. E. Brunstrom-Hernandez; K.M. Smith; A. Cavender; C. Dunn, PT*

*Dept. of Neurology, Pediatrics, Washington University School of Medicine, St. Louis, MO;*

*Pediatric Neurology Cerebral Palsy Center, St. Louis Children's Hospital, Orthotic and Prosthetic Lab, Inc, St. Louis, MO*

**Purpose:** To help participants understand the comprehensive approach to treating the child with Cerebral Palsy (CP) through the use of advanced therapeutic orthotic management in combination with existing comprehensive treatment plans including surgery, botulinum toxin A, casting and therapy.

**Target Audience:** This course is relevant to clinicians treating children with Cerebral Palsy

**Course Summary:** We will present the use of innovative dynamic orthoses (developed at the Pediatric Neurology CP Center under the leadership of Dr. Brunstrom-Hernandez) to complement the comprehensive management of the child with Cerebral Palsy. We will provide detailed information on how clinicians can use existing dynamic hinges and other orthoses to create unique bracing strategies to improve range of motion and optimize walking ability. Three scenarios for the use of dynamic orthoses will be discussed: 1) to increase ROM, 2) to allow increased mobility and efficiency during gait. 3) To help patients increase strength and endurance, and ultimately reduce their need for orthoses. We will discuss how dynamic orthoses complement other treatments (post surgical recovery, Botulinum Toxin therapy), and therapy interventions. Case studies will be presented to illustrate the potential benefits of a dynamic orthoses program. Differences in orthotic management from early childhood through adolescence will be highlighted.

### **Objectives:**

- 1) Differentiate between the different designs, capabilities and potential uses of various types of dynamic orthoses.
- 2) Demonstrate an understanding of how to develop and adapt an individualized management program for patients that includes the use of dynamic orthoses.
- 3) Learn to identify patients that could benefit from a dynamic orthosis' program.
- 4) Understand how dynamic orthoses can be used to enhance the benefits of other treatments (surgery and pharmacological interventions).

*Questions to Students for Course Feedback (3 to 4):*

- 1) How do measurements of R1 and R2 relate to dynamic orthotic management?
- 2) How can dynamic orthoses be used in conjunction with daytime ambulating orthoses to increase gait efficiency?
- 3) How do day and nighttime orthotic managements augment Botulinum injections?

8:00 am / CCP #4

**RIGHT PROXIMAL FEMORAL DEFICIENCY AND  
LEFT SIDED SPASTIC HEMIPLEGIA**

*Jorge Fabregas, MD; Brian Giavedoni CP, LP; Colleen Coulter-O'Berry PT, DPT, PhD, PCS  
Children's Healthcare of Atlanta, Atlanta, GA*

Patients who are diagnosed proximal femoral focal deficiency and spastic hemiplegia as independent entities encounter many obstacles throughout their life. What happens when that patient is afflicted with both?

In this case, the patient is an 18 year old male, with left spastic hemiplegia due to prematurity and a neglected right proximal femoral focal deficiency, Aiken C. Many questions are raised in his treatment. Is there a difference between treatments of child newly diagnosed with PFFD vs. a neglected teenager with the same diagnosis and classification? Is any surgical intervention warranted? Patient also complains of chronic knee pain in the left leg and back. Is any surgical intervention warranted for the left limb? Which limb would you address first?

The question of long term outcome is raised in reference to surgical intervention or observation and prosthetic fitting. Prosthetic options would require staging over the course of several surgical interventions. What are his prosthetic options?

We present a case of JP, his clinical presentation, treatment rationale and eventual outcome.

8:20 am / CCP #5

**CHALLENGING CASE: HIGH AK AMPUTATION COUPLED WITH SEVERE  
CONTRALATERAL SPASTIC HEMIPARESIS**

*Robin C. Crandall, MD; Shriners Hospitals for Children, Minneapolis, MN*

A 14 -year-old white male patient followed for 12 years at the Twin Cities Shrine will be presented. This patient has a high above knee amputation on the left side and a severe spastic hemiparesis involving the contralateral side. Ambulatory status continued to decline in spite of multiple procedures including osteotomies and Botox injections. Femoral and tibial derotation osteotomies were carried out at age 6. A progressive knee flexion contracture occurred resulting in primarily wheelchair use. Eventual open hamstring releases, coupled with 8 plate placement over the anterior femoral physis was carried out. This procedure was complicated by painful extremity. The patient's neuropraxia ultimately recovered and the patient is now ambulating with only minimal wheelchair use. Gait videos as well as complication discussion will be presented.

8:40 am / CCP #6

**IMPLEMENTATION OF A MODULAR LOWER EXTREMITY PROSTHESIS  
IN CONJUNCTION WITH EXTRNAL FIXATION TO OPTIMIZE STUMP  
ALIGNMENT AND FUNCTION.**

*Maureen Suhr, PT, DPT; Magdalena Oledzka, PT, MBA, PCS; Glenn Garrison, CPO;  
Daniel Green, MD; Hospital for Special Surgery, New York, NY*

Proximal Femoral Focal Deficiency (PFFD) is complex congenital orthopedic condition that continues to offer challenges in management from childhood through adulthood due to muscle imbalance, proximal and distal joint instabilities, rotational deformities, malalignment, and limb length discrepancies. Additionally, as described below, orthopedic management of PFFD is often complicated by other limb anomalies.

The patient is currently a 9 year-old girl born with bilateral PFFD, tibia hemimelia, bilateral hip dislocation, and left club foot. Shortly after birth, patient's right ankle was disarticulated and her fibula was fused to her significantly shortened femur on the right. The patient was fit with a prosthesis as she began pulling to stand and walking. The patient became an independent ambulator with bilateral lofstrand crutches. As the patient matured and her body mass increased and biomechanical alignment was altered, her fibula, the primary weight bearing surface in her stump, became increasingly angulated with a varus deformity.

Orthopedic surgeons collaborated with the patient and her family to discuss treatment options. Ultimately the decision was made to perform a fibular osteotomy with application of a Taylor Spatial Frame to improve the varus deformity.

In order to achieve weight bearing to promote healing and remodeling of the bone, and to optimize function, the surgeons consulted the orthotist to develop a modular prosthesis to attach to the external fixator and provide a weight bearing surface during ambulation. Following prosthetic application, the patient resumed outpatient physical therapy. Rehabilitation intervention included weight bearing activities, as well as proximal strengthening and flexibility exercises to promote optimal postural alignment in order to facilitate a stable and symmetrical gait pattern. Challenges to rehabilitation included the patient's bilateral hip dislocation, her pre-operative physical presentation with significant lumbar lordosis and proximal weakness, and her previous habitual gait compensations.

Ongoing study of the efficacy of external fixation combined with a prosthetic component to optimize stump alignment in a complicated pediatric patient with PFFD and absent tibia is being evaluated.

9:00 am / CS #3

## **THE USE OF CUSTOM LINER AND SHUTTLE LOCK IN A VAN NESS PROSTHESIS**

*James Kallen, CPO(c)*

*Precision Prosthetics/Orthotics Services Ltd, Red Deer, AB, Canada*

*Amputee Clinic Team, Alberta Children's Hospital*

The use of a prosthesis for a patient inflicted with PFFD in combination with a Van Ness procedure or rotational plasty has often provided valuable cosmetic and functional restoration of gait. The quality of gait depends on many factors most notably the classification of lesser to severe on the Aitken scale.

While cosmetically acceptable gait is generally reserved for the less severe it is the higher Aitken classification that yields diminishing results. Poor joint axis alignment and joint formation lead to complications with prosthetic alignment, stability, and in some cases suspension.

The use of a custom made Alpha Liner in conjunction with a Coyote Summit lock provided the necessary control and suspension for a type D Aitken classed patient to enjoy an active lifestyle. The use of the custom liner and lock allowed this teen to pursue a playing position in her complete high school volleyball team which would not have been enjoyed in an ischial weight bearing prosthesis typically sought out for her Aitken classification.

9:15 am / Paper #10

## **CRUCIATE LIGAMENT DYSPLASIA IN FIBULAR DEFICIENCY**

*Janet L. Walker, MD; Vishwas Talwalkar, MD; Robert Royalty, MD*

*University of Kentucky Department of Orthopaedic Surgery*

*Shriners Hospital for Children, Lexington Kentucky*

**Introduction:** Absence or hypoplasia of the cruciate ligaments is a common finding in fibular deficiency. While knee instability rarely requires surgical treatment, it may complicate limb lengthening or require additional accommodation in a prosthetic prescription. Manners, et al\* described radiographic assessment noting a diminished femoral notch with a classification based mainly on tibial spine development and found correlation with the cruciate ligament hypoplasia or absence on MRI. Type I dysplasia, with normal medial tibial spine and hypoplasia of the lateral spine, was associated with ACL hypoplasia and normal PCL. Type II dysplasia, with hypoplasia of the medial spine and absence of the lateral spine, was associated with ACL absence and PCL hypoplasia. Type III, with absence of both tibial spines, was found to have absence of both ACL and PCL. The purpose of this study was to determine the correlation of this classification of ligament dysplasia with the severity of the fibular deficiency and its growth disturbance of the distal femur.

**Methods:** Retrospective review of 53 patients 6 years or older with unilateral fibular deficiency and existing radiographs of both knees were reviewed. Notch views used by Manners, et al were not available. Severity of the fibular deficiency was determined using the Achterman and Kalamchi classification. The growth disturbance of the distal femur was assessed overall based on the ratio of the medial condyle height on the involved and uninvolved sides and also the lateral femoral hypoplasia of the involved side (ratio of involved lateral to medial condylar heights). Comparisons were analyzed using ANOVA and Chi square.

**Results:** Average age at radiograph was 12.7 years (6.3-27.7 years). Seventeen patients had Type I dysplasia, 22 had Type II dysplasia, and 9 had Type III. Three patients had normal tibial spine anatomy and 2 could not be classified as the lateral tibial spine was more developed than the medial one. These last 5 were excluded from further analysis. In the remaining 48 patients, no correlation of the Achterman and Kalamchi classification with the ligament classification was found. Eight patients had had hemi or complete epiphyseodesis of the distal femur and were excluded from the analysis of distal femoral growth disturbance. In the remaining 40 patients, there was no correlation of the ligament classification with the degree of lateral hypoplasia or the overall hypoplasia of the distal femur. Only 18 patients were skeletally mature. One patient, following 2 tibial lengthenings was considering ligament reconstruction for knee instability symptoms.

**Conclusions:** These data suggest that in fibular deficiency, the deficient development of the cruciate ligaments is not correlated with the severity of the deficient fibula or the distal femur. Using this classification in growing children may require a normal for comparison to determine tibial spine hypoplasia and it is difficult to apply under 6 years of age because of the later development of the lateral tibial spine.

**Reference:** Manners et al: J Bone Joint Surg 88:130-137, 2006.

9:25 am / Paper #11

**PRESERVATION OF THE NATIVE KNEE IN PATIENTS WITH MALIGNANT BONE TUMORS IN THE METAPHYSEAL AREA OF THE DISTAL FEMUR AND PROXIMAL TIBIA, USING MASSIVE ALLOGRAFTS**

*J. Ivan Krajbich, MD, FRCS(C); Kelly Alexander, RN*

**Goals:** Demonstrate the feasibility of preservation of the patient's native knee in malignant bone tumors about the knee as long as the epiphysis of the distal femur or proximal tibia respectively is free of tumor and can be preserved.

**Methods:** 14 patients who met the criteria of having malignant sarcoma in either distal femoral or proximal tibia metaphysis with no invasion into the epiphysis and underwent knee saving procedure using massive metaphyseal allograft were reviewed. There were 4 distal femur lesions and 10 proximal tibial lesions with 8 females and 6 males. All patients had at least a 2-year follow-up. Final outcome and complications were reviewed in all patients.

**Results:** Patients were alive and well at the time of the review. There were 3 infections necessitating allograft removal and local recurrence. There were allograft fractures which healed with fixation revision and bone graft. All patients with retained allograft regained at least 90 degrees of the knee range of motion. There were no significant long term complications, although several patients use a knee brace for sports activity.

**Conclusions:** Our study demonstrates good long term results of metaphyseal allograft replacement and knee preservation in pediatric age group treated for malignant bone tumors. Careful selection of patients to avoid local tumor recurrence is mandatory. Complication rates are about the same as for any other limb salvage group other than the fact that long term results are considerably better than the literature reported data for endoprosthetic replacement patients.

Attractive alternative to endoprosthetic replacement in the pediatric age group in a carefully selected group of patients.

10:15 am / Symposium V

**CHALLENGES AND SOLUTIONS IN TREATING THE ORTHOPEDIC NEEDS OF CHILDREN WITH OBESITY**

*Maureen Maciel, MD; Sandra Smith, MSPT; Janet Marshall, CPO; Jane Becker RD; Colleen Coulter Berry, DPT PCS; Brian Giavedoni CP, Pamela Patt, RD, CSP, LD, CNSD  
Shriners Hospitals for Children, Tampa, FL; Shriners Hospitals for Children, Chicago, IL; Children's Healthcare of Atlanta, Atlanta, GA; Shriners Hospital for Children, Chicago, IL*

Children with obesity commonly require treatment for orthopedic diseases as a result of being overweight such as Blounts disease. Reversely, several acquired or congenital diagnoses such as amputation, cerebral palsy, spina bifida or spinal cord injury put the child at high risk for increased weight gain. The clinic teams will share their experiences dealing with the needs of these patients as well as the interventions required to effectively treat them through case presentations and special programming available in their facilities and communities. A discussion with audience regarding the barriers to successfully change habits and how to positively influence this population will be led by the panel.

12:00 pm / CS #4

## **EXPLORING CULTURAL DIFFERENCES IN THE IRAQI LIMB-LOSS PATIENT**

*Kelly Alexander, RN; Sabrina Jakobson Huston, CPO  
Shriners Hospitals for Children, Portland, Oregon*

Providing prosthetics can be a challenge for providers of the limb-deficient patient, especially when the patient is of different ethnicity and culture. Patients with shoulder disarticulation or hip disarticulation present different fitting and rehabilitation concerns over distal limb deficiencies.

Decision making for the patient with a limb deficiency involves numerous factors. These may include cosmesis, durability, and functional goals of the patient and family. Labor and production costs may be a contributing factor, considering the average life expectancy of a prosthesis in the pediatric population is 12-15 months. Cultural factors become influential in the decision making process.

We present two cases for discussion. Both cases concern individuals who came from their native Iraq to the Portland Shriners Hospital for potential surgical and prosthetic treatment.

Case #1 is a teenage boy with a massive tumor in the upper arm. He was unable to obtain adequate surgical treatment in Iraq, resulting in a rather large, awkward, and heavy tumor and an effectively useless arm and hand. After undergoing forequarter amputation, he was fit with a simple foam "shoulder".

Case #2 is a young boy who is a victim of a US missile attack in Western Iraq. The shrapnel severed his bowels, leg, and most of his hip. He was ultimately fit with a custom, hemipelvectomy prosthesis.

We will discuss our decision making and creative solutions for these patients, which resulted in meeting the patients' goals while restoring both self confidence and psychosocial well being, all within a cultural context completely unique, yet appropriate, to these patients.

12:20 am / Symposium VII

## **APPLICATIONS OF EXTERNAL POWER TO PROSTHESES AND ORTHOSES**

*Robert D. Lipschutz, CP*

*Rehabilitation Institute of Chicago, Chicago, IL*

As technology advances, there has been an increase in the application of externally powered components in both Prosthetics and Orthotics. Historically; much of the focus of external power has been in the area of Upper-Limb Prosthetics. A re-invigorated interest using external power in prostheses and orthoses has brought about the advent of devices such as microprocessor controlled lower-limb prostheses, electro-mechanically assisted stance-control orthoses and non-invasive functional electrical stimulation. Improvements in reliability and miniaturization of micro-electronic technology have enabled these recent advancements to occur. This presentation will explore the past, present and possible future applications of external power to address the needs of individuals requiring prosthetic and orthotic services.

Objectives of this symposium are to describe powered prostheses and orthoses of the past and present with a focus on emerging technology and how it is currently being utilized by practitioners. Also, to stimulate the audience to think about how these and future devices can assist their patient population and how they can influence the direction in which these developments are headed.

*Poster #1*

### **THE INFLUENCE OF A FOOT ORTHOSIS ON THE FUNCTION OF A CHILD WITH DEVELOPMENTAL DELAY**

Deborah Ann George, PhD, PT, and Lindsay Elchert, MPT

Physical Therapy Program (D.A.G.), The University of Findlay; and Blanchard Valley Regional Health Center (L.E.), Findlay, Ohio

**Background and Purpose:** Foot orthoses may lead to improved function when used to control faulty foot biomechanics. The purpose of this case report was to describe the influence of modified stabilizing foot splints (SFSs) on the function of a child with developmental delay.

**Case Description:** The participant was a 19-month old girl with hypotonia and developmental delay due to hydrocephalus and congenital absence of the corpus callosum. Intervention: Modified SFSs were created with the child's feet held in a subtalar neutral position.

**Outcomes:** Five items from the Peabody Developmental Motor Scale II (rise to stand, standing, lowering, cruising, and stepping forward) were tracked over three weeks, under three conditions: with shoes and orthoses, shoes only, and barefoot. The ability to perform these items was improved when wearing shoes and orthoses.

**Conclusion:** The outcomes indicate that future study of the modified SFS as an intervention is warranted.

*Poster #2*

**SERIAL CASTING WITH ANTERIOR CUT-OUT TO INCREASE DORSIFLEXION ROM TO DYNAMIC AFO WEAR**

*Nancy M. Hylton , PT, LO  
Children's Therapy Center of Kent, Kent, Wa*

In our 30 year history using AFOs in children with C.P., a minimum of 90 degrees of ankle ROM dorsiflexion is needed for optimal Dynamic AFO fit. Occasionally, children with Cerebral Palsy, especially very active Hemiplegic or Diplegic patients, arrive for orthotic consultation with limited functional ankle dorsiflexion less than 90 with knee extended. This increased muscle tightness and functional shortening is most often associated with periods of rapid long bone growth in which muscle length is unable to adapt.

Active prolonged stretch is the typical mechanism which stimulates adaptive muscle growth in children as long-bone growth occurs. In children with Cerebral Palsy, the eccentric and isometric muscle contractions associated with active stretch appear to be more difficult than concentric muscle contractions, putting them at higher risk for decreased muscle growth adaptation.

Serial casting is an established therapeutic tool to assist functional muscle growth and soft tissue tension reduction associated with rapid long-bone growth in Cerebral Palsy. Our particular style of serial casting incorporates an anterior cut-out which permits an additional 5 to 10 degrees of weight-bearing dorsiflexion within the cast. Very precise use of ¼ inch thick casting felt, an inner soft cast compression layer followed by an outer more rigid fiberglass cast with anterior opening from approximately 3 inches above the ankle bend, permits excellent stabilizing and seating of the heel with protection of tibia, heel and malleoli during active dorsiflexion motion in the cast.

Children are encouraged use active weight-bearing and balance to strengthen the casted leg in more typical movement and weight-bearing strategies. This combination of active weight-bearing strategies and additional motion into dorsiflexion, which is available, appears to produce more rapid improvements in functional ROM and less post-casting weakness.

*Poster #3*

**MODERATE TO SEVERE SPASTIC DIPLEGIA COMPARISON OF 3 DIFFERENT DYNAMIC AFO STYLES**

*Nancy M. Hylton , PT, LO  
Children's Therapy Center of Kent, Kent, Wa*

CN is a 9 year old girl with moderate to severe spastic diplegia who has used supra-malleolar style ultra flexible Dynamic AFOs since she was 2 years old with excellent full daytime wear compliance to provide improved foot/ankle alignment, stability, balance, movement and tone control. She is an active posterior walker ambulator who attends 5<sup>th</sup> grade in a local elementary school. One year ago, her school therapist decided that she would be better served by a Dynamic AFO which blocked her strong bilateral equinus tendency. She was custom molded by our facility for a #3.5 style Dynamic AFO and appeared to have better control of her plantarflexion

spasticity at fitting with no subsequent fit concerns coming to our attention until recently when she was scheduled again for molding new Dynamic AFOs to replace those she had now out-grown.

When CN arrived at this appointment, it was learned that she had been very non-compliant in the wear of her DAFOs, even though her mother felt that her walking was better while wearing them. The head school therapist had also indicated to her mother that due to CN's complaints, she was permitted to go without any orthoses during school hours. Mother was instructed to have her wear the DAFOs at home, but CN was very resistant to this. When asked, CN indicated that it was "much harder for her walk" with this style of DAFO and they "made her walk too slow" to keep up with her friends at school. After discussion, she agreed that she would be compliant in wearing #4 style supra-malleolar DAFOs, as "these do not slow her down so much."

For our own information, Dynamic Orthotic Systems has also decided to make, at our cost, a second pair of Flexi-Sport Dynamic AFOs off the same molds. CN is willing to try wearing this style of DAFO, as well, to help us problem-solve orthotic choices for other children. The result of this case study will be presented.

*Poster #4*

### **CLEARANCE ADAPTATIONS IN CHILDREN WITH LIMB LOSS DURING EARLY WALKING**

Mark D. Geil, Colleen Coulter-O'Berry

Georgia State University, Children's Healthcare of Atlanta, Atlanta, GA

Young children with limb loss who require a prosthetic knee joint present a unique rehabilitation challenge to clinicians. Historically, clinical protocols have placed the goal of stability over the goal of neuromotor development. The most stable knee is one that is locked into full extension at all times. However, this stability comes with disadvantages. A fully extended knee is a substantial hindrance during crawling, walking, and age-appropriate functional activities. Nonetheless, standard practice does not provide children with a flexing knee joint until they reach four or five years of age (1-3). This is conventional wisdom has not been supported with biomechanical evidence but has remained unchallenged until recently.

The objective of this study was to follow recently conducted research on infants with unilateral limb loss crawling with locked and unlocked knees to determine the impact of the knee following the transition to walking. The study tested hypotheses that children with transfemoral limb loss will adopt one or more of three gait adaptations (circumduction, hip hiking, or vaulting) when the prosthetic knee is locked into full extension, and that the magnitude of the adaptations will decrease kinematically when the knee is unlocked.

Seven healthy children with unilateral transfemoral amputation or knee disarticulation ( $\leq 5$  years old) participated. Children were able to walk safely unassisted and had been fit with an articulating knee in their first prosthesis. Prior to data collection the parent/guardian provided consent for their child to participate in the approved study protocol. 15 eight-mm markers were attached to standard anatomical landmarks. Each participant completed three walking trials with

the normally flexing prosthetic knee, three with the knee mechanically locked into full extension, and three with the knee flexing again. Kinematics were recorded at 120 Hz using a 7-camera motion analysis system (ViconPeak, Englewood, CO). Trials were averaged for each participant and specific kinematic variables associated with each adaptation were compared between conditions using paired t-tests with an  $\alpha$ - level of 0.05.

In the locked knee condition, every subject exhibited one or more of the three analyzed accommodations. One subject exhibited the same accommodation in the unlocked condition, though the magnitude was decreased. The remaining six subjects showed none of the three analyzed clearance accommodations in the unlocked condition, although some other gait abnormalities were present, typically associated with hip flexion and extension necessary to articulate the prosthetic knee. All subjects flexed the prosthetic knee effectively in the unlocked condition.

The children in this study had been provided with an articulating knee joint in their first prosthesis, so the unlocked condition represents their developing gait pattern. The presence of acute accommodations in the locked condition and the general absence of any chronic clearance accommodations demonstrate the effectiveness of the “early knee” protocol in promoting more typical motor development.

**References:** 1) Cummings D, Kapp S. *J Prosth Orth.* 1992; 4(4): 196-206; 2) American Academy of Orthopedic Surgeons: Atlas of Limb Prosthetics: Surgical and Prosthetic Principles. CV Mosby, 1981; 3) Stanger M.; in Campbell SK, et al.(eds). Physical Therapy for Children. WB Saunders, 1994. pp 325-351.

*Poster #5*

### **THE ROLE OF A PROSTHETIC KNEE ON TEMPORAL AND SPATIAL PARAMETERS OF CRAWLING**

*Mark D. Geil, Colleen Coulter-O’Berry, Carolyn B. Heriza*

*Georgia State University, Children’s Healthcare of Atlanta, Rocky Mountain University of Health Professions; Atlanta, Georgia; Provo, Utah*

Children with limb loss at or above the knee face specific challenges at different stages of development. When transitioning from crawling to walking, and during the intermediate activity of pull-to-stand, a prosthesis must accomplish multiple and sometimes disparate goals: the mobility necessary for crawling and the stability necessary for standing and walking. This investigation tested the hypothesis that crawling mobility would be reduced when the traditional treatment protocol of a prosthesis lacking an articulating knee joint is followed.

Crawling pattern, velocity, and cadence were measured in five children with unilateral limb loss at the knee disarticulation or transfemoral level. Testing occurred within three weeks of the fitting of each child’s first prosthesis, which included an articulating knee. Two conditions were tested: prosthetic knee in its fully articulating state and prosthetic knee locked into extension. Each subject’s motion was captured at 120 Hz for the two crawling conditions using an 8-camera Peak Performance (ViconPeak, Englewood, CO) optical capture system with a 10-marker set using landmarks on the torso and legs. Cadence and velocity were measured for successful trials

as determined by completion of three successive crawling cycles without stopping along the 10 meter path. The start of the crawling cycle for each limb was identified by knee contact. Velocity was estimated based on the movement of any of the four torso markers (acromion or PSIS) along the anterior-posterior axis of the global coordinate system per unit time. Velocity and cadence were compared in each condition using paired two sample t-tests with significant differences based on an alpha level of 0.05. Additionally, each trial was observed to determine crawling pattern. Two patterns were possible: “step-to” crawling and “step-through” crawling, depending on whether the contralateral knee was advanced in front of the ipsilateral knee during crawling (step-through) or not.

The hypotheses were supported for both velocity and cadence. Across all subjects, average velocity in the unlocked condition was 0.327 m/s ( $\pm$  standard deviation 0.107 m/s), compared to an average velocity of  $0.235 \pm 0.124$  m/s in the locked condition. Average cadence across all subjects in the unlocked condition was  $127.30 \pm 41.05$  crawling steps per minute compared to average cadence of  $105.19 \pm 27.94$  crawling steps per minute in the locked condition. With one exception, the children exhibited a more typical “step-through” crawling pattern when the knee was unlocked and a less efficient “step-to” pattern when the knee was locked.

Despite the wide variability present in infant crawling patterns, the results of this study were consistent across subjects. Although subjects used different patterns to achieve crawling with a prosthesis and to accommodate to the locked knee condition, the locked knee slowed them down in every case. These data indicate that the traditional prescription protocol for children with transfemoral limb loss may inhibit crawling, which may in turn have long-term implications on motor development.

*Poster #6*

**ACCEPTANCE OF THE DYNAMIC MOVEMENT WRIST HAND ORTHOSIS IN HEMIPLEGIC CEREBRAL PALSY PATIENTS: A PILOT STUDY**

Kali Marquardt; James Wynne, CPO; Annette Correia, OT; Rayne Dingman, OT; Martin Matthews, M.Phil; DipORT; MBAPO

Children’s Hospital Boston, Boston, Massachusetts, USA

Dynamic Movement Orthosis (DMO) is a type of Dynamic Elastomeric Fabric Orthoses (DEFO). DMO’s are custom made to measurement orthoses fabricated from computer generated patterns of Spandex® material. This skin tight fitting material provides strong proprioceptive feedback. The DMO includes sections of Spandex® reinforcements oriented to provide corrective forces to the covered body segment. The DMO Wrist Hand Orthosis (WHO) has been utilized for treatment of patients with hemiplegic cerebral palsy. This device is typically designed to reduce tone, aid in wrist extension, and improve thumb positioning. The DMO WHO has been prescribed and fit in a pediatric cerebral palsy clinic for the last two years, necessitating a pilot Quality Assurance (QA) to review progress with this relatively new device. In addition, there is a paucity of research on indications for use, appropriate follow up protocol, outcomes, and patient satisfaction with the DMO WHO.

There are two aims in this study: 1) To complete a QA on DMO WHO orthotist charts; 2) To document trends in DMO WHO use including wearer profile, treatment plan, follow up schedule, and outcomes.

A retrospective review was conducted in a pediatric team oriented clinic. Twenty five randomly selected qualifying patients that were evaluated and fit from January 2008 to July 2009 were reviewed. A chart review, parent survey, and therapist survey were conducted. The chart review focused on wearer profile, treatment plan, follow up schedule, and common adjustments. Patient/ parent satisfaction, compliance, ability to don/doff, and changes in ADLs were assessed with a review parent survey. The occupational therapist survey focused on generalized therapist perception of device and noticeable changes in ROM, tone, and function.

Preliminary results from a chart audit demonstrate typical wearer profile, follow up schedule, and common adjustments made. Number of adjustments secondary to inaccurate measure decreased over time. Parent survey reported high parent and patient satisfaction. After initial weaning in period, patients report improvements in donning and acceptance. Therapists reported functional improvements and identified that orthosis as a therapeutic tool. Overall, preliminary results of the study showed that patients that are followed closely with occupational therapy and the orthotist report the most use of the device. In addition, functional goals identified during the initial evaluation were met.

Further investigation will provide an evidence based approach to DMO WHO treatment for this patient population. This, coupled with experience with the intervention, will assist with optimal design and establishment of reasonable functional goals. Results of this pilot study will direct future research into quantification of functional improvement with the device.