Association of Children's Prosthetic-Orthotic Clinics
Professionals helping kids be Kids

2014 Annual Meeting
March 5-8
Anaheim, California
Disney's Paradise Pier® Hotel

"Professionals Helping Kids be Kids"

ABSTRACTS

THURSDAY, March 6th Pacific Ballrooms C&D

7:00 – 8:00 AM	**CONTINENTAL BREAKFAST** in Pacific Ballrooms A&B
7:00 AM – 5:00 PM	**REGISTRATION**
8:00 AM – 5:10 PM	**SCIENTIFIC PROGRAM** in Pacific Ballrooms C&D
8:00 – 8:05 AM	**Welcome – *J. Ivan Krajbich, MD, President***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
8:05 – 8:15 AM	**Introduction of New Investigator Research Award Winner – *J. Ivan Krajbich, MD***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
8:15 – 9:15 AM	**SESSION I – LOWER LIMB ORTHOTICS & MOTION ANALYSIS** ***Moderator: Colleen P. Coulter, PT, PhD, DPT, PCS***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
8:15 – 8:25 AM Paper 1	Validation Of An Instrumented AFO To Collect Real-Time Ankle Moment Data During Gait: AFO Stiffness Objectively Prescribed **Michael S. Orendurff, PhD**: 3A (Orthocare Innovations), Toshiki Kobayashi, PhD: 3A (Orthocare Innovations), Kristie F. Bjornson, PT, PhD: (n), Stefania Fatone, PhD: 8 (Archives of Physical Medicine and Rehabilitation; Prosthetics Orthotics International); 9 (American Academy of Orthotists and Prosthetists; International Society for Prosthetics and Orthotics Australian National Member Society), Susan Sienko Thomas, MA, PhD(c): (n), Cathleen Buckon, OTR/L, MS: (n), Bo Foreman, PT, PhD: 3B (Orthocare Innovations), Madeline Singer, BA: 3B (Orthocare Innovations), Teri Rosenbaum-Chou, PhD: 3A (Orthocare Innovations), and Lucas Lincoln, MS: 3A (Orthocare Innovations)
8:25 – 8:35 AM Paper 2	The Affects Of Solid AFOS Versus Floor Reaction AFOS In Changing The Gait Pattern Of Children Diagnosed With CP **Hank White, PT, PhD**: (n), Juanita Jean Wallace, MS: (n), Samuel F. Augsburger, MS: (n), Janet L. Walker, MD: (n), and Henry J. Iwinski, MD: (n)
8:35 – 8:45 AM Paper 3	Comparison Of Dynamic (DAFO) Vs. Adjustable Dynamic Response (ADR) AFOS In Children With Cerebral Palsy Tishya A. L. Wren, PhD: 4 (Arthrocare); 5 (Ultraflex; National Institutes of Health (NIAMS & NICHD); 9 (Gait and Clinical Movement Analysis Society), James William Dryden, CPO: 3A (Orthopliance Group); 4 (Orthopliance Group), Nicole Mueske, MS: (n), Sandra W. Dennis, PT: 4 (Allergan, Inc.), Bitte S. Healy, PT: (n), and **Susan Ann Rethlefsen, PT, DPT**: (n)
8:45 – 8:55 AM Paper 4	Does Anterior Tibialis Tendon Transfer Weaken Ankle Strength? A Prospective Study **Hank White, PT, PhD**: (n), Juanita Jean Wallace, MS: (n), Samuel F. Augsburger, MS: (n), Janet L. Walker, MD: (n), and Henry J. Iwinski, MD: (n)
8:55 – 9:15 AM	Discussion
9:15 – 10:15 AM	Symposium I: Serial Casting For Long-Term Correction Of Equines Deformities **Brigid Driscoll, PT, CO**: (n) and Mary Weck, PT: (n)
10:15 – 11:00 AM	**BREAK** in Pacific Ballrooms A&B
11:00 AM – 12:00 PM	**SESSION II – LOWER LIMB ORTHOTICS** ***Moderator: Brian J. Giavedoni, MBA, CP, LP***: (n)

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11:00 – 11:10 AM Paper 5	Orthotic Management In Cerebral Palsy: Habitual Walking Activity **Kristie Bjornson, PT, PhD**: (n), Chuan Zhou, PhD: (n), Michael S. Orendurff, PhD: 3A (Orthocare Innovations), Richard D. Stevenson, MD: (n), and Dimitri Christakis, MD, MPH: (n)
11:10 – 11:20 AM Paper 6	Challenging Case Study: Are There Benefits To Bracing When Significant Plantar Flexion Contractures Are Present? Sandra W. Dennis, PT: 4 (Allergan, Inc.), James William Dryden, CPO: 3A (Orthopliance Group); 4 (Orthopliance Group), Susan Ann Rethlefsen, PT, DPT: (n), Nicole M. Mueske, MS: (n), Tishya A. L. Wren, PhD: 4 (Arthrocare); 5 (Ultraflex; National Institutes of Health (NIAMS & NICHD); 9 (Gait and Clinical Movement Analysis Society), and **Mark D. DeHarde**: 3A (Ultraflex Systems, Inc.); 4 (Ultraflex Systems. Inc.); 9 (OPERF)
11:20 – 11:30 AM Paper 7	Long-Term Use Of Neoprene Knee Extension Kos With Custom Moldable Low Temperature Thermoplast **Nancy M. Hylton, PT, CO**: (n)
11:30 – 11:45 AM Paper 8	Challenging Case: Protecting The Skin And Soft Tissues Part 1: Toddler Born With Klippel Trenaunay Weber Syndrome **Colleen P. Coulter, PT, PhD, DPT, PCS**: 9 (Association of Children's Prosthetic and Orthotic Clinics and Rebecca Hernandez, CPO/L: (n)
11:45 AM – 12:00 PM	Discussion
12:00 – 1:00 PM	**Presidential Speaker – Michael D. Sussman, MD**: 8 (Journal of Pediatric Orthopedics) Evidence based medicine: How did we get here, and how it can lead us astray
1:00 – 2:00 PM	**LUNCH** in Pacific Ballrooms A&B
2:00 – 4:00 PM	**Workshop** – Physician Guided Clinical Forum ***Moderator: J. Ivan Krajbich, MD****:* 9 (Association of Children's Prosthetic and Orthotic Clinics)
4:00 – 4:45 PM	**BREAK** in Pacific Ballrooms A&B
4:45 – 5:45 PM	**SESSION III – SURGICAL ENHANCEMENT** ***Moderator: Jorge A. Fabregas, MD****:* 3B (integra)
4:45 – 4:55 PM Paper 9	The Effect Of Systemic Administration Of Sclerostin Antibodies In A Mouse Model Of Limb Lengthening **Asim Mohammedanas Makhdom, MD**: (n), Dominique Lauzier: (n), and Reggie C. Hamdy, MD: 8 (BMC Musculoskeletal Disorders); 9 (Limb Lengthening Research Society)
4:55 – 5:15 PM Paper 10	The Accordion Maneuver And The Effects Of Compression Loading On Delayed Regenerate Bone Formation In Cases Of Limb Lengthening **Asim Mohammedanas Makhdom, MD**: (n), Adrian S. Cartaleanu, MD: (n), Juan Sebastian Rendon, MD: (n), Reggie C. Hamdy, MD: 8 (BMC Musculoskeletal Disorders); 9 (Limb Lengthening Research Society), and Isabelle Villemure, PhD: (n)

FRIDAY, March 7th Pacific Ballrooms C&D

7:00 – 8:00 AM	**CONTINENTAL BREAKFAST** in Pacific Ballrooms A&B
7:00 AM – 5:00 PM	**REGISTRATION**

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7:30 AM – 5:30 PM	**SCIENTIFIC PROGRAM** in Pacific Ballrooms C&D
7:30 – 8:15 AM	**SESSION IV - SPINA BIFIDA** ***Moderator: Colleen P. Coulter, PT, PhD, DPT, PCS***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
7:30 – 7:40 AM Paper 11	Case Study: 2 ½ Year-Old Girl With L-4, L-5 Spina Bifida Very Severely Inverted Feet/Ankles **Nancy M. Hylton, PT, CO**: (n)
7:40 – 7:50 AM Paper 12	Maximizing Ambulatory Potential In Spina Bifida **Samuel R. Rosenfeld, MD**: 2 (Zimmer; Zimmer Spine); 3B (MediCrea Spine; Zimmer; Zimmer Spine)
7:50 – 8:00 AM Paper 13	Transitioning Spina Bifida Patients From Pediatric Rehabilitation Goals To Adult Rehabilitation Purpose **Samuel R. Rosenfeld, MD**: 2 (Zimmer; Zimmer Spine); 3B (MediCrea Spine; Zimmer; Zimmer Spine)
8:00 – 8:15 AM	Discussion
8:15 – 9:15 AM	Symposium II: Reciprocating Gait Orthosis **Jeremy J. Crowell, BOCP, BOCO**: 3A (Hosmer), Fillauer Companies, Inc.
9:15 – 10:00 AM	**SESSION V – SPINE** ***Moderator: Colleen P. Coulter, PT, PhD, DPT, PCS***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
9:15 – 9:25 AM Paper 14	Dual Case Study: Implementing A Custom Cervical Extension Collar To Address Congenital Cervical Kyphosis And Cervical Flexion Trauma **Chelsey B. Anderson, CPO, LPO**: 3A (Boston Brace Int, NOPCO clinics)
9:25 – 9:35 AM Paper 15	The Management Of Neuropathic Scoliosis In Children **Martin J. A. Matthews, M.Phil**: 3A (DM Orthotics Ltd); 3B (DM Orthotics Ltd); 4 (DM Orthotics Ltd), Suzanna J. Blandford: 3A (Plymouth University), Prof. John Marsden: 3A (Plymouth University), and Jenny Freeman, BA, BS, MSc, PhD: 3A (Plymouth University)
9:35 – 9:45 AM Paper 16	Innovative Solution: 2 ½ Year-Old Girl With SMA Type1 Light-Weight CTLSO **Nancy M. Hylton, PT, CO**: (n)
9:45 – 10:00 AM	Discussion
10:00 – 10:45 AM	**BREAK** in Pacific Ballrooms A&B
10:45 – 11:15 AM	**SESSION VI – TRUNK** ***Moderator: Colleen P. Coulter, PT, PhD, DPT, PCS***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
10:45 – 10:55 AM Paper 17	Chest Wall Anomaly Clinic: A Multidisciplinary Approach **Gloria Thevasagayam, BSc, PT**: (n) and **Ian Finlay**: 3A (Action Ortho Santé)
10:55 – 11:05 AM Paper 18	“A New Look At Pediatric Orthotic Care" Pectus Carinatum Orthosis **Jackie Valdez, BSc.(Sports Medicine), ABC (CO)**: (n)
11:05 – 11:15 AM	Discussion
11:15 AM – 12:00 PM	**SESSION VII - MULTI-LIMB INVOLVEMENT** ***Moderator: Phoebe R. Scott-Wyard, DO***: 9 (Association of Children's Prosthetic and Orthotic Clinics)

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11:15 – 11:25 AM Paper 19	Management Of The Quadrimembral Limb-Deficient Patient In A Non-Clinical Setting **Zach Hughes, CP, LP**: (n) and **Sherry S. Romaine, PT, DPT**: (n)
11:25 – 11:35 AM Paper 20	Neural Network Changes During Increased Experience For Individuals With Amputations Vivian J. Yip, OTD, MA, OTR/L: (n), **Lisa Aziz-Zadeh, PhD**: (n), and Sook-Lei Liew, PhD, OTR/L: (n)
11:35 – 11:45 AM Paper 21	Functional Status Of Children With Upper And Lower Extremity Amputation **Gül Sener**: (n), Özlem Ülger, PT, PhD: (n), Semra Topuz, PT, PhD: (n), Kezban Bayramlar, PhD, PT: (n), and Fatih Erbahçeci: (n)
11:45 AM – 12:00 PM	Discussion
12:00 – 1:00 PM	Business Meeting Lunch (members only) in Pacific Ballrooms C&D
1:00 – 2:00 PM	**Hector Kay Lecture – Lori A. Karol, MD**: 7 (Journal of the American Academy of Orthopaedic Surgeons; Saunders/Mosby-Elsevier); 8 (Journal of the American Academy of Orthopaedic Surgeons); 9 (Pediatric Orthopaedic Society of North America) Bracing Adolescent Idiopathic Scoliosis: Where are We in 2014?
2:00 – 2:45 PM	**SESSION VIII – FUNCTION AND QUALITY OF LIFE** ***Moderator: Wendy L. Hill, BSc, OT***: (n)
2:00 – 2:10 PM Paper 22	To Determining The Functional Level In Amputee Children **Özlem Ülger, PT, PhD**: (n), Semra Topuz, PT, PhD: (n), Kezban Bayramlar, PhD, PT: (n), and Gül Sener: (n)
2:10 – 2:20 PM Paper 23	Quality Of Life Of The Children Receiving Education In A Special School For The Physically Disabled **Kezban Bayramlar, PhD, PT**: (n), Semra Topuz, PT, PhD: (n), Özlem Ülger, PT, PhD: (n), and Gül Sener: (n)
2:20 – 2:30 PM Paper 24	Quality Of Life Of The Parents Who Have Children With Limb Loss **Semra Topuz, PT, PhD**: (n)**,** Özlem Ulger, PT, PhD: (n), Kezban Bayramlar, PhD, PT: (n), and Gül Sener: (n)
2:30 – 2:45 PM	Discussion
2:45 – 3:30 PM	**BREAK** in Pacific Ballrooms A&B
3:30 – 4:30 PM	**SESSION IX – PROSTHETICS – GENERAL** ***Moderator: David B. Rotter, CPO***: 9 (Association of Children's Prosthetic and Orthotic Clinics)
3:30 – 3:40 PM Paper 25	Participation In Sports Of Dutch Children With Lower Limb Deficiencies **Anka Michielsen, MSc, PT**: (n) and Iris van Wijk, MD, PhD: (n)
3:40 – 3:50 PM Paper 26	Riding A Bike **Anka Michielsen, MSc, PT**: (n) and Iris van Wijk, MD, PhD: (n)
3:50 – 4:05 PM Paper 27	Challenging Case Presentation: Jayden's Too Short **Brian J. Giavedoni, MBA, CP, LP**: (n), Colleen P. Coulter, PT, DPT, PhD: 9 (Association of Children's Prosthetic and Orthotic Clinics), and Michael L. Schmitz, MD: 3B (Stryker); 9 (Pediatric Orthopaedic Society of North America)
4:05 – 4:15 PM Paper 28	Born Just Right **David B. Rotter, CPO**: 9 (Association of Children's Prosthetic and Orthotic Clinics), and Jen Lee Reeves: (n)

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4:15 – 4:30 PM	Discussion
4:30 – 5:30 PM	Symposium III: Using Sport And Physical Activity To Improve Holistic Wellness And Teach Life Skills **Aaron Moffett, PhD**: (n) and Mark Campbell, MS, LMT, ATC: (n)
5:30 PM	**Adjourn**

SATURDAY, March 8th Pacific Ballrooms C&D

7:00 – 8:00 AM	**CONTINENTAL BREAKFAST** in Pacific Ballrooms A&B
7:00 AM – 1:00 PM	**REGISTRATION**
8:00 AM – 12:30 PM	**SCIENTIFIC PROGRAM** in Pacific Ballrooms C&D
8:00 – 9:00 AM	**SESSION X – UPPER LIMB** ***Moderator: Bob Radocy, MS***: 3A (TRS Inc. (Therapeutic Recreation Systems, Inc.)); 4 (TRS Inc.); 6 (TRS Inc.); 9 (Association of Children's Prosthetic and Orthotic Clinics)
8:00 – 8:10 AM Paper 29	Evaluation Of The Use Of And Satisfaction With Adaptive Devices: A Good Alternative To Prostheses In Children With Congenital Upper Limb Deficiencies? **Iris van Wijk, MD, PhD**: (n)
8:10 – 8:20 AM Paper 30	Functioning With A Congenital Below The Elbow Deficiency: The Role Of Adaptive Devices **Iris van Wijk, MD, PhD**: (n)
8:20 – 8:30 AM Paper 31	Hand Orthoses For Complex Cases With New Technology **Michael Ceder, CPO**: (n)
8:30 – 8:40 AM Paper 32	Creative Solution: Team Approach For A Toddler With Oralmandibular Limb Hypogenesis **Vivian J. Yip, OTD, MA, OTR/L**: (n) and Mary Leighton, OTR/L: (n)
8:40 – 9:00 AM	Discussion
9:00 – 10:00 AM	**SESSION XI – MOTION ANALYSIS** ***Moderator: Janet G. Marshall, CPO***: (n)
9:00 – 9:10 AM Paper 33	Sagittal Ankle Moment Patterns For Youth Running And Walking In Prosthetic Feet: Data Drives Design **Michael S. Orendurff, PhD**: 3A (Orthocare Innovations), Lucas Lincoln, MS: 3A (Orthocare Innovations), Teri Rosenbaum-Chou, PhD: 3A (Orthocare Innovations), Adam Arabian, PhD: (n), Wayne Daly, CPO: 3A (Orthocare Innovations), David Hensley, CPO: 3A (Orthocare Innovations), Toshiki Kobayashi, PhD: 3A (Orthocare Innovations), Philip E. Gates, MD: (n), Justina S. Shipley, CO, BOCO, BOCP, MEd: 3C (Comfort Products; Fillauer Companies); 9 (Louisiana Association of Orthotists and Prosthetists; Orthotics and Prosthetics Activities Foundation), Susan R. Campbell, PhD: (n), David Moe, CPO: (n), Kristie Bjornson, PT, PhD: (n), Susan Sienko Thomas, MA, PhD(c): (n), Cathleen Buckon, OTR/L MS: (n), Sabrina Jakobson Huston, CPO: (n), Todd C. DeWees, BS, CPO: (n), Ann Kennedy, CPO: (n), Michael Suckoski, CPO: (n), and J. Ivan Krajbich, MD: 9 (Association of Children's Prosthetic and Orthotic Clinics)

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9:10 – 9:20 AM Paper 34	Stride-To-Stride Fluctuations Are Related Pre/Post Adaptation For An Appropriate Prosthesis **Shane R. Wurdeman, PhD, MSPO, CP**: (n), Adam L. Jacobsen, CPO: (n), Sara A. Myers, PhD: (n), and Nicholas Stergiou, PhD: 7 (HUMAN KINETICS); 8 (Physical Therapy Journal, Knee Surgery Sports Arthrology and Traumatology, Journal of Biomechanics)
9:20 – 9:30 AM Paper 35	Oxygen Consumption During Stress Testing In Pediatric Amputees **Kelly A. Jeans, MS**: (n), Chan-Hee Jo, PhD: (n), Don R. Cummings, CP, LP: 9 (American Academy of Orthotists and Prosthetists), and Lori A. Karol, MD: 7 (Journal of the American Academy of Orthopaedic Surgeons; Saunders/Mosby-Elsevier); 8 (Journal of the American Academy of Orthopaedic Surgeons); 9 (Pediatric Orthopaedic Society of North America)
9:30 – 9:45 AM Paper 36	Comparing Oxygen Consumption Between A Bilateral Trans-Femoral Amputee And Their Identical Twin: A Case Study. **Todd C. DeWees, BS, CPO**: (n) and Susan Sienko Thomas, MA, PhD(c): (n)
9:45 – 10:00 AM	Discussion
10:00 – 10:30 AM	**BREAK** in Pacific Ballrooms A&B
10:30 – 11:30 AM	Symposium IV: Neurofibromatosis: Surgical; Orthotic, Prosthetic, And Rehabilitation Management In Children Colleen P. Coulter, PT, DPT, PhD, 9 (Association of Children's Prosthetic and Orthotic Clinics), **Jorge A. Fabregas, MD**: 3B (integra), and Brian J. Giavedoni, MBA, CP, LP: (n)
11:30 AM – 12:30 PM	**SESSION XII – LOWER LIMB** ***Moderator: Owen A. Larson, CP***: (n)
11:30 – 11:45 AM Paper 37	Protecting The Skin Part 2: Respecting Incisions, Pin Sites, Skin Grafts, And Donor Sites In Patients Who Endure Multi-Trauma Resulting In Amputations **Colleen P. Coulter, PT, PhD, DPT, PCS**: 9 (Association of Children's Prosthetic and Orthotic Clinics), Brian J. Giavedoni, MBA, CP, LP: (n), Jorge A. Fabregas, MD: 3B (integra), Rebecca Hernandez, CPO/L: (n), and Michael L. Schmitz, MD: 3B (Stryker); 9 (Pediatric Orthopaedic Society of North America)
11:45 AM – 12:00 PM Paper 38	Orthotic Intervention Options For Limb Salvage Treatment Of Fibular Hemimelia **Justina S. Shipley, CO, MEd, FAAOP**: 3C (Comfort Products; Fillauer Companies); 9 (Louisiana Association of Orthotists and Prosthetists; Orthotics and Prosthetics Activities Foundation)
12:00 – 12:10 PM Paper 39	Creative Prosthetic Fitting For Unilateral Tibial Deficiency And Knee Flexion Contracture Without Surgical Correction **Phoebe R. Scott-Wyard, DO**: 9 (Association of Children's Prosthetic and Orthotic Clinics) and David M. Craft, CP: (n)
12:10 – 12:20 PM Paper 40	Pediatric Partial Foot Prostheses: A New Treatment Option? **Pamela K. Hale, CPO**: 3A (Allard USA)
12:20 – 12:30 PM	Discussion
12:30 PM	**Adjourn**

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POSTERS
Located in Pacific Ballroom (Foyer)

Poster #1
Pediatric Partial Foot Prostheses: Utilizing A Custom Fit Dynamic Carbon Composite Prosthesis
Pamela K. Hale, CPO: 3A (Allard USA)

Poster #2
Unique Lower Extremity Orthotic Interventions For Children With Arthrogryposis: A Single Case Overview
Justina S. Shipley, CO, MEd, FAAOP: 3C (Comfort Products; Fillauer Companies); 9 (Louisiana Association of Orthotists and Prosthetists; Orthotics and Prosthetics Activities Foundation)

NEW THIS YEAR - The 2014 Annual Meeting evaluation is on-line ONLY. *Completion is required to obtain your Certificate of Attendance.* Access the survey at **https://www.surveymonkey.com/s/2014ACPOCAM** ***Directions on completing the survey*****:** You can go back to previous pages in the survey and update existing responses until the survey is finished or until you have exited. If you do not complete the survey before exiting, you will not see your previous answers, but you will be able to complete the survey. Your IP address is stored in the survey results to verify you have completed the survey. Once you have answered all the questions, you will be directed to the certificate of attendance. Please complete the survey as soon as possible. Your feedback is important and is considered in planning future educational events.
Please complete the online survey at by Friday, April 12, 2014.

Disclosure Statement
The presenting authors on papers and posters are printed in boldface. All authors are required to fill out and sign a financial disclosure statement disclosing whether or not he or she has received something of from a commercial company or institution, which related directly or indirectly to the subject of their presentation. The American Academy of Orthopaedic Surgeons has identified the options to disclose as follows:

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ACPOC does not view the existence of these disclosed interests or commitments as necessarily implying bias or decreasing the value of the author(s) participation in the course.

An indication of the participants' disclosures appear in parentheses after each individual name, in the program schedule, as well as the name of institution or company that provided the support.

The Program Committee has disclosed the following:
Robert D. Lipschutz, CP, Chair: (n); Submitted on: 05/22/2013; Jorge A. Fabregas, MD: 3B (integra); Submitted on: 11/05/2013 , J. Ivan Krajbich, MD: 9 (Association of Children's Prosthetic and Orthotic Clinics); Submitted on: 10/16/2013; Kristine K. Nolin, CPO (n); Submitted on: 1/29/14, Nicole T. Soltys, CP (n); Submitted on 2/3/14, and Hank White, PT, PhD (n); Submitted on: 09/30/2013

The ACPOC Staff has disclosed the following:
Angela Schnepf, MBA (Rosemont, IL): (n), Susan Shannon (Rosemont, IL): (n), Elizabeth Frale (Rosemont, IL): (n)

SESSION I – LOWER LIMB ORTHOTICS & MOTION ANALYSIS

THURSDAY, March 6th
8:15–8:25 AM
Paper 1

VALIDATION OF AN INSTRUMENTED AFO TO COLLECT REAL-TIME ANKLE MOMENT DATA DURING GAIT: AFO STIFFNESS OBJECTIVELY PRESCRIBED

Michael S. Orendurff, PhD, Toshiki Kobayashi, PhD, Kristie F. Bjornson, PT, PhD, Stefania Fatone, PhD, Susan Sienko Thomas, MA, PhD(c), Cathleen Buckon, OTR/L, MS, Bo Foreman, PT, PhD, Madeline Singer, BA, Teri Rosenbaum-Chou, PhD, and Lucas Lincoln, MS
Orthocare Innovations, Mountlake Terrace, WA; Seattle Children's Research Institute, Seattle, WA; Northwestern University, Chicago, IL; Shriners Hospital for Children, Portland, OR; University of Utah, Salt Lake City, UT

Current clinical practice for choosing the best ankle-foot orthosis (AFO) for children is an inexact process. Even with a gait laboratory, determining the effect of a specific orthotic prescription for children with cerebral palsy is complicated and time consuming. Adjustments to the AFO require addition gait lab testing for evidence of improvement. The goal of this project is to create an instrumented AFO that would adjust stiffness and initial angle until the ankle moment generated by the child during gait was as close to normal as possible. The parameters generated using an instrumented AFO could then be used to craft an optimal AFO for the child.

In this NIH-funded, IRB approved project, an instrumented AFO has been created to measure the sagittal moment generated during gait. The design can partition the total sagittal ankle moment into the contribution from the human ankle joint and the AFO itself. The instrumented AFO streams the moment data by Bluetooth to an iPad for the orthotists to observe. The system calculates optimal AFO stiffness by evaluating the sagittal ankle moment curve across stance phase, and achieves a near normal ankle moment by adjusting the resistance to bending the AFO. The purpose of this study was to validate the sagittal ankle moment derived from the instrumented AFO against the sagittal ankle moment from a computerized gait analysis system.

The instrumented AFO was validated against the ankle moment calculated from an 8-camera Vicon system and a Bertec instrumented treadmill. Three participants walked on the treadmill and the normalized root-mean square (nRMS) and Spearman's rho for the inverse dynamics sagittal ankle moment versus the instrument AFO sagittal ankle moment were calculated.

Participant	nRMS (%)	Spearman's rho
A	8.7 ± 0.7	0.83 ± 0.03
B	8.1 ± 0.2	0.90 ± 0.01
C	6.4 ± 1.1	0.88 ± 0.02

Validation data for the instrumented AFO shows excellent agreement with computerized gait analysis data. The instrumented AFO can collect 40 steps in under 2 minutes, and provide objective stiffness and initial angle data during gait.

The orthotist can craft a definitive polypropylene AFO to the stiffness and initial angle that optimized the child's sagittal ankle moment during gait.

This work was supported by NIH grant 2R44HD069095-02.

THURSDAY, March 6th
8:25-8:35 AM
Paper 2

THE AFFECTS OF SOLID AFOS VERSUS FLOOR REACTION AFOS IN CHANGING THE GAIT PATTERN OF CHILDREN DIAGNOSED WITH CP

Hank White, PT, PhD[a], Juanita Jean Wallace, MS[a], Samuel F. Augsburger, MS[a], Janet L. Walker, MD[a, b], and Henry J. Iwinski, MD[a, b]
[a] Shriners Hospitals for Children, Lexington, KY
[b] University of Kentucky Department of Orthopaedic Surgery, Lexington, KY

Children diagnosed with cerebral palsy (CP) often have muscle imbalances due to decreased motor control, muscle contracture and/or spasticity which often results in gait and balance problems(1). An ankle foot orthosis is designed to correct and/or prevent deformity, provide base of support, and improve efficiency in gait (2). Clinicians can often have differing opinions regarding which orthosis to use to improve the gait of children diagnosed with CP. A solid ankle foot orthosis (SAFO) is designed to rigidly fix the ankle in neutral dorsiflexion to control ankle dorsiflexion throughout the gait cycle and may control knee hyper-extension during stance. The Floor reaction AFO (FrAFO) is also designed to rigidly fix the ankle in neutral, to prevent excessive ankle dorsiflexion, as well as, associated excessive knee flexion during stance. Both AFO types control ankle motions by applying points of pressure at the same regions of the shank and foot.

We performed a retrospective study of children diagnosed with CP spastic diplegia who underwent a three-dimensional motion analysis study while walking barefoot and wearing their clinically prescribed AFOs on the same day. To date, this is the first study to compare the effects of SAFOs and FrAFOs for children diagnosed with CP. Children wearing bilateral FrAFOs were first identified and then matched with children who wore SAFOs based on the following criteria: age, GMFCS level, reported ambulatory distance, assistive device and magnitude of stance phase knee flexion when walking barefoot. Ten subjects were identified for each group. Using SPSS software an independent sample t-test was performed. There were no statistical differences between groups for age, height, weight, BMI, GMFCS, or barefoot temporal spatial data. Both groups wore bilateral AFOs, therefore statistical analyses regarding gait parameters were performed on both limbs, resulting in 20 limbs for each group. Despite controlling for maximal knee flexion in stance limbs that were prescribed FrAFOs had more knee flexion at initial contact (52-degrees vs. 43 degrees, $p<.05$) and more ankle dorsiflexion at mid-stance (15-degrees vs. 0.4-degrees, $p<.01$) when walking barefoot.

Since the two groups demonstrated different magnitudes of stance phase knee flexion and ankle dorsiflexion, we compared the change in each group's gait pattern from the barefoot walking trial to the braced walking trial to determine the magnitude of change between brace types. There was a significant difference in the change in knee flexion at initial contact (SAFO -0.3 degrees versus FrAFO -4.6 degrees, $p<0.05$); however there was not a significant change in knee flexion at mid stance (SAFO -2.8 degrees versus FrAFO -3.2 degrees). There was a significantly different change in ankle motions at initial contact (SAFO 8.9 degrees versus FrAFO -0.7 degrees $p<.05$), and a significant difference in change in ankle motion at mid-stance (SAFO +9.5 degrees, versus FrAFO -3.4 degrees $p<.05$). Because the location for the application of forces is similar for both orthosis, the results should not be that surprising. However, the results should make clinicians ask if it is worth spending the additional resources to make the FrAFO.

References:

1. Davids, J. Rowan, F. Davis, R. Indications for Orthosis to Improve Gait in Children with Cerebral Palsy. J. Am Acad Orthop Surg. 2007; 15: 178-188.
2. Morris, C. Orthotic Management of Children with Cerebral Palsy. J Pros Orth. 2002; 14(4): 150-158.

THURSDAY, March 6th
8:35-8:45 AM
Paper 3

COMPARISON OF DYNAMIC (DAFO) VS. ADJUSTABLE DYNAMIC RESPONSE (ADR) AFOS IN CHILDREN WITH CEREBRAL PALSY

Tishya A. L. Wren, PhD, James W. Dryden, CPO, Nicole M. Mueske, MS, Sandra W. Dennis, PT, Bitte S. Healy, PT, and **Susan A. Rethlefsen, PT, DPT**
Children's Hospital Los Angeles, Los Angeles, CA

Introduction:

Ankle-foot orthoses (AFOs) are commonly used to improve gait in children with cerebral palsy (CP). However, there are many different types of AFOs that can be prescribed and little evidence to guide orthosis selection for individual patients. The purpose of this study was to compare two different styles of AFOs in children with CP and crouch and/or equinus gait. The styles of bracing examined were Cascade dynamic (DAFO) AFOs and Ultraflex adjustable dynamic response (ADR) AFOs with variable stiffness tuned by the orthotist.

Methods:

10 children with CP (age 4-12 years; 6 GMFCS I, 4 GMFCS III) were fit with both DAFO and ADR. AFOs (5 unilateral, 5 bilateral). They wore each brace for 4 weeks in randomized order. Activity while wearing the braces was assessed during the wear period using Stepwatch Activity Monitors. Instrumented gait analysis, standing balance (center of pressure motion while standing on force plate), and patient-reported outcomes (OPUS questionnaires) were assessed at the end of each wear period. Outcomes were compared between braces and between braced and barefoot using paired t-tests.

Results:

Children took longer steps when wearing both types of orthoses compared with walking barefoot (5-6 cm difference, $p<0.01$), with a trend towards decreased cadence and increased velocity. Temporo-spatial parameters did not differ significantly between the two brace types. Both braces restricted plantarflexion in stance and swing compared with barefoot (2-15° difference, $p\leq0.03$), but plantarflexion was limited significantly more in the DAFOs (>8° difference, $p\leq0.02$). Hip extension in stance was improved in braces compared with barefoot (2-4° difference, $p\leq0.002$) with no difference between the two brace types. Knee extension in stance was better in ADR compared with DAFO orthoses (5° difference, $p=0.006$). Push-off power was significantly reduced in both AFOs (0.4-0.6 W/kg difference, $p\leq0.03$), but was significantly higher in ADR compared with DAFO AFOs (0.3 ± 0.2 W/kg difference, $p=0.04$). There were no significant effects of bracing or type of brace on gait asymmetry or standing balance. Patient satisfaction with the orthoses was significantly higher for the DAFOs (9.2 ± 6.7 point difference in OPUS device satisfaction, $p = 0.002$), and patients recorded more steps per day in the DAFOs (difference 798 ± 1138 steps/day, $p=0.05$).

Conclusions:

Kinematic and kinetic outcomes were better in the ADR AFO because it resists, but does not block, plantarflexion allowing for greater knee extension in stance and greater push off power. However, patient satisfaction and activity were higher for the DAFOs due to lower weight and better comfort, fit, cosmesis, and ease of use.

Acknowledgements:

Support for this study was provided by a research contract from Ultraflex Systems, Inc.

THURSDAY, March 6th
8:45-8:55 AM
Paper 4

DOES ANTERIOR TIBIALIS TENDON TRANSFER WEAKEN ANKLE STRENGTH? A PROSPECTIVE STUDY

Hank White, PT, PhD[a], Juanita Jean Wallace, MS[a], Samuel F. Augsburger, MS[a], Janet L. Walker, MD[a, b], and Henry J. Iwinski, MD[a, b]
[a] Shriners Hospitals for Children, Lexington, KY
[b] University of Kentucky Department of Orthopaedic Surgery, Lexington, KY

Since the introduction of the Ponseti method the treatment of clubfoot deformity has changed. Despite the effectiveness Ponseti treatment followed by abduction orthosis, a certain percentage of children experience reoccurrence of the clubfoot deformity. Therefore, despite orthotic intervention, the over pull of the anterior tibialis results in recurrent clubfoot deformity. The surgical technique to correct the recurrent deformity is the anterior tibialis tendon transfer. The insertion of the anterior tibialis tendon is moved from the first cuniform to the third cuniform. The purpose of the surgery is to balance the pull of the anterior tibialis to more a pure dorsiflexion motion, rather than typical dorsiflexion and inversion. From the literature, upper extremity surgery of the hand and fingers reports subjects will lose one grade of muscle strength after a tendon transfer. To date, it is also thought that transferring a foot/ankle muscle would result in a decrease in strength. Therefore, we performed this prospective study to assess the changes in ankle muscular strength in children with clubfoot deformity after undergoing an anterior tibialis tendon transfer for reoccurring deformity.

Data from twenty one subjects (14 male; 7 males) for a total of 30 involved limbs and 12 uninvolved limbs are presented. Mean age 3 years & 11months (range 2yrs 7 months to 7 years 4 months) at first visit. Mean time from first visit to surgery is one month (range same day of surgery to 5 months). Mean time to post-surgical assessment 7 months (range 5 to 12 months). Patient's ankle musculature strength was assessed using a hand held dynamometer. Three trials were performed for each action (ankle dorsiflexion, plantar flexion, inversion and eversion). Due to the young age of subjects, the maximum value of the three trials was used for statistical analysis.

Involved limbs demonstrated statistically significant increases in ankle dorsiflexors strength (10.6 to 12.5 lbs.) ($p<0.01$) and ankle plantar flexor strength (from 23.4 to 28.9 lbs.). A non-statistically significant increase in involved limb ankle inverter and everter strength was also noted. For the involved limbs, a positive correlation between change in dorsiflexors strength and time to follow up visit was noted ($r =0.6$).Uninvolved limbs demonstrated a statistically significant increase in inversion strength (11.1 to 15.6 lbs., $p<0.001$). Uninvolved limbs also demonstrated non-statistically significant increases in ankle plantar flexion, dorsiflexion and eversion. The involved limbs demonstrated weakness of all ankle musculature compared to the uninvolved limbs before surgical intervention. However, only the ankle dorsiflexors were statistically weaker (10.6 versus 14.0 lbs., $p<0.05$). Six months after surgical interventions, The involved limbs demonstrated weakness of all ankle musculature compared to the uninvolved limbs. However, only the ankle everters were statistically weaker (10.3 versus 16.0 lbs., $p<0.05$)

Results of this study are contradictory to the hypothesis that a muscle tendon transfer results in a decrease in strength for children with clubfoot deformity. Instead, the involved limbs undergoing anterior tibialis tendon transfers demonstrate a statistical increase in strength measured with a hand held dynamometer.

THURSDAY, March 6th
9:15-10:15 AM
Symposium I

Symposium I - SERIAL CASTING FOR LONG-TERM CORRECTION OF EQUINES DEFORMITIES

Brigid Driscoll, PT, CO and **Mary Weck, PT**
Ann&Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

The goal of this presentation is to teach participants about a comprehensive program that includes serial casting, physical therapy that focuses on strengthening and the correction of center of mass, and orthotic management for day and night in order to achieve long term correction of equines deformities.

Learning Objectives:

Upon completion of this educational activity you can incorporate the following into your practice of medicine:

1. Complete a comprehensive serial casting evaluation on a child with cerebral palsy, idiopathic toe walking, or clubfoot that includes range of motion, manual muscle testing, and a gait or weight-bearing evaluation.
2. You will have the knowledge to properly align the foot and ankle in relation to the lower extremity, taking into consideration triplanar involvement while correcting an equines deformity.
3. Comprehension of a home exercise program correcting thoracic alignment over the pelvis with the weight line through the calcaneus for correction of pre-existing standing or gait patterns for long-term correction of the equines.
4. Appropriate orthotic recommendations post serial casting for continued gait or standing training and management of the equines deformity.

This lecture presents thorough instruction and a strong rationale for the use of serial casting in the rehabilitation field. The course begins with discussion of retrospective global failures in serial casting that segways into a detailed lecture about the development of an all-encompassing serial casting program. Rationale and casting at R1 knee extended dorsiflexion is explained, emphasizing the implications and significance of range of motion at the talocrural joint and its effect on the midfoot. There is detailed instruction of custom molded plaster casts in all planes of the foot and ankle while separately addressing the hindfoot, midfoot, and forefoot and their relationship to the proximal lower extremity. A clinical gait assessment tool is presented and describes the impact of alignment on overall gait and the equines deformity. The explanation of center of mass over the base of support is explained, along with a discussion of the development of normal gait. Comparisons are made between normal gait, gait in cerebral palsy, and gait in idiopathic toe walking. Explanations are presented regarding the necessary muscle activation for gait, development of gait skills towards independent ambulation, and continued gait progression once steps are achieved. Instruction is provided regarding physical therapy intervention for strengthening, center of mass correction, and gait as part of a daily home program. Participants are instructed in day and night orthotic management for children post serial casting. Rationale of orthotic management is discussed in addition to fine tuning of AFOs. The serial casting follow-up maintenance program is also described. Case studies of casting participants are incorporated throughout the lecture. The course concludes with results from formal IRB approved research of our serial casting program.

SESSION II – LOWER LIMB ORTHOTICS

THURSDAY, March 6th
11:00 -11:10 AM
Paper 5

ORTHOTIC MANAGEMENT IN CEREBRAL PALSY: HABITUAL WALKING ACTIVITY

Kristie Bjornson, PT, PhD, Chuan Zhou, PhD, Richard D. Stevenson, MD, Dimitri Christakis, MD, MPH, and Michael S. Orendurff, PhD
Seattle Children's Research Institute; University of Washington, Seattle WA;
University of Virginia, Charlottesville, VA; Orthocare Innovations, Mountlake Terrace, WA

The influence of ankle foot orthoses (AFO) on walking in cerebral palsy (CP) has been studied extensively in the gait lab, yet there are limited data to date on the influence of AFOs on levels of habitual community walking. This pilot feasibility study examines the influence of various AFO's on daily walking performance in children with cerebral palsy (CP) in both laboratory and community settings.

A randomized cross-over single subject design was employed with a convenience sample, recruited from regional pediatric hospital, of 11 children with CP, bilateral involvement, Gross Motor Function Classification System levels I = 1, II =9, and III = 1; average age 4.3 (3.0 to 6.0) years. Five children presented with true equinus, 2 jump gait and 4 crouch gait patterns. Current AFO were: hinged AFO (n= 3), solid AFO (SAFO, n= 4), non-articulated AFO with 90 degree plantarflexion stop free dorsiflexion (n=3) and a supramalleolar AFO (SMAFO, n=1). Two SAFOs were wedged to incline the shank to vertical angle (SVA) at midstance with one point loading rocker footwear modification. Participants were randomized to 2 weeks with or without their current AFO/footwear followed by a 2 week cross over to the other condition. Walking activity was sampled with the StepWatch (SW) accelerometer (5 days) through average total strides/day, percent daytime hours walking, number of strides > 30 strides/min, peak activity index and stride activity curves. A Mann-Whitney U test was employed for group analysis with intra-subject visual analysis for > one standard deviation (SD) from mean AFO with/without condition differences.

Midstance SVA ranged from -3 (reclined) to +24 degrees (inclined) with AFOs on. Group comparison between conditions documented no significant differences in walking, amount, intensity ($p = .56$-$.90$) or across stride rates (Fig. 1). Within subject comparison documented increased daily total strides/day for two subjects and four participants with increased percent time walking with AFOs. Number of strides at > 30 strides/min and a peak activity index increased > one SD with AFO ON condition two participants. These same 2 participants had positive changes for all StepWatch outcomes while wearing AFO. Range of change was: 1585 - 2337 total strides/day; 9 - 21% time walking; 1030-1373 for strides > 30 stride/min; 7 - 8 strides/min peak activity index; and higher stride activity across all stride rates (Fig. 2 & 3). At GMFCS level II, they had true equinus and jump gait patterns and wore SAFO with an average SVA of 9 degrees inclined at midstance.

Our results suggest that the majority of this sample were not wearing AFO/footwear prescriptions which enhance both walking activity levels and intensity in the community. SW monitoring has potential to inform AFO/footwear prescription to optimize community walking. Further work is needed to examine optimal orthoses relative to gait pattern and the influence of shank inclination and footwear modifications on community walking in CP.

This work was supported by funding from NIH K23 HD060764

Figure 1.

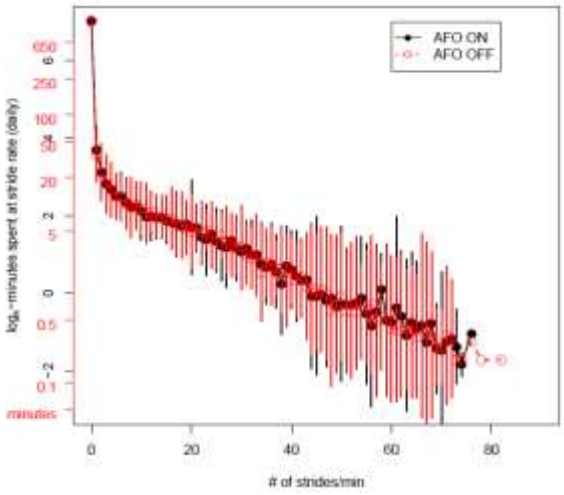


Figure 2.

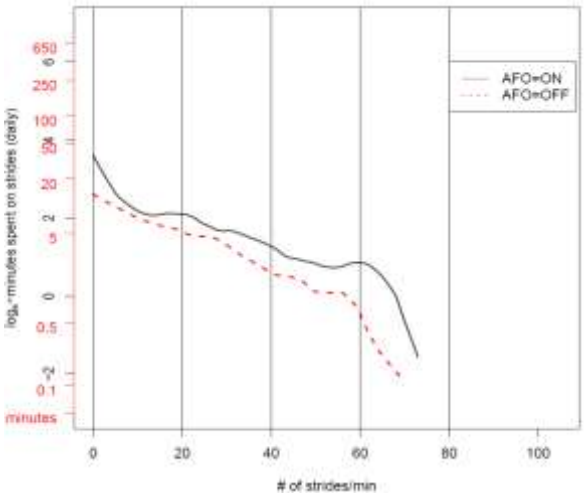
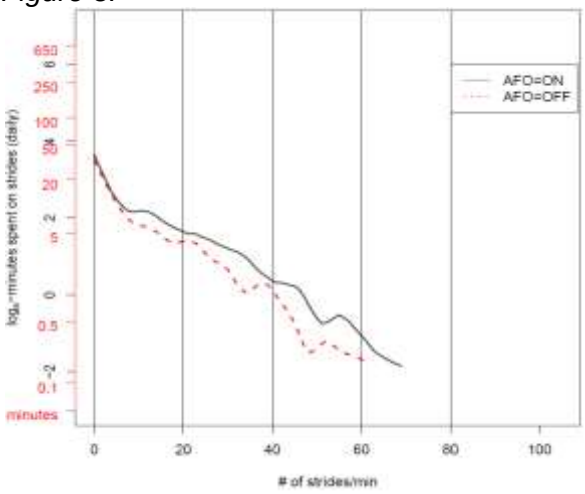


Figure 3.



CHALLENGING CASE STUDY: ARE THERE BENEFITS TO BRACING WHEN SIGNIFICANT PLANTAR FLEXION CONTRACTURES ARE PRESENT?

Sandra W. Dennis, PT[2], **Mark D. DeHarde**[1], James W. Dryden, CPO[2], Susan A. Rethlefsen, PT, DPT[2], Nicole M. Mueske, MS[2], and Tishya A.L. Wren, PhD[2]
[1]Ultraflex Systems, Inc., Pottstown, PA
[2]Children's Hospital Los Angeles, Los Angeles, CA

THE PROBLEM:

JE is a 13 year old male diagnosed with cerebral palsy, diplegia. He functions at a GMFCS level 1. He has had lower extremity surgery five times since 2005 including multiple tendon lengthenings bilaterally (tendo-Achilles, posterior tibialis and hamstrings) and a split anterior tendon transfer on the left. He has worn multiple types of braces on the left side. He has not been able to tolerate wearing a brace on the right due to his recurrent gastroc and and soleus contractures (-15° bilaterally) and his planovalgus foot.

JE was enrolled in a pilot study evaluating two types of orthotics. Following his first clinical evaluation it was determined that due his diplegia he may benefit from bilateral bracing. JE and his parents agreed to a 4 week trial of bilateral adjustable dynamic response (ADR) AFOs.

CLINICAL DATA:

Bilateral ADR braces(vs. barefoot) improved his standing balance by decreasing anterior/posterior sway by 65% (52.2 mm ± 11.8 to 18.1 ± 3.5) and decreasing medial/lateral sway by 44% (50.0 mm ± 9.2 to 27.9 ± 5.6) while standing on a force plate.

Outcome questionnaires were completed by JE's father prior to beginning the study when he was wearing a left articulating AFO and following the 4 week trial of bilateral ADR AFOs. The results of the Orthotics and Prosthetics Users Survey (OPUS) showed a 10 point decrease for device satisfaction and a 10 point (12%) increase in function after the 4 week trial of bilateral ADR AFOs. The *Pediatric Outcomes Data Collection Instrument* (PODCI) showed an increase in transfers and basic mobility and a decrease in the happiness scale.

The StepWatch Activity Monitor indicated a 78% decrease in the number of steps per day while wearing the bilateral ADR AFOs compared to unilateral bracing (1138 vs. 5092).

Instrumented gait analysis showed the use of bilateral ADR braces (vs. barefoot) led to an increase in velocity (0.94 m/s vs. 0.74 m/s) and a decrease in stance phase stability on the right. The bilateral ADR braces led to an increase in terminal stance hip extension, knee hyperextension on the left and more consistent hyperextension on the right, and the presence of a heel rocker (loading response plantar flexion) bilaterally, although there was also excessive knee flexion in loading response on the right. An increase in plantar flexion was seen bilaterally throughout the gait cycle due to the wedging of the braces. The plantar flexion moment in stance on the right was normalized, but did not lead to an increase in push off power.

THE SOLUTION:

The results demonstrate that it was possible to brace the subject's right side by accommodating his plantar flexion contracture and foot deformity. Bilateral bracing did improve his function, but had mixed effects on his gait parameters and decreased his satisfaction and happiness.

Questions for the audience - What are your recommendations for bracing for this child? What could be done to improve his satisfaction with the braces?

Acknowledgements:
Support for this case study was provided by a research contract with our company, Ultraflex Systems, Inc..

THURSDAY, March 6th
11:20-11:30 AM
Paper 7

LONG-TERM USE OF NEOPRENE KNEE EXTENSION KOS WITH CUSTOM MOLDABLE LOW TEMPERATURE THERMOPLAST

Nancy M. Hylton, PT, LO,
Children's Therapy Center of Kent
Dynamic Orthotic Systems
127 South 156th, Burien, Washington 98166
nhylton1@comcast.net

Night splinting to maintain or increase muscle length in the presence of moderate to severe spasticity is commonly used for short and long-term stretching of muscles. This presentation will share our experience over the past 20+ years using comfortable and inexpensive, custom moldable, light-weight KOs to manage hamstring and hip flexor spasticity and contractures, crouch gait and improve knee/hip extension ROM in persons with moderate to severe CP.

The bracing protocols we have used will be shared both for night time wear and during therapeutic use during daytime in very young to teenage and young adult patients with moderate to severe cerebral palsy. Examples will include 1) a 2 ½ year old child with moderate spastic diplegia, typical equinus/crouch stance in supported upright with sequence of knee serial casting to extended Thermoplast KOs and independent free ambulation over a period of 6 months. 2) a 14 year old girl with moderate to severe dystonia, -30/-40 degree knee flexion contractures, serial casted to about -5/-10 degrees, then into Thermoplast KOs to achieve assisted standing transfers (which had been lost) and active use of TAOS standing and walking orthosis. 3) a 29 year old person with moderate to severe spastic quadriplegic cerebral palsy who has used night extension KOs since 5 years of age, following a selective dorsal rhisotomy, for daily assisted standing and hamstring/adductor stretching exercises. These are still worn at night. If not worn, hamstring/hip flexor and adductor spasticity begins to increase with a decrease in assisted standing and walking skills.

It is important that parent and child buy into regular fulltime nightly wear, but this system has shown much better compliancy because of comfort and ease of use.

THURSDAY, March 6th
11:30-11:45 AM
Paper 8

CHALLENGING CASE: PROTECTING THE SKIN AND SOFT TISSUES, PART 1: TODDLER BORN WITH KLIPPEL TRENAUNAY WEBER SYNDROME

Colleen P. Coulter, PT, DPT, PhD, PCS and Rebecca Hernandez, CPO/L
Children's Healthcare of Atlanta, Atlanta, GA

"At birth there was something terribly wrong with our baby". These were the words spoken by the mother about her beautiful energetic 13 month old twin toddler diagnosed with Klippel Trenaunay Syndrome, KTW. KTW is a rare condition that affects the development of the blood vessels, soft tissues, and bones. Port wine stains (red birthmarks), overgrowth of the bones and soft tissues, and vein malformations are three distinctive characteristics of KTW. Although KTW is typically diagnosed at birth, the impact on the musculoskeletal, integumentary, and cardiovascular systems present life long challenges to the child, family, and healthcare providers.

This case will address the problems and challenges facing this child with the creative solutions designed by a "team" of dedicated professional, the child, and her family.

The Problem:
Complications of KTW depend on location of the vascular malformations and severity of presenting characteristics that can include: skin breakdown and bleeding; cellulitis/ infection; lymphedema; lymphatic drainage; pain from edema; limb length discrepancy from hypertrophy of the limbs; syndactyly and polydactyly of the toes and fingers; and internal bleeding.
With exception of infection and cellulitis, from birth, the infant in this case presented with all of these characteristics as well as dry crusty skin over the port wine lesions and circumferential banding around the typical creases at the knee and ankle creating restrictions of knee, ankle and foot ROM. The swelling proximal and distal to these creases/bands added to the already present challenges.

The challenges for the team treating this infant are: preventing lesions and infection; preserving active and passive ROM, supporting age appropriate development, ongoing education to the family and healthcare providers, parental concerns for the health and appearance of their child; dedication of the family to the home program; and justifying funding support for life course challenges.

The Solution:
Ongoing challenges are present with an active *developing and growing* toddler. *TEAM* collaboration and prevention of anticipated impairments are most important.

- Lymphedema- compression, lymphatic massage
- Banding- deep soft tissue myofascial massage
- Restricted ROM- stretching exercises, AFO
- Limb length discrepancy- shoe lift and AFO design. Both lower limbs, pelvis, and trunk addressed
- Cellulitis/infection- ongoing skin care, wound care with open lesions, compression
- Growth and development- Monthly monitoring of:
    - Skin, lesions, and toes
    - Custom compression garments with fabrication
    - ROM active and passive

    - Development. Need to keep up with twin brother
    - AFO fit and function

The Outcome: (at time of submission, ongoing)

- No infections
- Only 2 pin size lesions that bled with lymphatic drainage
- Equal limb length with orthotic intervention
- Painful PROM to the left lower extremity
- Maintaining ankle AROM and PROM, ~ - 10 degrees neutral soft with end feel
- Full knee extension increase of ~ 30 degrees in past 2 months
- Pulling to stand, cruising, and dancing
- Able to wear dresses and act like a “Princess Diva”

ICD-10 code Q87.2
ICD-9 code 759.89

PRESIDENTIAL SPEAKER

THURSDAY, March 6th
12:00-1:00PM

EVIDENCE BASED MEDICINE: HOW DID WE GET HERE, AND HOW IT CAN LEAD US ASTRAY

Michael D. Sussman, MD
Shriners Hospital for Children, Portland, OR

Every day we are faced with a multitude of decisions, some of which we make automatically, without even recognizing that we have done so, while others require much thought and weighing of options before we make them. When making decisions regarding patient care, we should have evidence regarding the best options for interventions gleaned from our experience as well as results from the literature. We must make sure our patient fits the profile of the disorder which matches with the evidence, and that our treatment will not result in unintended consequences. This is "evidence based treatment."

PART 1. Recent analyses of influential published papers in the scientific literature have found that many of them have conclusions which are invalid. Reasons for this are that studies may be:

1. A fluke of statistics, frequently due to lack of sufficient sample size.
2. Misinterpretation of data, often by overzealous investigators.
3. Publication of positive studies, and suppression of negative studies
    a. By investigators
    b. By industry sponsors
    c. By journals
4. Industry sponsorship of studies is particularly prone to bias
5. Outright fraud may occur, although this is infrequent.

PART 2. When we do have valid studies the decision making is still not straightforward. There are many factors which affect our ability to use well performed studies in a reasonable fashion. These include:

1. Most of us are resistant to new approaches which challenge our longstanding practices- "The Semmelweiss reflex."
2. Periods of intense concentration lead to "Decision Fatigue."
3. In addition there may be many unrecognized influences on our final decision, some of which may be quite subtle, and difficult for us to recognize.

Knowledge of the decision-making process, and factors that influence it, will help us to make better decisions.

SESSION III – SURGICAL ENHANCEMENT

THURSDAY, March 6th
4:45- 4:55 PM
Paper 9

THE EFFECT OF SYSTEMIC ADMINISTRATION OF SCLEROSTIN ANTIBODIES IN A MOUSE MODEL OF LIMB LENGHTHENING

Asim M. Makhdom, MD, MSc (c), Dominique Lauzier, and
Reggie C. Hamdy, MB, ChB, MSc, FRCS(C)
Division of Orthopaedic Surgery
Shriners Hospital for Children, Montreal Children Hospital
McGill University, Montreal, Quebec, Canada

Introduction:

Distraction osteogenesis (DO) is a surgical technique widely used to treat limb length deficiencies in children. One limitation of this technique is the long time of the external fixator needs to be left in place until the bone is completely consolidated. This might lead to significant morbidities in terms of persistent pain, increase risk of pin tracts infection and negative psychological impact on children and their families. Sclerostin is a secreted glycoprotein that interacts with the lipoprotein receptor-related protein 5 (LRP5) and inhibits the intracellular Wnt signaling pathway, leading to decreased bone formation activity by osteoblasts. When Sclerostin is inactivated, bone formation is therefore stimulated. We hypothesized that the systemic administration of sclerostin antibodies (Scl-Ab) can accelerate bone regeneration in a mouse model of DO.

Methods:

A total of 110 mice were randomized to saline versus Scl-Ab injection groups. After DO surgery in the right tibiae, mice were injected intraveounsly once weekly with Scl-Ab (100mg/kg) versus saline(0.1 ml). Mice were sacrificed at four time points, day 11(mid-distraction phase), day 17(end of distraction), day 34(mid-conslidation) and day 51 (end of conslidation). Radiographic (Faxitron), microstructural (μCT) and qualitative histological analysis was performed for the lengthened tibiae at all time points. In addition, biomechanical testing was performed at day 34 and 51.

Results:

Micro-CT results showed an increase of bone volume in the Scl-Ab treated group at day 11 ($P=0.009$) when compared to the saline group. A trend toward increase bone volume was observed in the Scl-Ab groups at day 17, 34 and 51 ($P>0.05$). Histological results showed predominate presence of chondrocyte and fibrocartilage in Scl-Ab group at day 11 when compared to the saline group. Radiographic bone fill scores were higher in the Scl-Ab treated groups at all time points. Furthermore, biomechanical analysis revealed trend toward higher values of ultimate force and work to ultimate point in Scl-Ab treated groups at day 34 and 51 ($P>0.05$) when compared to the saline groups.

Conclusion:

Our data demonstrate the benefits of Scl-Ab on acceleration of bone regeneration and suggest its potential utility in clinical situations to reduce the treatment period with an external fixator during DO procedures.

THURSDAY, March 6th
4:55-5:15 PM
Paper 10

THE ACCORDION MANEUVER AND THE EFFECTS OF COMPRESSION LOADING ON DELAYED REGENERATE BONE FORMATION IN CASES OF LIMB LENGHTHENING

Asim M. Makhdom, MD, MSc (c)[1], Adrian Sever Cartaleanu, MD[1], Juan Sebastian Rendon, MD[1], Isabelle Villemure, PhD.[2], and Reggie C. Hamdy, MB, ChB, MSc, FRCSC[1]
[1]Division of orthopaedic surgery
Shriners Hospital for Children, Montreal Children Hospital
McGill University, Montreal, Quebec, Canada
[2]Department of Mechanical Engineering
Polytechnique Montreal, Montreal, Quebec, Canada

Introduction:

The distraction osteogenesis (DO) technique has been used worldwide to treat limb deficiencies in children. Although very successful, absent or delayed callus formation in the distraction gap can lead to significant morbidities related to an extended presence of the external fixator. These include unfavorable psychological impact, increased pin tract infections, persistent pain and increased risk of osteopenia. In some cases, subsequent surgical interventions might be required. An alternate cycle of distraction-compression (accordion maneuver) is one approach to spark or accelerate bone regeneration. The aim of this study is to report our experience with the accordion maneuver in cases with absent or delayed bone formation during DO and to provide a detailed description of this technique, as performed in our center. We also present a review of the literature regarding the use of accordion maneuver in cases of DO, non-unions and fractures in both human and animal studies.

Patients and Methods:

We reviewed the database of all patients undergoing limb lengthening from the year of 1997 to 2012. The demographic data, clinical course and imaging information, diagnosis, surgery, lengthening details, and complications were all collected from the medical record system. Sixty-five patients (forty-one males and twenty-four females) underwent 72 interventions (35 on right side, 37 on left side), in which 72 bone segments were lengthened (44 femora and 28 tibiae). The specific indication for using the accordion maneuver was an absent or delayed callus formation in the distraction gap, judged radiographically.

Results:

Four patients (6.15%) out of 65 showed poor bone regenerate in their tibiae and therefore accordion maneuver was applied for a mean of 6.75 weeks. Of these, three patients have had successful outcome with this technique. Our accordion regime consisted of alternating distraction with compression as follows: distraction (0.25 mm) in the morning, then compression (0.25 mm) in the afternoon, followed by distraction (0.25 mm) in the evening. The literature showed that this technique is successful approach to trigger bone healing. However, details of how and when to apply this combination of distraction-compression forces were lacking.

Conclusion:

The accordion technique is safe noninvasive approach to promote bone formation, thus avoiding more invasive surgical procedures in cases of poor distraction callus in limb lengthening. Future research in the form of multi-institutional clinical as well as experimental studies is needed in order to optimize the use of the accordion technique as a non-invasive and non-pharmaceutical method to stimulate bone formation in the context of DO.

SESSION IV – SPINA BIFIDA

FRIDAY, March 7th
7:30-7:40 AM
Paper 11

CASE STUDY: 2 ½ YEAR-OLD GIRL WITH L-4, L-5 SPINA BIFIDA VERY SEVERELY INVERTED FEET/ANKLES

Nancy M. Hylton, PT, CO
Children's Therapy Center of Kent
Dynamic Orthotic Systems
127 South 156th, Burien, Washington 98166
nhylton1@comcast.net

This is a little girl adopted from Bangalor, India who stood on the tops of her completely inverted feet and ankles when she arrived at our facility with her new parents. She was highly motivated to be upright, but had no point of stability due to the fact that she was weight-bearing on the tops of her very severely inverted feet. This presentation will show our serial casting protocol combined with 5 minute cold laser treatments by her mother at each cast change, to produce rather remarkable changes in 3 weeks- time. We will show progressive pictures and videos of this process. Once she had 90 degrees, neutral ankle dorsiflexion, she was molded for mid-calf height Dynamic AFOs with plantarflexion and dorsiflexion restraint provided by an adjustable circumferential D-ring proximal strap. The final pair of serial casts were applied while the AFOs were fabricated. The first serial casting worked to achieve maximum M-L neutral alignment needed to be set in 30-40 degrees of plantarflexion with heel wedges applied to provide weight-bearing through the complete foot. With these casts, she was immediately interested in trying to walk with a loaned K-products posterior walker. She continued to experiment more and more as the ankle/foot position became more typical in successive serial casts.

FRIDAY, March 7th
7:40-7:50 AM
Paper 12

MAXIMIZING AMBULATORY POTENTIAL IN SPINA BIFIDA

Samuel R. Rosenfeld, MD
CHOC Children's Hospital, Orange, CA

Goals:
Understanding the musculoskeletal deformities in Spina Bifida, neurologic sequelae, and progressive rehabilitation requirements in this patient population.

Learning objectives:
1) Determining the realistic functional goals of interdisciplinary management.
2) What are the significant physical impairments leading to the inability to maintain ambulatory status?
3) What are the significant physical impairments leading to the inability to maintain independent sitting activities?
4) What are the orthotic requirements to prevent deformity and loss of functional skills?

FRIDAY, March 7th
7:50-8:00 AM
Paper 13

TRANSITIONING SPINA BIFIDA PATIENTS FROM PEDIATRIC REHABILITATION GOALS TO ADULT REHABILITATION PURPOSE

Samuel R. Rosenfeld, MD
CHOC Children's Hospital, Orange, CA

Goals:
Understanding the neurologic, functional, socioeconomic, orthopaedic, and urologic consequences in the long term management of Spina Bifida.

Learning objectives:
1) Interdisciplinary management of adult patients with Spina Bifida to monitor and treat fluctuating neurologic status, declining function, orthopaedic problems and complications, skin breakdown, infection, osteomyelitis, and amputation.
2) Adult Spina Bifida patient requirements for orthopaedic, neurosurgical, and urologic care.
3) Need for the "medical home" to provide interdisciplinary care.
4) Importance of socialization, independence, education, and vocational counseling.
5) Maintaining orthotics and equipment.

FRIDAY, March 7th
8:15-9:15 AM
Symposium II

Symposium II: RECIPROCATING GAIT ORTHOSIS

Jeremy J. Crowell, BOCP, BOCO
Fillauer Companies
Campbell, CA

My intent in this workshop is to illustrate how RGOs work, the different populations that use RGOs and how to insure their overall success. We will discuss historical perspectives in relation to RGOs and why that is significant. There are a variety of subjects needed to be covered in this comprehensive overview. I will be discussing indications/contraindications with regard to patient pathologies. Clinical management will also be described, beneficial ways of impression taking, fabrication, adjustment and delivery. You will receive insight as to the physiologic and psychological advantages of wearing an RGO. Finally, the future direction of these orthotics, and different applications that can be used.

SESSION V – SPINE

FRIDAY, March 7th
9:15-9:25 AM
Paper 14

DUAL CASE STUDY: IMPLEMENTING A CUSTOM CERVICAL EXTENSION COLLAR TO ADDRESS CONGENITAL CERVICAL KYPHOSIS AND CERVICAL FLEXION TRAUMA

Chelsey B. Anderson, CPO, LPO
NOPCO Children's Hospital, Boston, MA

These case studies are intended to present an alternative solution to immobilization of the cervical spine for congenital cervical kyphosis and post-operative trauma bracing. Two patients seen by NOPCO in Children's Hospital Boston received custom cervical extension orthoses to address cervical kyphosis between the ages 11 months to 3 years.

Case 1:
11 month old male presenting with a congenital cervical anomaly: C2/3 subluxation, cervical kyphosis C2-5, and associated symptoms of hypotonia, spinal cord injury. Initial orthotic intervention with a soft cervical collar proved unsuccessful in reducing cervical kyphosis. During treatment, a custom cervical extension collar was fabricated and utilized over the span of 8 months with improvements noted in x-rays and motor development, achievement of developmental milestones. Surgical intervention was required 11 months into treatment, due to new C2 & 3 instability, spinal cord edema, syringomyelia. Use of a Halo 3 months, followed by continued use of a custom cervical extension collar.

Case 2:
16 month old male involved in a MVA presenting with C2 fracture, incomplete central cord lesion, brachial plexus injury , and subluxation of C2/3 requiring spinal fusion for instability. Patient also presents with collapsing cervical kyphosis of C3-7. Orthotic intervention postoperatively included a HALO for 2 months followed by use of a Miami J collar full time for 2 weeks, and then a custom cervical extension collar to address progressive cervical kyphosis below the fusion.

These two cases implement the use of a custom cervical extension collar that utilizes a three point pressure system promoting cervical extension. Cervical extension, rotation, and lateral bending are not limited, allowing increased function and development while restricting cervical flexion. In this presentation, the process of diagnosis, surgical and orthotic intervention over time, and results will be reviewed through both cases.

FRIDAY, March 7th
9:25-9:35 AM
Paper 15

THE MANAGEMENT OF NEUROPATHIC SCOLIOSIS IN CHILDREN: AN AUDIT

Suzanna J. Blandford, **Martin J. A. Matthews, M.Phil**, Prof. John Marsden, and
Jenny Freeman, BA, BS, MSc, PhD
Faculty of Health and Human Sciences, Plymouth University, Plymouth, Devon, United Kingdom

Background:
Scoliosis is a common problem in children with neurological conditions. Associated with complications including pain and respiratory compromise, it impacts negatively on function and quality of life. Effective management typically requires multi-disciplinary intervention which may include physical therapy and provision of orthoses and postural management equipment. Evidence from case studies demonstrates that dynamic elastomeric fabric orthoses (DEFO's) may provide an effective alternative to rigid bracing, which often causes discomfort and hence is associated with non- compliance. This audit describes the routine management of pediatric neuropathic scoliosis, more specifically orthotic management, and investigates whether the progression of scoliosis differs with different management approaches.

Methods:
A retrospective audit of physiotherapy notes (and associated community health notes where available) of children with neurological conditions were audited in five Healthcare Trusts across England. A standardized data collection form was used to gather diagnostic and demographic information and data pertaining to scoliosis characteristics and management.

Results:
180 sets of notes were audited. The average age of the children was 9.1 years (range 9 months to 19 years, SD 4.7years). Seventy nine children (44%) were diagnosed with cerebral palsy of whom 57/79 (72%) used a DEFO; 6 (3%) had neuromuscular dystrophy (NMD) of whom 1/6 (17%) used a DEFO; 3 (2%) had a spinal condition, all of whom used a DEFO; 41(23%) had developmental delay of whom 30/41 (73%) used a DEFO; and 51 (28%) were categorized as other (including Rett syndrome, epilepsy) with 28/51 (55%) using a DEFO. Of the 180 notes audited 60/180 (33%) children, who had no report of scoliosis or spinal curvature, used a DEFO as a preventative measure. A further 43/180 (24%) had a spinal curve developing, of whom 22/43 (51%) used a DEFO. Scoliosis was confirmed in 77/180 (43%) children of whom 50/77 (65%) had used a DEFO. Of the 50 who had been prescribed a DEFO, evidence for the time of prescription was available in 35 sets of notes highlighting that 26/35 (74%) were issued with the DEFO following scoliosis diagnosis. Nine children (9/35, 26%) who had been prescribed a DEFO as a preventative measure went on to develop a scoliosis. Fifteen of the 77 children with confirmed scoliosis (19%) required surgical management. Prior to surgical management 5 of these children (33%) used both a rigid brace and three forms of postural equipment, one of whom had initially been managed with a DEFO. The remaining 10 did not use any form of orthoses; of these one child (1/15, 7%) had used all 3 forms of postural equipment; 5/15 (33%) used 2 forms of postural equipment; and in 4/15 children (27%) there was no evidence in the notes of postural management using either orthoses or equipment.

Conclusion:
This audit of routine practice highlights the significant variation in use of orthoses across different locations. It provides some evidence for the potential role that DEFO's have in the management of children with neurological conditions both at risk of and with established scoliosis. It highlights the need for future research.

FRIDAY, March 7th
9:35-9:45 AM
Paper 16

INNOVATIVE SOLUTION: 2 ½ YEAR-OLD GIRL WITH SMA TYPE1 LIGHT-WEIGHT CTLSO

Nancy M. Hylton, PT, CO
Children's Therapy Center of Kent
Dynamic Orthotic Systems
127 South 156th
Burien, Washington 98166
nhylton1@comcast.net

This is a situation when a little girl with very severe SMA, who was vent dependent with profound paucity of movement and lack of head and trunk control, was seen in our center for new AFOs. Her nurse was very concerned about difficulties providing safe neck/head support during daily transfer activities and helping her to adapt to greater upright inclines in sitting. This presentation shows our problem-solving of this problem and the fabrication of a lightweight (Neoprene + low temperature thermoplast provide by BENIK, Inc) custom molded back panel (head, neck, trunk and pelvis) with precise CTLSO support combined with a standard SPIO compression TLSO front panel. The custom molding was quite challenging because of trach, keeping airway free and open managed with constant PO2 monitoring. Custom jaw stabilization for head and neck could be easily attached to the molded back and will be able accommodate significant growth and is easy and lightweight for single person to manage in transferring activities during 24 hour care.

SESSION VI – TRUNK

FRIDAY, March 7th
10:45-10:55 AM
Paper 17

CHEST WALL ANOMALY CLINIC: A MULTIDISCIPLINARY APPROACH

Gloria Thevasagayam, BSc, PT and **Ian Finlay**
Shriners Hospital for Children, Montreal, Quebec, Canada

Chest wall anomalies (CWA) comprise a variety of congenital and acquired abnormalities of the musculoskeletal structure of the chest that occur in approximately 1:100 children. They are broadly categorized as abnormalities of overgrowth (pectus carinatum- PC), depression (pectus excavatum -PE) or malformation which may negatively affect quality of life and body image.

Surgical and non-surgical treatment options are available but have been introduced into practice without scientific investigation. Considering the importance of establishing evidence of treatment, its effectiveness and translating it into practice, it is imperative to have thorough evaluation methodologies in place from the beginning to measure outcomes of such innovative practices.

A novel multidisciplinary clinic in the treatment of pediatric patients with CWA was started at our center in 2011. Under the guidance of a nurse care coordinator patients undergo a thorough assessment by a pediatric surgeon, attend a physiotherapy class on good posture and if indicated meet with an orthotist: all during a half day clinic. Many patients with PC are being treated with the FMF brace which has shown correction in this population. Some of the patients with PE are being treated surgically via the Nuss procedure.

Research was introduced to evaluate this novel treatment approach for its degree of family centered care, for the effectiveness of the physiotherapy class and to describe quantitatively the quality of life and self-esteem of the youth with CWA.

In this poster, we will describe our CWA clinic focusing on the physiotherapy postural class and the FMF brace use and follow-up. The outcome measures described below were administered to forty patients attending the clinic on two or more visits.

The results of the following outcome measures will be reported as follows:

- The MPOC-20 (Measure of Process of Care), a self-report tool measuring parents' perception of the extent to which health care professionals provided family centered care. Parents scored this clinic on average 4.6/7 which indicates: "sometimes" meets parents' needs. Care was rated as coordinated and comprehensive, but parents felt that written information was lacking.
- A pre and post questionnaire evaluating parents' and patients' perception of posture and its importance for general health and well-being. The pre questionnaire found that both parents and patients felt posture was important. Patients' posture was scored an average of 5.5/10 on a visual analog scale. A questionnaire given 6 months post the physiotherapy class is still being distributed. Scores will be analyzed (before ACPOC).
- The Pediatric Quality of Life Inventory (PedsQL) and the Modified Pectus Evaluation Questionnaire (PEQ). No difference has been found in how patients with PE or with PC perceive their self-image. However, teenagers with PE rate their function lower than teenagers with PC. Quality of life among teenagers with CWA is not different from general population.

FRIDAY, March 7th
10:55-11:05 AM
Paper 18

"A New Look At Pediatric Orthotic Care" The Pectus Carinatum Orthosis

Jackie Valdez, BS, CO
Trulife, Poulsbo, WA

Introduction:
Pectus carinatum is a deformity of the chest wall in which the sternum and rib cartilage protrude outward, sometimes referred to as pigeon chest. It occurs four times more often in boys than in girls and typically becomes more pronounced during the early growth spurt of adolescence.
This course will introduce Pectus Carnatum and the treatment options available.

Methods:
The course will use didactic and collaborative teaching methods with a formal presentation. This course combines practical and theoretical knowledge, reviews evidence, and allows opportunities to consolidate learning through the use of videos.

Results:
Pectus carinatum can cause a variety of symptoms, including chest pain, shortness of breath, difficulty exercising and asthma symptoms. Patients may also experience psychological distress and negative body image. Attendees will be introduced to the signs and symptoms as well as will learn the basic concept behind the Pectus Carinatum Orthosis needed to reshape the chest without causing skin breakdown or so much discomfort that the child will not wear the brace.

Conclusion:
Pectus Carinatum has gained recognition over the past few years and the pectus orthosis has been found to be a safe and effective treatment. Full time use of the Pectus Carnatum orthosis on a flexible pigeon chest deformity has shown to have very successful outcomes.

SESSION VII – MULTI-LIMB INVOLVEMENT

FRIDAY, March 7th
11:15-11:25 AM
Paper 19

MANAGEMENT OF THE QUADRIMEMBRAL LIMB-DEFICIENT PATIENT IN A NON-CLINICAL SETTING

Zach Hughes, CP, LP
Atlanta Prosthetics and Orthotics
and
Sherry S. Romaine, PT, DPT
DeKalb County Schools

The congenital quadrimembral limb-deficient child presents a multitude of challenges for all professionals involved in the child's clinical care. In addition to these professional challenges, the child must also learn how to adapt to the ever-changing world with their limb differences.

This social and physical development cannot, of necessity, take place in an institution of medicine for the school-aged child; it must often occur in the child's school, where they spend 7 hours each day surrounded by their peers and they are watched over by a support staff. In this case study, the patient was able to be effectively treated in the school environment because of the help provided by the readily available student support staff.

The subject of this challenging case is a 6 year old male with quadrimembral congenital limb difference. The subject presents with bilateral transverse deficiency of forearms, complete, and bilateral transverse deficiency of femurs, distal third, with good end-bearing capabilities on his residual limbs. The subject is at or slightly above-average for his age group in terms of intelligence. We began comprehensive treatment of his condition as he began school at the age of 5. The co-author of the presentation worked with the subject to get him to use the "stubby type" lower limb prostheses with articulating foot, but the child had no way to keep himself in an upright posture without assistance from another person. She solicited our company for assistance in creating a solution for the patient to walk independently, while working with him at his school due to time and transportation constraints.

This case study chronicles our treatment of the subject as we transitioned him from a crawling gait with "stubbies" that were rarely used, to a bilateral set of above knee prostheses with moving knee joints, and a bilateral set of arm sockets mounted to a walker for the patient to use independently for moving between classes. The presentation will focus in equal parts on the treatment plan and the challenges of working outside of a clinic in a school environment. The aim is to solicit audience feedback on the current issues that we face in treating challenging patients in a non-clinical environment, and to use this feedback as we move forward with the care of the patient/case subject.

FRIDAY, March 7th
11:25-11:35 AM
Paper 20

NEURAL NETWORK CHANGES DURING INCREASED EXPERIENCE FOR INDIVIDUALS WITH AMPUATIONS

Sook-Lei Liew, PhD, OTR/L
National Institute of Neurological Disorders and Stroke, NIH, Bethesda, MD
Lisa Aziz-Zadeh, PhD
Brain and Creativity Institute, University of Southern California, Los Angeles, CA
and
Vivian J. Yip, OTD, OTR/L
Child Amputee Prosthetics Project, Shriners Hospitals for Children, Los Angeles, CA

Observing actions performed by others engages one's own sensorimotor regions, typically with greater activity for actions within one's own motor abilities or for which one has prior experience. However, it is unclear how experience modulates this neural response when we observe actions performed by someone with a different body from ourselves. Using fMRI, we scanned 16 typically-developed participants as they observed actions performed by an individual with limb differences, and by a typically-developed individual. Importantly, all participants had little to no previous experience or contact with an individual with limb differences before. Participants initially demonstrated greater activity in their own sensorimotor regions observing actions made by the residual limb compared to the hand, with more empathic participants activating part of their sensorimotor network more strongly. Activity in that region may indicate matching the kinematics of a novel effector to one's own existing sensorimotor system, a process that may be more active in more empathic individuals. Participants then received extended visual exposure to each individual, after which they showed little difference between activation in response to residual limb compared to hand actions. This suggests that visual experience may attenuate the difference between how residual limb and hand actions are represented using one's own body representations, allowing us to flexibly map physically different others onto our own body representations with experience and over time. Interestingly, individuals with greater experience (e.g., occupational therapists who worked with children with limb differences) represented both hand and residual limb actions onto similar neural regions when they first viewed each, suggesting they had already encoded the kinematics for both hands and residual limbs. Overall, these results suggest that experience - whether interpersonal or visual, such as through the media - may influence our neural systems encoding others actions and help us to understand people with different bodies from ourselves better.

FRIDAY, March 7th
11:35-11:45 AM
Paper 21

FUNCTIONAL STATUS OF CHILDREN WITH UPPER AND LOWER EXTREMITY AMPUTATION

Gül Şener, Özlem Ülger, PT, PhD, Semra Topuz, PT, PhD, Kezban Bayramlar, PhD, PT, and Fatih Erbahçeci
Hacettepe University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Prosthetics Orthotics and Biomechanic Unit, Ankara, Turkey

Objective:
The aim of this study was to evaluate the functional level of children with lower and upper limb loss after a rehabilitation program.

Methods:
This study included a total of 81children, aged 8 to 17 years with upper and lower limb loss. Children were wearing their first prostheses and they were divided into two groups (lower limb amputees (n=41) and upper limb amputees (n=40). There were forthy children with acquired limb loss while forty one children had congenital limb loss. The children underwent prosthetic fitting, prosthetic training and rehabilitation. The Child Amputee Prosthetics Project - Functional Status Inventory (CAPP-FSI) was used at the initial visit without prosthesis, 3 weeks after the prosthetic training and 6 months after discharge with and without prosthesis. The results with and without the prosthesis were compared between lower and upper amputee groups.

Results:
There were significant differences in CAPP-FSI performed at the beginning at the 3rd week, and at the 6th month without prosthesis and at the 3rd week and at the 6th month with prosthesis ($p<0.05$). The lower group received higher scores in the CAPP-FSI at the beginning, at the 3rd week and at the 6th month ($p<0.05$). Patients in the lower limb group used their prostheses for 8 hours a day and the upper group for 0 to 4 hours.

Conclusion:
Daily prosthesis usage time and the child's experience with the prosthesis during daily activities are the determining factors for the functional level in upper and lower limb child amputees. Functionality may improve based on these factors.

HECTOR KAY LECTURE

FRIDAY, March 7th
1:00-2:00 PM

BRACING ADOLESCENT IDIOPATHIC SCOLIOSIS: WHERE ARE WE IN 2014?

Lori A. Karol, MD
Professor, Department of Orthopaedic Surgery
University of Texas, Southwestern
Texas Scottish Rite Hospital for Children, Dallas, TX

Recent research has supported the efficacy of bracing in slowing progression and decreasing the likelihood of surgery in patients with adolescent idiopathic scoliosis. The BRAIST study, spearheaded by Weinstein and Dolan, was a matched cohort study in which there was a statistically significant decrease in surgical progression in patients who were prescribed braces compared to a group that was observed. Compliance monitoring has shown poor brace wear by most teens with idiopathic scoliosis, yet has also shown that increased hours of wear correlate with less curve progression. Compliance counseling increases patient wear, leading to improved outcomes.

SESSION VIII – FUNCTION AND QUALITY OF LIFE

FRIDAY, March 7th
2:00-2:10 PM
Paper 22

TO DETERMINE THE FUNCTIONAL LEVEL IN AMPUTEE CHILDREN

Özlem Ülger, PT, PhD, Semra Topuz, PT, PhD, Kezban Bayramlar, PhD, PT, and Gül Şener
Hacettepe University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Prosthetics Orthotics and Biomechanic Unit, Ankara, Turkey

Objective:
To determine the functional level in amputee children with their prosthesis.

Methods:
Amputee children (n=15) aged between 6-12 years who used their prosthesis at least for 1 year were enrolled in this study. The second group consisted of healthy children (n=25). Twenty-two disabled children with special needs and attending to special education school were enrolled to the control group. All the children were assessed with the Functional Level Determining Questionnaire (FLDQ) designed for the children between 6-12 age (total score=105).

Results:
Demographic characteristics such as age, sex and body mass index were same for each group ($p>0.05$). Although the scores of FLDQ were in similar in the groups of amputee and healthy children ($p>0.05$), their scores were higher than the children who had special needs ($p<0.05$). When the amputee children were divided into two group as acquired and congenital, the congenital group were more functional ($p<0.05$). The children who used prosthesis for longer term were more successful in the activities ($p<0.05$).

Conclusion:
Regardless of the cause or level of amputation, amputation less affects than other physical disabilities. Early prosthetic applications contribute to the functional level of children.

FRIDAY, March 7th
2:10-2:20 PM
Paper 23

QUALITY OF LIFE OF THE CHILDREN RECEIVING EDUCATION IN A SPECIAL SCHOOL FOR THE PHYSICALLY DISABLED

Kezban Bayramlar, PT, PhD, Semra Topuz, PT, PhD, Özlem Ülger, PT, PhD, and Gül Şener
Hacettepe University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Prosthetics Orthotics and Biomechanic Unit, Ankara, Turkey

Objective:
To assess the quality of life and to identify the factors effecting quality of life in amputee students who attend school for the physically disabled.

Methods:
Fifty two students were enrolled to the study. Nottingham Health Profile (NHP) was used to assess the quality of life.

Results:
Thirteen were female and 39 were male of the participants, aged 8-17 years. Twenty-five participants were amputees, 27 were diagnosed with cerebral palsy, muscular dystrophy, spina bifida, poliomyelitis. 84.6% of the amputee students did not use prosthesis. In the other group without amputation, 65,4% of the students were using wheelchair or walking aid devices. Quality of life of students in both groups was affected according to the total and subscores of NHP($p<0,05$).

Conclusion:
It was concluded that participant's limitation in their physical activity had negative impact on their quality of life.

FRIDAY, March 7th
2:20-2:30 PM
Paper 24

QUALITY OF LIFE OF THE PARENTS WHO HAVE CHILDREN WITH LIMB LOSS

Semra Topuz, PT, PhD, Özlem Ülger, PT, PhD, Kezban Bayramlar, PhD, PT, and Gül Şener
Hacettepe University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Prosthetics Orthotics and Biomechanic Unit, Ankara, Turkey

Objective:
This study was planned to determine quality of life and anxiety level of the parents who have children with limb loss.

Methods:
43 parents who have children with limb loss were included in the study. Children were divided into 2 groups according to the causes of amputation (21 children with acquired limb loss, 22 children having congenital limb loss). The children were between the ages of 8 and 15 years. WeeFIM was used to assess the functional independence of children. NHP was used to evaluate the quality of life of the parents. State-Trait Anxiety Inventory (STAI FORM TX I ve II) was used to determine anxiety levels of the parents.

Results:
Demografic characteristics of the children were similar in both groups ($p>0.05$). Functional levels of children were found to be higher in congenital limb loss ($p<0.05$). The quality of life scores were found to be similar in the parents who have children with acquired and congenital limb loss ($p>0.05$). Anxiety levels were better in parents having congenital limb loss child ($p<0.05$). A high correlation was recorded in between functional level of children and quality of life and anxiety level of their parents ($p<0.05$).

Conclusion:
It can be concluded that having a child with limb loss affects the quality of life parents. The functional levels of children may affect quality of life and anxiety levels of parents.

SESSION IX – PROSTHETICS – GENERAL

FRIDAY, March 7th
3:30-3:40 PM
Paper 25

PARTICIPATION IN SPORTS OF DUTCH CHILDREN WITH LOWER LIMB DEFICIENCIES

Anka Michielsen, PT, MSc and Iris van Wijk, MD, PhD
Rehabilitation Centre De Hoogstraat, Utrecht, The Netherlands

Objective:
Sports can and do, make a profound and positive impact on individuals. Physical activity, including sports, is linked to reduced risk of illnesses including obesity, cardiovascular diseases and some cancers. Studies have found that sport programmes can enhance self-esteem and confidence . Children playing sports have a more positive body image and experience higher states of psychological wellbeing compared to children who do not play sports.

Purpose:
To describe sports participation of Dutch children with congenital lower limb deficiencies (LLD) in comparison with typically developing children.

Methods:
Cross-sectional study. A questionnaire was sent by mail to 94 children and adolescents with LLD , aged 8-18 years.

Results:
Final analyses are still pending; definite results will be presented at the conference. Participation in sports of Dutch children and adolescents with LLD (age range 8-18 years) does not differ from sports participation in healthy peers. A small percentage of the children that do participate in sports, do not play the sports of their choice. Although being able to participate in sports some of the children think they are not able to participate in every sport. Running, jumping and endurance were mentioned as the most limiting factors in participating in sports of preference.

Conclusions:
Dutch children and adolescents with LLD participate in sports similar to those among typically developing children. Not all children participate in the sports of their preference because of experienced limiting function of the lower limb prosthesis.

FRIDAY, March 7th
3:40-3:50 PM
Paper 26

Riding a Bike!

Anka Michielsen, PT, MSc and Iris van Wijk MD, PhD
Rehabilitation Centre De Hoogstraat, Utrecht, The Netherlands

Goal:
Like all children in the Netherlands, those with a lower limb deficiency (LLD), want to be able to ride a bike! A soon as they have the motor ability to ride a tricycle, like their peers, we will intervene in preparing the tricycle to fit the needs of the child.

In this presentation we will report on our experiences in facilitating the children with LLD to be able to ride a bike.

We will present our ideas and adaptive device that makes it possible for every child with unilateral LLD to be able to ride a bicycle. Different cases will be demonstrated with the use of photographs and videos.

FRIDAY, March 7th
3:50-4:05 PM
Paper 27

CHALLENGING CASE PRESENTATION: JAYDEN'S TOO SHORT

Brian J. Giavedoni, MBA, CP, LP, Colleen P. Coulter, PT, DPT, PhD, and Michael L. Schmitz, MD
Children's Healthcare of Atlanta, Atlanta, GA

Jayden is a 10 year old energetic young man who has been followed by the The Limb Deficiency Program at Children's Healthcare of Atlanta when he was 6 weeks old.
He presents as a transverse deficiency of the right femur with a very short femur. No developmental delays have been noted or reported. Jayden is a very active young man who has managed to successfully wear a prosthesis. Initially, due to the very short limb, consideration was given to fitting him as a hip disarticulation and this was quickly dismissed due to both his mother's and Limb Deficiency team's goals.

He has become a very challenging fit due to the extremely short femoral segment. His last x-ray (2013) revealed a bone fragment the size of a golf ball. Movement of the remnant is achieved by soft tissue contraction and pelvic tilt combined with pelvic rotation. Suspension has been the major issue we have had to deal with over the years. He is a very active young man and numerous different techniques have been utilized over the years.

Several factors have created the current dilemma of finding a socket / suspension system that will allow freedom of movement while still affording secure and reliable suspension. The obvious choice is to move him into a hip disarticulation style socket thus resolving both suspension and socket fit. Jayden has 2 prostheses: a conventional daily use one and a running prosthesis that he received through a CAF grant. He successfully achieves a step over step running pattern. Although willing to wear the TES belt for running he is unwilling to tolerate the belt for daily activities in his non-running prosthesis.

This case presents a clinical presentation that all members have had to deal with in their clinicians and their practices.

FRIDAY, March 7th
4:05-4:15 PM
Paper 28

BORN JUST RIGHT

David B. Rotter, CPO
Scheck and Siress P&O, Chicago, IL
and
Jen Lee Reeves
Columbia, MO
Founder, Born Just Right

Born Just Right was founded by a mother dedicated to ensuring that her daughter born with an above the elbow limb deficiency would get everything out of life. What started out as a mother blogging about her daughter's life has developed into an on-line community of thousands the world over. As the author Thomas Friedman aptly put it, the world is flat. The power of the internet allows people who share common interests to connect with one another irrespective of where they reside.

Prosthetic management of the upper limb deficient child is no longer the exclusive domain of the doctor, therapist or prosthetist. The consumer of today is better informed, researched and emboldened by community. Questions such as "why wear a prosthesis" are openly asked and the conventional wisdom of experts is challenged.

What is the best way to approach prosthetic management of the upper limb deficient child? It is the intent of this paper to show a mom and daughter's journey to answer that question. Case examples of prostheses constructed over the past seven years will be shown. It is also the intent of this paper to illustrate the conversations that take place in this unique community so that we may better understand the people we are charged with taking care of.

FRIDAY, March 7th
4:30-5:30 PM
Symposium III

Symposium III: USING SPORT AND PHYSICAL ACTIVITY TO IMPROVE HOLISTIC WELLNESS AND TEACH LIFE SKILLS

Aaron Moffett, PhD and Mark Campbell, MS, LMT, ATC
California State University, San Bernardino and US Army Warrior Transition Command
San Bernardino, CA and Washington, DC

With nearly one in four people in the US having a disability and with rates of obesity in children and those with disabilities increasing, the Surgeon General (2005) stated that improving the health and wellness of all people with disabilities (PWD) across the lifespan is a major public health issue. He also emphasizes the importance of practitioners taking a holistic approach to improving health and wellness of PWD. The authors of this presentation use a holistic perspective when developing sport and physical activity programs to teach life skills (e.g, confidence, goal-setting, assertiveness, social skills, assertiveness, etc.) and improve health and wellness to people with disabilities. In 2013, The Office of Civil Rights for the US Department of Education also recognized the importance of physical activity and sports teaching the holistic student when stating that schools are legally required to provide opportunities for their students with disabilities to participate in physical activity and sports because of the benefits that sport can have on students such as social, academic, and personal. There are many different wellness models and programs that showcase multiple domains for overall well-being. One model being used by the authors when working with children and the US military consists of six areas of wellness: spiritual, emotional, career, physical, family, and social.

Primarily, the US military is taking this holistic approach to healing and adaptive reconditioning for their wounded warriors including those who use prosthetics and orthotics. The purpose of adaptive reconditioning is to aid in the recovery of wounded/ill/injured military by reconditioning their physical, emotional, mental, and cognitive states through adapted physical activities in order to assist their transition back into the military or the community. Many people say that sport is a classroom-like environment that can be used to teach life skills to enhance the six area of wellness. Sport and performance psychology practitioners have the ability to use sport and exercise to help individuals enhance well-being within each domain. By identifying strategies for incorporating a holistic physical activity and wellness plan within clinics, the audience can take a holistic approach to improving well-being within themselves, their practice and any clientele they serve. The presenters will use multiple teaching strategies including: power point, multimedia components, small and large group discussion, and the opportunity for audience participation.

SESSION X: UPPER LIMB

SATURDAY, March 8th
8:00-8:10 AM
Paper 29

EVALUATION OF THE USE OF AND SATISFACTION WITH ADAPTIVE DEVICES: A GOOD ALTERNATIVE TO PROSTHESES IN CHILDREN WITH CONGENITAL UPPER LIMB DEFICIENCIES?

Iris van Wijk [a], MD, PhD
[a] Rehabilitation Centre De Hoogstraat, Utrecht, The Netherlands

Background:
Although most children with congenital upper limb deficiencies are very creative in finding solutions, regular visits to rehabilitation centers are undertaken for advice. One of the solutions for perceived activity limitations is the prescription of a prosthesis. Literature shows that the rejection rate of a prosthesis in children is high(Postema, 1999; Biddiss, 2007a; Biddiss, 2007b; Wagner, 2007). Reasons for rejection often mentioned are: lack of functional gain, discomfort, more sensory feedback without it.

Terminal devices adapted for prosthetic users are used specifically for sports and hobbies like playing a musical instrument. They do not seem to be useful to children with upper limb deficiencies unless the activity they perform requires bimanual handling (lifting barbells, playing the violin) (Walker, 2008). Moreover, some children refuse to wear the terminal device, because they (or their relatives) develop homemade adaptations which meet better children's needs (Walker, 2008).

Objective:
To explore and evaluate the use of adaptive devices in children with upper limb deficiencies in the Netherlands.

Methods:
A quantative study based on data collected with a questionnaire sent to children 2-20 years of age with a congenital upper limb deficiency.

Results:
218 questionnaires were returned (127 boys and 91 girls). 166 children ever used any adaptive device, while 80 of them ever used a prosthesis. Satisfaction with the adaptive devices was significantly higher than the satisfaction with the prosthesis. More detailed results will be presented at the conference

SATURDAY, March 8th
8:10-8:20 AM
Paper 30

CREATIVE SOLUTIONS
FUNCTIONING WITH A CONGENITAL BELOW THE ELBOW DEFICIENCY: THE ROLE OF ADAPTIVE DEVICES

Iris van Wijk [a], MD, PhD
[a] Rehabilitation Centre De Hoogstraat, Utrecht, The Netherlands

In the Netherlands each year about 14 children with a transverse deficiency of the upper limb are born.

In rehabilitation centre The Hoogstraat these children and their parents are seen at regular intervals by a team which consists of a physician, a physiotherapist, an occupational therapist, a social worker, a prosthetist, and adaptation technician

The main objective for the team is to inform the parents about the functional prognosis of their child. This includes advice on the benefits and disadvantages of wearing a prosthesis.

The prosthesis is supposed to enhance function, but in practice we see that a lot of prostheses are not used the way they are designed and rejection rates are high. Children often dislike the comfort (weight) of the prosthesis, they do not experience a gain in function and have more sensory feedback without the prosthesis.

Apart from the prosthesis, which has a generic grasp and support function, we make a lot of tailor made “ortheses” for specific functions like eating, playing sports and playing an instrument. We call them adaptive devices.

During our presentation we will give an overview of the different types of adaptive devices. These devices are light-weighted, cheap and easy to don and dof by the child itself. The design often leaves the skin free for sensory feedback.

We will also show newly designed try-out prosthesis, usable for children and adults. With the vacuum socket children can really feel and experiment with the prosthesis before making a definite choice.

SATURDAY, March 8th
8:20-8:30 AM
Paper 31

HAND ORTHOSES FOR COMPLEX CASES WITH NEW TECHNOLOGY

Michael Ceder, CPO
Teamolmed
Orthopedic Department, Jönköping, Sweden

The patients in need of orthotics for upper limb who we meet at our orthopedic department belong many times to difficult cases that not occupational therapists can solve. Many times this depends on lack of materials and / or lack of knowledge of manufacturing. One reason could also be when not prefabricated orthoses work satisfactory. The group of patients we are talking about is often spastic with more or less intractable deformities.

Traditionally these orthoses are made by using a plaster mold or manufactured directly on the patient with a low temperature plastic. Both ways have their difficulties in getting the desired final position of the hand- and finger joints and is time consuming for both the patient and the manufacturer.

Since 2008 we have worked with CAD/CAM technology and accumulated experience. The technology has a great potential to correcting, copying and mirror the any body shape. It is also possible to effectively save the molds and reproduce them.

The difficulty with CAD/CAM has been to scan patients who can't keep current body still and /or the desired position of the short time it takes to scan. Hands have been especially hard to deal with when there are many parts to be held in the right position at the same time, this is not especially easy with plaster either. As we have developed tools to facilitate this problem essentially we now with good results can produce all kinds of orthotics, from head to foot, for all possible patient cases. Patients are delighted with this development.

The new molds of foam, instead of plaster, has forced us to think in new materials and manufacturing methods. Felt is a material found suitable for hand orthoses. The material's advantages are that it is easily shaped, washable, have good breathability, and also good acceptance and comfort.

Some of the advantages of CAD/CAM are that even if we were not scanned at the perfect angle, we can by the patient conditions produce orthotics in the desired position. Children are growing individuals and often require new molds for manufacturing. Contracture treatment with the goal of improving angles, often require new molds to the new conditions that arise with the treatment. Benefits are large as we can scale up models for growth or change angles without using plaster of Paris or scan the patient again.

We have good experience in the manufacturing method of these hand orthoses that we wish to share with you.

SATURDAY, March 8th
8:30-8:40 AM
Paper 32

CREATIVE SOLUTION: TEAM APPROACH FOR A TODDLER WITH ORALMANDIBULAR LIMB HYPOGENESIS

Mary Leighton, OTR/L
Camp No Limits, Wales, ME
and
Vivian J. Yip, OTD, OTR/L
Child Amputee Prosthetics Project, Shriners Hospitals for Children – Los Angeles, CA

Nicholas is a three year old boy with oralmandibular limb hypogenesis. He is tongue tied with congenital bilateral above elbow deficiencies, left knee disarticulation and right partial foot deficiency. He was brought to a pediatric sensory integration clinic where working with children with limb difference was far from the focus of the clinic. He had not received any therapy or prosthetic care prior. He was observed to crawl and walk on his knees. The therapists were new graduates and did not have any experience with children with limb difference. He began occupational and physical therapy three times a week to develop strength, balance, and self- care skills needed for everyday activities. As new graduates, the therapists were eager to learn how they might be able to provide the appropriate care for Nicholas. They approached different resources and found very limited information about persons with limb difference.

Nicholas was an outgoing and active boy, however even at three years of age, he was discouraged by stares and lacked the confidence to try any new activities. He often sadly expressed that he was the only one in the world like him and cried.

Nicholas was from a broken family and his mother was not involved with his care. The family that fostered Nicholas was seeking information of how to best cope and manage his limb differences. The therapists and the family worked together to explore resources to answer the many questions they had but the search was not successful and weekly therapy sessions did not seem to be enough. The therapists and family worked together to adapt feeding utensils, clothing, and adapting his bike so that he could ride it however there was a lack of knowledge by the therapists and family on all the options. The idea of meeting another peer with similar limb loss became the crucial thought in order to have successful outcomes. Nicholas was making gains however that desire to meet someone else and have a role model clearly became most important. As time went on he became more aware and self-conscious of people staring and pointing, limiting his progression in many everyday activities.

Nicholas had met other children with disabilities but when he saw someone on the computer with limb loss like him, his eyes lit up. The team knew that they needed to develop an opportunity for Nicholas to meet peers like him. The team thought that a camp setting would be ideal since Nicholas enjoyed the outdoors. After extensive research, it was disappointing to find that no camp of this kind existed in the New England area at that time. After nearly a year and a half from Nicholas' first visit, the clinic team was able to coordinate a cabin with four families, parents and siblings included a prosthetist, and an individual from a non-profit adaptive ski program to form a "camp" for Nicholas. The family and therapists saw a significant change in Nicholas behavior, self-esteem, confidence and willingness to participate in activities. The therapists, parents, and siblings all felt they benefitted and learned much more than they had compared to the year and a half they had in the clinic.

SESSION XI – MOTION ANALYSIS

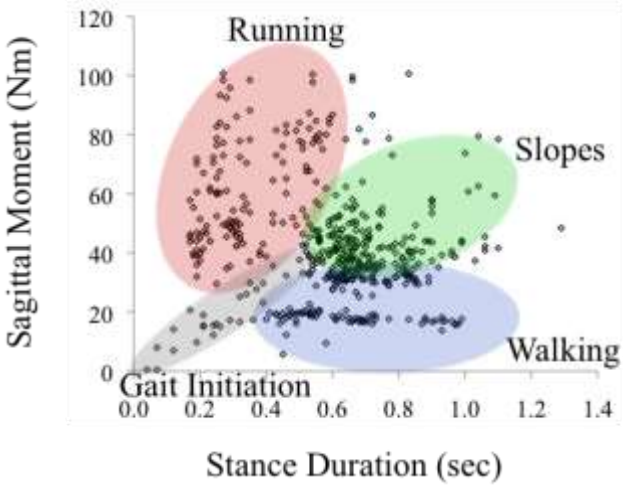
SATURDAY, March 8th
9:00-9:10 AM
Paper 33

SAGITTAL ANKLE MOMENT PATTERNS FOR YOUTH RUNNING AND WALKING IN PROSTHETIC FEET: DATA DRIVES DESIGN

Michael S. Orendurff, PhD, Lucas Lincoln, MS, Teri Rosenbaum-Chou, PhD, Adam Arabian, PhD, Wayne Daly, CPO, David Hensley, CPO, Toshiki Kobayashi, PhD, Philip E. Gates, MD, Justina S. Shipley, CO, BOCO, BOCP, MEd, Susan R. Campbell, PhD, David Moe, CPO, Kristie Bjornson, PT, PhD, Susan Sienko Thomas, MA, PhD(c), Cathleen Buckon, OTR/L MS, Sabrina Jakobson Huston, CPO, Todd C. DeWees, BS, CPO, Ann Kennedy, CPO, Michael Suckoski, CPO, and J. Ivan Krajbich, MD
Orthocare Innovations, Mountlake Terrace, WA; Seattle Pacific University, Seattle, WA; Shreveport Shriners Hospital, Shreveport, LA; Barber Prosthetics, Vancouver, Canada; Seattle Children's Research Institute, Seattle, WA; Shriners Hospital for Children, Portland, OR

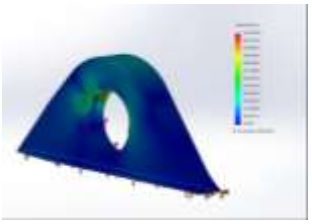
Designing robust and high performance prosthetic feet for children is a challenging task. Children with limb loss have a much wider range of movement capabilities than most adults with limb loss. Children's play can often involve sudden running movements that last just a few seconds. As a result, changing to a "running leg" is not an option, as it is for many active adult prosthetic users.

This NIH funded, IRB approved project sought to objectively record the sagittal ankle moment during running and walking activities of children with limb loss in real-world settings. Parents signed a consent form and children signed an ascent form prior to participating. A small load cell was fit to their prosthetic limb and sagittal moments were streamed by Bluetooth to a computer as the children walked, ran and simulated sports and playground activities on grass, gravel, asphalt and concrete surfaces. Activities on both level and sloped surfaces (6° and 20°) were recorded. Peak moments were extracted and plotted against stance time to determine the absolute loads and loading rates that were developed during usual activities. These parameters were used as design criteria to create a novel microprocessor controlled prosthetic foot for children.



Loading rates during overground running were more than double the rates set for current ISO testing of prosthetic feet (500 Nm/s vs 200 Nm/s), but the peak moments were considerably lower than adult values (100 Nm vs 400 Nm). These load criteria were used in the design of a mesofluidic microprocessor controlled prosthetic foot for children.

We utilized an ACE engineering model: Analytical – Computational – Experimental. The analytical estimates from literature parameterized the initial design; a computation model to estimate local stresses with the load values from the human subject data during real world activities parameterized the secondary design; and finally an experimental model



confirmed these estimates in mechanical testing with an actual physical model of the prosthetic foot.

The moment-time data was also used to aid in defining and improving a control algorithm for the microprocessor. Feed-forward estimate of each state-space (running, walking, slopes, standing, jumping, etc) were categorized by the frequency of gait changes that the children demonstrated on the load cell. The number of similar steps was highly irregular with frequent and dramatic changes in locomotor activities of the participating children. Once the safety of the mechanical characteristics of the microprocessor foot are established, user input will be needed to test and refine the control algorithm. Current efforts appear to provide high confidence that the foot behaves in a predictable manner for all tasks, but extensive patient testing will be required for validation and possible performance enhancements.

This process supports the concept of using real world gait kinetics as design criteria for prosthetic components. The ecological validity of collecting loading data outside of the laboratory for children with limb loss may help create more functional devices that are better suited to the demands these children place on their prostheses during everyday activities.

This work is funded by NIH Grant 2R44HD066861-02

SATURDAY, March 8th
9:10-9:20 AM
Paper 34

STRIDE-TO-STRIDE FLUCTUATIONS ARE RELATED PRE/POST ADAPTATION FOR AN APPROPRIATE PROSTHESIS

[1,2]**Shane R. Wurdeman, PhD, MSPO, CP**, [3]Adam L. Jacobsen, CPO,
[2]Sara A. Myers, PhD, and [2]Nicholas Stergiou, PhD
[1]Advanced Prosthetics Center, Omaha, NE; [2]University of Nebraska at Omaha, Omaha, NE;
[3]Veterans Affairs Medical Center, Omaha, NE

INTRODUCTION:

Stride-to-stride fluctuations are strongly correlated to prosthesis preference.[1] This finding describes a preferred state as being one where the prosthesis and the patient are working together, rather than opposing each other, organizing into a more desired and optimal adaptable movement. A less appropriate prosthesis design has been shown to have greater stride-to-stride fluctuations.[2] Thus, a prosthesis that is more appropriate may lend itself to a more predictable behavior as the prosthesis and patient work together. The purpose of this study was to determine the relationship between stride-to-stride fluctuations before and after receiving a new prosthesis in an adult population with implications for pediatric patients.

METHODS:

Subjects: 28 transtibial amputees consented to participate in this IRB approved, randomized, crossover design study (age: 53.6 ± 11.3 yrs; ht: 177.4 ± 8.0 cm; mass: 98.4 ± 19.3 kg; time since amputation: 8.3 ± 9.2 yrs).
Procedures: Subjects were randomly fitted with either an appropriate or less appropriate prosthesis according to their functional level. A certified prosthetist swapped out the subjects' prescribed foot/ankle/pylon for the test components followed by proper alignment. Next, subjects walked on a treadmill at their self-selected pace for 3 minutes while kinematics were recorded (12 cameras, 60 Hz). After a 3 week adaptation period,[3] testing was repeated followed by swapping components with the other design (appropriate or less appropriate). Testing was repeated again following initial fitting of the other prosthesis and after 3 weeks of wear.
Data Analysis: Stride-to-stride fluctuations within the ankle angle time series were analyzed using the largest Lyapunov exponent (LyE).[1,2] Pearson correlations were used to test relationships between initial ankle LyE (prosthetic and sound ankle) and final ankle LyE (prosthetic ankle) (α=0.05).

RESULTS:

A strong relationship for LyE of the appropriate prosthesis design was found for the prosthetic ankle at initial fitting and final visit ($r=0.709$, $p<0.001$). A moderate relationship was found for the sound ankle LyE at initial fitting and prosthetic ankle LyE at final visit for the appropriate prosthesis design ($r=0.475$, $p=0.019$). No such relationships existed for the "less appropriate" design.

DISCUSSION:

When a patient receives a new prosthesis, learning occurs as the neuromuscular system explores the mechanics of the prosthesis to formulate a walking pattern. If the prosthesis is of an appropriate design for the individual, an effective and adaptable walking pattern emerges based on the initial fitting conditions. A less appropriate prosthesis does not result in such expected outcomes. These behaviors are possibly predictable from the initial behavior of the sound leg ankle motion as well, albeit a weaker correlation. This finding, however, is in adults, whose neuromuscular system is not as plastic as children. During the motor development in the immature neuromuscular system, there lies potential for greater adaptability which may yield a larger spectrum of devices that could be considered appropriate, or the developing neuromuscular system may be restricted from fully developing if given an inappropriate device. Future work with children is necessary to determine translation into a pediatric population.

REFERENCES:
1. Wurdeman et al. *JRRD.* 50, 671-686, 2013.
2. Wurdeman et al. *Proceedings of AAOP 2014*. 2014.
3. English et al. *JRRD*. 32, 32-35, 1995.

ACKNOWLEDGMENTS
This work was supported through funds from the Orthotics and Prosthetics Education and Research Foundation, Inc. (OPERF) (OPERF-2012-FA-2), American Society of Biomechanics Grant-In-Aid Award, AAHPERD Research Consortium Doctoral Grant, and a UNMC Widaman Graduate Fellowship.

SATURDAY, March 8th
9:20-9:30 AM
Paper 35

OXYGEN CONSUMPTION DURING STRESS TESTING IN PEDIATRIC AMPUTEES

Kelly A. Jeans, MS, Chan-Hee Jo, PhD, Don R. Cummings, CP, LP, and Lori A. Karol, MD
Texas Scottish Rite Hospital for Children, Dallas, TX

Introduction:

Pediatric amputees have been shown to have nearly normal oxygen cost during self-selected over-ground walking (SSW), until the amputation level is above the knee.[1] The increase in VO_2 Cost in trans-femoral or hip disarticulation amputees is due to their reduction in SSW speed. Since children are required to participate in physical education and are encouraged to be active along with their peers, there is the question of aerobic capacity. By having these amputees participate in a graded submaximal stress-test, we would be able to measure their VO_2 capacity during exercise and predict their VO_2 maximum.

Methods:

Thirty-five pediatric amputees (9-19yrs) underwent baseline VO_2 testing during rest and at SSW followed by a graded submaximal VO_2 stress test walking on a treadmill (TMW). The patient cohort consisted of 21 patients with an amputation below the knee (*BK*: 9Syme, 1Boyd and 11trans-tibial) and 14 patients with amputations through the knee and above (*AK*: 10knee-disarticulation and 4trans-femoral). Oxygen consumption and heart rate (HR) data were collected using a Cosmed K4b[2] system with a Polar HR monitor. The graded TMW protocol was conducted with incremental increases in speed and grade until 85% of HR maximum (220-age) was reached. If the patient chose to terminate the test early, VO_2 maximum was not predicted.[2] Twenty-two age matched controls were used for comparison. Statistical analysis included ANOVA with post-hoc analysis with alpha set to 0.05.

Results:

There were no differences found in patient demographics or in resting values (p>0.05).

All patients were able to walk at their SSW during TMW. (Table 1) Both BK and AK groups had a higher VO_2 Cost than controls and AKs walked significantly slower than the BK and controls (p<0.05).

		BK *21*		**AK** *14*		**Control** *22*		
		mean	SD	mean	SD	mean	SD	**p**
	VO_2 Cost ml/kg/m	0.27	0.06	0.32	0.05	**0.22***	0.04	**<0.0001**
TM Data at SSW	HR bpm	125	15	129	19	117	12	0.0610
	Velocity m/min	72.1	9.9	**64.1^**	7.8	73.7	8.0	**0.0064**
	% HR Max	61%	7%	63%	9%	57%	6%	0.0561

Table 1. Results collected at ~SSW speed on the TM.
*BK / AK > Control, ^BK / Control > AK (p<0.05)

Of the 35 subjects, 12 elected to stop testing (34%) and did not complete the exercise protocol. This left 23 participants (13BK and 10AK) who finished the protocol and VO_2 maximum was predicted using linear regression. Data for the final stage and predicted values can be found in Table 2. Results showed that the AK group walked significantly slower than both the BK and control groups, while the AK group reached the target HR earlier in the inclines, than the controls. No differences were found in the final stage VO_2 Rate, HR, %HR Max, or in predicted VO_2 Max (p>0.05).

		BK *13*		AK *10*		Controls *22*		
		mean	SD	mean	SD	mean	SD	**p**
Final Load	Velocity m/min	93.8	7.7	**84.4^**	9.0	95.0	7.0	**0.0027**
	Incline % grade	8.8%	5.4%	6.9%	5.3%	**11.9% ~**	2.9%	**0.0113**
Final Stage	VO_2 Rate ml/kg/min	32.9	7.6	27.3	4.8	31.5	5.9	0.1037
	HR bpm	173	7	169	9	173	5	0.1950
	% HR Max	84%	4%	82%	4%	84%	2%	0.3768
Predicted	VO_2 Rate ml/kg/min	42.2	11.7	35.2	6.8	40.7	7.7	0.1595

Table 2. Results for the final stage and Predicted VO_2 max during graded TMW. ^BK / Control > AK, ~ Control > AK ($p<0.05$)

Discussion:

Data shows that 66% percent of pediatric amputees were able to complete the TMW protocol. Overall, results show that pediatric amputees averaged the same VO_2 Rate and HR when they reach ~82-84% of predicted HR maximum. No significant differences were seen between BK and controls during TM testing. However, during the last stage of testing, patients with prosthetic knees (AK) walked slower, and reach the target HR earlier in the incline stages than the control group. Differences in predicted VO_2 maximum did not meet statistical significance between groups.

References*:*

1. Jeans, Browne, Karol. Effect of amputation level on energy expenditure during overground walking by children with an amputation. J Bone Joint Surg Am. 2011;93:49-56.

2. Powers, Howley. Exercise Physiology. Dubuque, IA: Brown and Benchmark, 1997.

SATURDAY, March 8th
9:30-9:45 AM
Paper 36

COMPARING OXYGEN CONSUMPTION BETWEEN A BILATERAL TRANS-FEMORAL AMPUTEE AND THEIR IDENTICAL TWIN: A CASE STUDY

Todd C. DeWees, BS, CPO and Susan Sienko Thomas, MA, PhD(c)
Shriners Hospital, Portland, OR

This case presentation details the comparison in oxygen consumption and activity level between a bilateral trans-femoral amputee and her identical twin sister. The amputations were a result of septic staph. Since there is little data on oxygen consumption in pediatric trans-femoral amputees, this case gives a rare opportunity for comparison. This comparison is not made with typical aged matched norms but with an identical twin. This gives us the closest possible genetic and environmental comparison to what the true change in oxygen consumption would be for this individual. I believe that this case study provides a unique opportunity to better understand oxygen consumption in pediatric bilateral trans-femoral amputees.

SATURDAY, March 8th
10:30 – 11:30 AM
Symposium IV

Symposium IV: NEUROFIBROMATOSIS: SURGICAL; ORTHOTIC, PROSTHETIC, AND REHABILITATION MANAGEMENT IN CHILDREN

Jorge A. Fabregas, MD, Colleen P. Coulter, PT, DPT, PhD, and Brian J. Giavedoni, MBA, CP, LP
Children's Healthcare of Atlanta, Atlanta, GA

Neurofibromatosis (NF) is a genetic multisystem disorder that can affect the nerves, bones, skin, and connective and soft tissues.

Tumors generally grow along the nerves or can be found on or under the skin. Common findings in children presenting with NF may include: café-au-lait spots and tumors; CNS lesions; scoliosis; skull and facial deformities; hemihypertrophy with bone overgrowth, tibial pseudoarthrosis; vascular disease and pain.

The condition has been classified into either NF1 (von Recklinghausen's) or NF2 (central) with NF1 being the most common presentation. NF1 has a better prognosis with a lower incidence of CNS tumors than NF2. Children diagnosed with NF present a multitude of challenges to healthcare providers who should work as a team to provide coordinated care for optimal outcomes. Orthopedics, orthotics and prosthetics, and rehabilitation play a large role in the management of children with NF.

Commonly seen is congenital pseudarthrosis that may be evident at birth, including bowing of the tibia. Thinning and angulation of long bones can occur throughout early childhood and adolescence, with prominence of the anterior tibia and progressive deformity.

This symposium will focus on the orthopedic, orthotic, prosthetic, and rehabilitation management of the child with NF. Treatment often poses unique orthopedic,orthotic,prosthetic, rehabilitation and psychosocial challenges requiring a concerted effort from a multidisciplinary team.

Objectives:

1. To identify the challenges in treating children in this population
2. To discuss orthopedic, prosthetics and therapy options for the infant, toddler and young child
3. To demonstrate the efficacy of various treatment protocols

Goals: the participants will:

1. Gain a working knowledge of NF and its implications
2. Understand the nuances of orthotic and prosthetic fittings in this population
3. Familiarize themselves with the psychosocial impact of this disease
4. Discuss the challenges presented to the clinical team

SESSION XII – LOWER LIMB

SATURDAY, March 8th
11:30-11:45 AM
Paper 37

PROTECTING THE SKIN PART 2: RESPECTING INCISIONS, PIN SITES, SKIN GRAFTS, AND DONOR SITES IN PATIENTS WHO ENDURE MULTI-TRAUMA RESULTING IN AMPUTATIONS

Colleen P. Coulter, PT, DPT, PhD, PCS, Brian J. Giavedoni, MBA, CP, LP,
Rebecca Hernandez, CPO/L, Michael L. Schmitz, MD, and Jorge A. Fabregas, MD
Children's Healthcare of Atlanta, Atlanta, GA

Children who endure significant traumatic events have multiple system involvement that may include the soft and connective tissues, muscles, skin, and bones. Infections are common. In trauma that involves significant damage to the skin and often de-gloving, coverage of viable underlying tissues may present the biggest challenge to the surgical, prosthetic, and rehabilitation team affecting healing and road to recovery.

The Problem:
There is a delicate balance of *when* to initiate prosthetic fitting, *how* to suspend, *what* components are appropriate for the stage of healing, and *why* wearing schedules differs in patients who have significant loss and damage to skin, extensive skin grafts, donor sites, incisions, healing fractures, and pin sites from external fixation on their residual limbs.
Despite medical advances in medications, topical dressings, wound vacs, liners and suspension technology, prosthetic components, skin coverage, and nutritional support, we struggle to heal, protect, and preserve the healing fragile skin needed to protect and cover the residual limb.

The Solution:
At Children's Healthcare of Atlanta, we have encountered a number of patients with pelvic and lower extremity fractures and lower limb crush injuries with significant loss of skin.
Some have had chronic infections, failed limb sparing procedures, delayed healing, and recurrent breakdown of once healed tissue thin skin. In several cases, the time span of slowly healing wounds is much longer than anticipated. These complications create a burden on the patient's physical and emotional wellbeing and a challenge to the healthcare team. Lessons have been learned through successes and disappointments that patience, timing, simplicity, and education to the patient, family and community providers can lead to very positive outcomes. The patients presented will tell their story about what worked or better yet did not work on their road to recovery. Interventions for wound care, managing scars, adhesions, and banding, and respecting the insensate limb will be discussed.

Trauma- ICD 9 code 959.7 leg, 959.8 multiple trauma
ICD 10 code S88.9 unspecified amputation leg

Skin Graft- ICD 9 code 86.91, 86.65 synthetic and 86.66 donor host to donor recipient
ICD 10 code T86.829, failure of skin graft T86.821

SATURDAY, March 8th
11:45 AM-12:00 PM
Paper 38

ORTHOTIC INTERVENTION OPTIONS FOR LIMB SALVAGE TREATMENT OF FIBULAR HEMIMELIA

Challenging Case

Justina S. Shipley, CO, MEd, FAAOP
Shriners Hospitals for Children, Shreveport, LA

The Problem:
The patient presents with left fibular hemimelia with the absence of fifth metatarsal and phalanx, the navicular and talus are present, and some tibial bowing. Patient is currently 18yo has opted for limb salvage, has severe valgus at the ankle, severe hallux valgus, is in fixed plantar flexion of about 20* and the tibia and has fallen off of the talus causing rotation at the ankle in the medial plane. The patient currently bears weight on the medial malleolus, has constant skin break down issues and has a 3.4 cm leg length discrepancy. Patient breaks most devices within a short time frame because he is very active and plays sports. The problem is trying to find a device that would be durable, minimize skin problems and breakdown but maximize function of foot and ankle in their current state.

The Solution or what has been done:
At a young age the patient was prescribed a thermoplastic AFO, which would slide off so it was replaced with a double upright AFO and a shoe lift. Patient has had serial casting several times to try and control the Achilles tendon tightness, as well as botox injections. The patient had a tibial corticotomy with Ilizarov fixator that bridged the foot. The lengthening procedure resulted in 7.5 cm of distraction and tibial bowing was corrected. Follow-up complications of pin site infection and a knee flexion contracture occurred. He also was prescribed a clam shell AFO and a dyna-splint for knee flexion contracture after the pins were removed from the foot. After frame removal patient was placed in a rocker bottom shoe and a valgus prevention AFO. Heel cord tightness was still an issue and valgus deformity of the foot continued to worsen. A screw was placed in the medial malleolus to help with valgus deformity, with a left opening wedge osteotomy with iliac crest bone graft, peroneus brevis, peroneus longus and Achilles Z-lengthening followed by casting. A thermoplastic AFO with valgus prevention was continued along with a shoe lift. Continued issues with valgus deformity at the ankle and hallux valgus, with plantar flexion and leg length discrepancy continued to make orthotic intervention more difficult. An AFO of graphite laminate with accommodation for plantar flexion and valgus with extra padding is currently being worn. The shoe lift has been discontinued. Limb salvage is still the preferred treatment option to this patient.

SATURDAY, March 8th
12:00-12:10 PM
Paper 39

CREATIVE PROSTHETIC FITTING FOR UNILATERAL TIBIAL DEFICIENCY AND KNEE FLEXION CONTRACTURE WITHOUT SURGICAL CORRECTION

Phoebe R. Scott-Wyard, DO and David M. Craft, CP
Shriners Hospital for Children, Los Angeles
Child Amputee Prosthetics Project clinic

8 y/o F who was born with features of what was originally felt to be VACTERL association. Her diagnoses include: Anal atresia with vaginal-rectal fistula, which was repaired in Korea; vertebral anomaly without significant scoliosis; renal abnormalities of vesicoureteral reflux s/p surgical repair; congenital heart disease (PDA, ASD), surgically treated; and a right upper extremity radial deficiency with a radially deviated hand with active elbow joint and a pedunculated nonfunctioning thumb, a fairly functional four-digit hand; and a right lower extremity tibial deficiency with no significant knee function and knee flexion contracture with subluxation. Family has been adamant about not undergoing surgical conversion to a knee disarticulation, despite the clinic's strong opinion that she would be much more functional with this surgery.

In the meantime, she was fit with an extension prosthesis, a very non-conventional above-knee type with the leg flexed completely at the knee with the foot posteriorly at the level of the hip. However, with growth and continued deformity of her residual foot, her fit issues have made prosthetic fitting very difficult, and Pt only tolerates 10 minutes of wear. Therefore, alternative options for prosthetic fitting were discussed, as her foot had gotten large enough to impede comfortable socket containment. Pt was fit with a novel bent-knee type prosthesis with flexible inner socket and laminated front/base with posterior window for her leg to be external to the socket. It was felt that as the Pt crawls at home without difficulty, therefore she should easily be able to weight-bear through her femoral condyles. Suspension was with Velcro strap around thigh portion. Father was concerned that her foot would hang down and people would see it, therefore, a strap was placed around the heel to keep it close to the socket, but allow for ease of movement when seated for comfort. Photos and videos of patient with different prostheses to be demonstrated.

SATURDAY, March 8th
12:10-12:20 PM
Paper 40

PEDIATRIC PARTIAL FOOT PROSTHESES: A NEW TREATMENT OPTION?

Pamela K. Hale, CPO
Allard USA, Rockaway, NJ and Active Life, Inc., Glendale, CA

INTRODUCTION:

Documentation of pediatric partial foot amputation (PFA), prosthetic intervention and effectiveness of treatment is insufficient. Recommendations regarding pediatric prosthetic intervention advise downsizing, sequenced complexity and modularity that does not interfere with increased activity level.[2] Current pediatric treatment options mimic adult options with the intervention proportional to the extent of tissue lost.[3] It has been recommended that any amputation involving the metatarsal heads or proximal structures requires a prosthetic intervention that extends proximal to the ankle.[4] A prosthesis utilizing a custom fit rigid dynamic carbon composite (DCC) ankle foot orthosis (AFO) structure to aid in the restoration of gait has been utilized for the adult PFA patient.[5]

METHODS:

A custom fit tibial tubercle height rigid DCC with carbon anterior shell AFO with a custom toe-filler type socket with posting are the components of the proposed prosthesis (DCCP). The custom fit DCC is a prefabricated full carbon footplate, rigid lateral strut and carbon composite anterior shell. The footplate is semi-rigid with a tapered rocker, a flexible heel section and a rigid stable mid-foot section. A single patient with bilateral congenital longitudinal amputations was fit with the proposed design and temporal spatial data and pelvic kinematic data was collected utilizing the BTS Engineering G-Walk system. Three bilateral treatment conditions; high top shoe, toe filler prosthesis, and new shoe with prosthesis fabricated with DCCP were compared to barefoot.

RESULTS:

Speed and cadence decreased with interventions while stance duration increased. Double limb support duration trended down when interventions above the ankle were used. Coronal and transverse pelvic motion was relatively symmetrical in all conditions. Sagittal plane motion was asymmetrical in all conditions with most motion anterior to neutral.

DISCUSSION:

The use of a tibial tubercle height toe filler prosthesis utilizing DCC AFO appears to aid in increased stance stability for this patient as inferred by increased single limb support duration while speed decreased. The patient's preferred method of ambulation is barefoot and with the high top shoes. Both the toe filler and DCCP were new interventions for the patient; prior to testing she used each system for 30". We intend to continue to measure gait parameters for the next 6 months to identify if further use will enhance function.

As with most orthotic/prosthetic interventions, further research on specific effects on gait function utilizing the DCCP need to be conducted. Preliminary data regarding use of the DCC AFO in the normal pediatric population indicates that a dynamic response carbon AFO, similar to the rigid DCC design, provides improved function in running, jumping and walking performance while Gross Motor Function Measure was also improved.[1] Similar outcomes are expected with a PFA DCC prosthesis due to the similarity of the gross structure and function of the rigid DCC design.

REFERENCES:

1. Bapty, E et al. *CAPO.* Victoria, BC Canada, 2012.
2. Cummings, DR & Kapp, SL. *JPO*; V4, N4, 196, 1992.
3. Dillon, M. *O&P Edge*; February 2010.
4. Fatone, S. *O&P Business News*; April 2011.
5. Kennedy, S & Meier, R. *The O&P Edge*; January 2011

Poster 1

PEDIATRIC PARTIAL FOOT PROSTHESES: UTILIZING A CUSTOM FIT DYNAMIC CARBON COMPOSITE PROSTHESIS

Pamela K. Hale, CPO
Allard USA, Rockaway, NJ

INTRODUCTION:

Documentation of pediatric partial foot amputation (PFA), prosthetic intervention and effectiveness of treatment is insufficient. However, recommendations regarding pediatric prosthetic intervention advise downsizing, sequenced complexity and a modular design that does not interfere with an increased activity level.[2] In the general population PFA is the most common amputation surgery with 2 per 1000 affected.[4] Transmetatarsal or mid-tarsal amputations account for approximately 24% of PFAs.[3] In the pediatric population 40% of amputations are attributed to trauma, with majority due to lawn mower and household accidents.[8] Current pediatric treatment options mimic those for adults with the extent of the intervention proportional to the extent of tissue lost.[3] Recently it has been recommended that any amputation including or proximal to the metatarsal heads requires a prosthetic intervention that extends proximal to the ankle.[6] A prosthesis utilizing a custom fit rigid dynamic carbon composite (DCC) ankle foot orthosis structure to aid in the restoration of gait has been proposed for the adult PFA patient.[7] By extending above the ankle the prosthesis aids in the progression of the center of pressure along the foot and restores the biomechanics of walking.[6]

METHODS:

A prosthetic design for treating the pediatric partial foot amputee that restores gait function by addressing the biomechanical deficits is proposed. A new design custom fit rigid DCC with carbon anterior shell AFO customized with a toe-filler type socket with posting are the components of the proposed prosthesis. The AFO is custom fit design with a full carbon full length foot plate with a rocker, rigid lateral strut and carbon composite anterior shell. This design aids in restoring gait by allowing for a controlled plantarflexion moment at initial contact, a stable midstance and a controlled tibial advancement through terminal stance, while maintaining a 3rd rocker rollover and providing propulsion at terminal stance. The ability to customize the socket, dynamic properties, alignment and interface helps to protect the skin of the residuum while the dynamic function can be customized for functional needs.

DISCUSSION:

This design is proposed based on reported outcomes of adult PFA patients. Gait studies utilizing the proposed PFA DCC design need to be conducted. Preliminary data regarding use of the DCC AFO in the pediatric population indicates that a dynamic response carbon AFO, similar to the rigid DCC design, provides improved function in running, jumping and walking performance while Gross Motor Function Measure was also improved.[1] Similar outcomes are expected with a PFA DCC prosthesis due to the similarity of the gross structure and function of the rigid DCC design.

REFERENCES:

1. Bapty, E et al. *CAPO.* Victoria, BC Canada, 2012.
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5. Dillon, MP*. Lower Extremity Review;* Feb 2010.
6. Fatone, S. *O&P Business News*; April 2011.
7. Kennedy, S & Meier, R. *The O&P Edge*; January 2011.
8. Tooms, RE. Atlas of Limb Prosthetics , chapter 32, 2002.

Poster 2

UNIQUE LOWER EXTREMITY ORTHOTIC INTERVENTIONS FOR CHILDREN WITH ARTHROGRYPOSIS: A SINGLE CASE OVERVIEW

Justina S. Shipley, CO, MEd, FAAOP
Shriners Hospitals for Children, Shreveport, LA

This is a single case overview of unique lower extremity orthotic intervention strategies for children with arthrogryposis. This overview will explain alternative and new options for orthotic devices used to help with ambulation for patients with a diagnosis of arthrogryposis. The prescription criteria and strategies used for device fabrication will be discussed in addition to the ambulation performance after device application. The implications of the results of the orthotic intervention will also be addressed.

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