POSNA

2014 ANNUAL MEETING

Welcome

POSNA UPCOMING MEETINGS

11th Annual International Pediatric Orthopaedic Symposium
December 3-6, 2014 – Orlando, FL
Presented by POSNA and AAOS

POSNA Specialty Day
March 28, 2015 – Las Vegas, Nevada

POSNA 2015 Annual Meeting and Pre-Course
April 29 – May 2, 2015
Marriott Marquis – Atlanta, Georgia

POSNA

Acknowledgments

The Pediatric Orthopaedic Society of North America gratefully acknowledges the following for their generous financial support during 2014:

Howard Steel Foundation
St. Giles Foundation
Angela S.M. Kuo Memorial Fund

Double Diamond Level
K2M*
Medtronic*
OrthoPediatrics*

Diamond Level
DePuy Synthes*
Stryker*

Platinum Level
Biomet Spine/Trauma*
Shriners Hospitals for Children

Gold Level
Arthrex, Inc.
BioMarin Pharmaceutical Inc.
Globus Medical
Medicrea, USA*
Pega Medical*
Wright Medical

Silver Level
Alphatec Spine*
Ellipse Technologies, Inc.
Orthofix*

Thank You

*Provided financial support for the 2014 Annual Meeting

Welcome

On behalf of our local host, David Skaggs and his wife Val Ulene, we welcome you to Hollywood and the 2014 POSNA Annual Meeting. Many POSNA volunteers and staff have been working hard to make our experience in Hollywood spectacular. The meeting opens on Wednesday morning with the pre-course entitled "Quality, Safety, Value: From Theory to Practice Management." Min Kocher has enlisted experts both inside and outside of POSNA to help all of us understand how the changing healthcare environment and a focus on quality and value will affect our practice. The scientific sessions begin Wednesday afternoon: Todd Milbrandt and his program committee have assembled some of the highest rated papers submitted into an outstanding quality and value session that will help your patients.

The opening ceremony on Wednesday evening allows us to recognize our industry sponsors and the outstanding achievement of several of our members. The Award's Committee has selected the following individuals: Humanitarian Award, Rick Schwend and Special Effort and Excellence Award, Bryan Tompkins. The Distinguished Achievement Award recipient, Al Crawford, will be introduced on Thursday. The Opening Ceremony Steele lecturer is Jamie Lee Curtis, giving us a celebrity's welcome to Hollywood with a talk entitled "Live Wisely, Love Well."

We want to call particular attention to the "no-fly zone" on Thursday afternoon. Member feedback from past annual meetings and the POSNA Member Needs Assessment shows that a resounding majority of POSNA members want a free afternoon for recreation, community building, and exploration of our host city. We have organized tennis and hiking as well as provided information on a large number of local attractions that would interest you on Thursday afternoon. With the help of our local hosts, we've paid careful attention to avoid the outrageous prices tour companies propose to make all of your activities worthwhile and of good value. We hope that you will get out with friends, spouses and fellow members and enjoy Hollywood, Los Angeles, and Southern California.

The Presidential Guest lecturer on Friday morning will be Chad Price, well known to members as a pediatric orthopaedic innovator, critical thinker and leader. Chad's lecture will continue the forward-looking pre-course theme with a talk entitled "Pediatric Orthopedics and You: How to Survive the Next 10 Years."

The wildly successful POSNA Subspecialty Day will continue with its Friday afternoon timeslot. Five concurrent sessions (Hip, Spine, Sports, Hand/Upper Extremity and Neuromuscular/Lower Extremity) will run concurrent free paper and symposia formats.

The social schedule includes a welcome reception immediately following the opening ceremony on the pool deck underneath the Hollywood stars. After such a cold winter in most of North America, this will be a much anticipated opportunity to kick off the summer season. Thursday evening has been traditionally reserved for fellowship reunions and other gatherings with friends and colleagues. With the venue in Hollywood, just steps from the site of the Academy Awards, our Friday event is appropriate; you will get the full red carpet treatment at our own POSNA Oscars Party. Enjoy POSNA 2014 in Hollywood!

Jack Flynn, MD, POSNA President

POSNA

2014 ANNUAL MEETING

ABOUT POSNA

The Pediatric Orthopaedic Society of North America (POSNA) is a group of professionals comprised mostly of pediatric orthopaedic surgeons. We are board certified in orthopaedic surgery and have participated in additional training to become specialized in the care of children's musculoskeletal health and our practice reflects this dedication. We, as a group, strive to become the authoritative source on such care through appropriate research that will lead to the best evidence-based patient care. On this page you will find more information about our society and a way to contact us with questions.

MISSION STATEMENT

To assure the best possible care of children with musculoskeletal disorders by implementing the highest quality education of pediatric orthopaedists, by supporting evidence research and by developing appropriate alliances with related organizations.

POSNA

TABLE OF CONTENTS

POSNA

GENERAL MEETING INFORMATION

LEARNING OBJECTIVES

Upon completion of this program, participants should be able to:

- Objective 1: Discuss 3 new developments in pediatric orthopaedic surgery.
- Objective 2: Implement 2 new techniques in the participants' practice of pediatric orthopaedic surgery.
- Objective 3: Describe the impact of advances in basic molecular and biomechanical sciences and discuss their likely impact upon the practice of pediatric orthopaedic surgery.
- Objective 4: Demonstrate an understanding of current megatrends in medical practice, such as the move from volume to value, and gain insights into improving the quality, safety and value of care delivered in their practice.

ACCREDITATION

This Annual Meeting of the Pediatric Orthopaedic Society of North America has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of the American Academy of Orthopaedic Surgeons and POSNA. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

CONTINUING MEDICAL EDUCATION

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **20.5** ***AMA PRA Category 1 Credits***.™ Physicians should claim credit commensurate with the extent of their participation in the activity.

FDA STATEMENT **(UNITED STATES)**

Some drugs or medical devices demonstrated at this Annual Meeting may not have been cleared by the FDA or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Academy policy provides that "off label" uses of a drug or medical device may be described in the Academy's CME activities so long as the "off label" use of the drug or medical device is also specifically disclosed (i.e., it must be disclosed that the FDA has not

cleared the drug or device for the described purpose). Any drug or medical device is being used "off label" if the described use is not set forth on the product's approval label.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (ie., the drug or medical device is being discussed for an "off label" use).

DISCLAIMER

The material presented at the Annual Meeting has been made available by the Pediatric Orthopaedic Society of North America for educational purposes only. The material is not intended to represent the only, nor necessarily best, method or procedure appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty which may be helpful to others who face similar situations.

POSNA disclaims any and all liability for injury or other damages resulting to any individual attending the Annual Meeting and for all claims which may arise out of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by physician or any other person.

DISCLOSURE

Each faculty member in this meeting has been asked to disclose if he or she has received something of value from a commercial company or institution, which relates directly or indirectly to the subject of their presentation. The Academy has identified the options to disclose as follows:

1. Royalties from a company or supplier;
2. Speakers bureau/paid presentation for a company or supplier;
3. (a) paid employee or (b) paid consultant or
   (c) unpaid consultant for a company or supplier;
4. Stock or stock options in a company or supplier;
5. Research support from a company or supplier as a PI;
6. Other financial or material support from a company or supplier;
7. Royalties, financial or material support from publishers;
8. Medical/orthopaedic publications editorial/governing board;
9. Board member/committee appointments for a society; n-no conflicts.

n. No conflicts

LANGUAGE

English will be the official language of the POSNA Pre-Course and Annual Meeting.

POSNA ANTITRUST POLICY

It shall be the policy of the Pediatric Orthopaedic Society of North America (POSNA) to be in strict compliance with all Federal and State Antitrust laws, rules and regulations. Therefore: These policies and procedures apply to all membership, board, committee, and all meetings attended by representatives of the POSNA.

Discussions at POSNA meetings often cover a broad range of topics pertinent to the interests or concerns of orthopaedic surgeons. As a general rule, except as noted below, discussions at POSNA meetings can address topics without raising antitrust concerns if the discussions are kept scrupulously free of even the suggestion of private regulation of the profession. However, a number of topics that might be (and have been) discussed at POSNA meetings may raise significant complex antitrust concerns. These include:

- Membership admissions, rejections, restrictions, and terminations;
- Method of provision and sale of POSNA products and services to non-members;
- Restrictions in the selection and requirements for exhibitors at the POSNA Annual Meeting or in CME activities;
- Collecting and distributing certain orthopaedic practice information, particularly involving practice charges and costs;
- Obtaining and distributing orthopaedic industry price and cost information;
- Professional certification programs;
- Group buying and selling; and
- Inclusions or exclusion of other medical societies in organizational activities or offerings.

When these and related topics are discussed, the convener or members of the POSNA group should seek counsel from its General Counsel.

POSNA urges its Board, committees and members not to participate in discussions that may give the appearance of or constitute an agreement that would violate the antitrust laws. Notwithstanding this reliance, it is the responsibility of each POSNA Board or member to avoid raising improper subjects for discussion. This policy has been prepared to ensure that POSNA members and other participants in POSNA meetings are aware of this obligation.

NO SMOKING POLICY

Smoking is not permitted during any meeting or event.

NO CAMERAS OR VIDEO CAMERAS

Cameras or video cameras may not be used in any portion of the scientific session.

NO REPRODUCTIONS

No reproductions of any kind including audio tapes and videotapes may be made of the presentations at this meeting without the prior written permission of POSNA. POSNA reserves all of its rights to such material and commercial reproduction is specifically prohibited.

PHOTOGRAPHS

Registration and attendance at, or participation in, POSNA activities constitutes an agreement by the registrant to allow POSNA to use and distribute (both now and in the future) the registrant's or attendee's image in POSNA member communications and promotional materials.

POSNA extends sincere appreciation to K2M for a restricted grant in support of the printing of this final program.

POSNA

2014 HALF-DAY PRE-COURSE

QUALITY, SAFETY, VALUE: FROM THEORY TO PRACTICE MANAGEMENT

Wednesday, April 30, 2014
8:00 AM–12:30 PM
Hollywood Loews Hotel, Hollywood, California

DESCRIPTION

Quality, Safety, and Value are the buzzwords of modern medicine and healthcare reform. Major efforts are underway in these arenas from a variety of stakeholders including physicians, physician practices, hospitals, insurers, and government organizations including CMS, HHS, and PCORI. In addition, the Affordable Care Act contains provisions and regulations regarding safety and quality. POSNA and AAOS are actively involved with several quality, safety, and value initiatives. Because this is a hot topic involving many parties and is changing rapidly, orthopaedic surgeons may lack knowledge of what is value, how quality is being measured, performance measures, value-based healthcare, accountable care organizations, bundled payments, AAOS initiatives, ABOS initiatives, governmental programs, and specific contemporaneous programs. This program addresses these gaps by discussing healthcare reform and value based medicine and also by providing deliverables of current initiatives that members can incorporate into their practices.

This program will address both the broader theory and context of healthcare reform as it relates to value, safety, and quality via value-based healthcare in addition to providing specific deliverables about programs that are underway and can be incorporated into members' practices. The faculty includes POSNA members who are actively engaged in these areas and outside experts who are leaders in this field such as **Dr. Atul Gawande, Dr. Kevin J. Bozic and Dr. David Jevsevar**. The program includes talks, roundtables, and room for discussion for dynamic learning. The hospital perspective and the system perspective are provided. New payment schemes such as accountable care organizations, pay for performance, and bundled payments are discussed. AAOS, POSNA, and ABOS initiatives are overviewed. Specific "deliverable" initiatives among POSNA members are also overviewed.

OBJECTIVES

Upon completion of this program, participants should be able to:

1. Describe the concept of Value-Based Medicine and the contemporaneous forces in healthcare reform that are driving an emphasis on Safety, Value, and Quality.
2. Recognize the Quality, Safety, and Value initiatives being undertaken by POSNA, AAOS, and ABOS.
3. Prepare their practice for healthcare reform by understanding the hospital perspective, the healthcare system perspective, and new payment schemes such as accountable care organizations, pay for performance, and bundled payment.
4. Take home "deliverables" to their practice for Quality, Safety, and Value initiatives promulgated by POSNA members.

ACCREDITATION

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of the American Academy of Orthopaedic Surgeons and the Pediatric Orthopaedic Society of North America. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

CONTINING MEDICAL EDUCATION

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **4.25** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

POSNA

2014 PRE-COURSE AGENDA

QUALITY, SAFETY, VALUE: FROM THEORY TO PRACTICE MANAGEMENT

Wed., April 30, 2014 • 8:00 AM–12:30 PM • Ray Dolby Ballroom

Chair: *Mininder S. Kocher, MD*

8:00 AM–8:05 AM **Opening Welcome**
POSNA President: *John (Jack) M. Flynn, MD*
Philadelphia, PA
Chair: *Mininder S. Kocher MD*
Boston, MA

SESSION 1

8:00 AM–8:50 AM
VALUE-BASED HEALTHCARE
Moderator: *Michael G. Vitale, MD*
New York, NY

8:05 AM–8:30 AM **KEYNOTE: Moving from Volume to Value: Why and How**
Kevin J. Bozic, MD, San Francisco, CA

8:30 AM–8:35 AM **POSNA Quality, Safety, Value Initiative**
James McCarthy, MD, Cincinnati, OH

8:35 AM–8:40 AM **Value of Pediatric Orthopaedic Surgery**
Mininder S. Kocher, MD, Boston, MA

8:40 AM–8:50 AM DISCUSSION

SESSION 2

8:50 AM–9:30 AM
HEALTHCARE DELIVERY
Moderator: *James H. Beaty, MD*
Memphis, TN

8:50 AM–9:00 AM **Preparing Your Practice for Healthcare Reform**
Kevin J. Bozic, MD, San Francisco, CA

9:00 AM–9:10 AM **Hospital Perspective: ACO's, Bundled Payments, and Metrics**
James R. Kasser, MD, Boston, MA

9:10 AM – 9:20 AM **Health System Perspective: Variation, Costs, and Physician Behavior**
David Jevsevar, MD, Saint George, UT

9:20 AM – 9:30 AM DISCUSSION

9:30 AM – 9:40 AM VIDEO SPOTLIGHT
An Interview with Atul Gawande, MD

9:40 AM – 9:55 AM BREAK

SESSION 3

9:55 AM – 10:40 AM
AAOS and ABOS INITIATIVES
Moderator: *Steven L. Frick, MD*
Orlando, FL

9:55 AM – 10:00 AM **Historical Perspective**
Michael J. Goldberg, MD, Seattle, WA

10:00 AM – 10:10 AM **AAOS Initiatives**
James O. Sanders, MD, Rochester, NY

10:10 AM – 10:15 AM **From CPG to ROCK**
Kevin G. Shea, MD, Boise, ID

10:15 AM – 10:25 AM **ABOS Initiatives**
Stephen A. Albanese, MD, East Syracuse, NY

10:25 AM – 10:40 AM DISCUSSION

SESSION 4

10:40 AM – 12:15 PM
DELIVERABLES
Moderator: *Mininder S. Kocher, MD*
Boston, MA

10:40 AM – 10:45 AM **Simulation**
Donald S. Bae, MD, Boston, MA

10:45 AM – 10:50 AM **Team STEPPS**
Howard R. Epps, MD, Houston, TX

10:50 AM – 10:55 AM **Radiation Safety**
Michelle S. Caird, MD, Ann Arbor, MI

10:55 AM – 11:10 AM DISCUSSION

11:10 AM – 11:15 AM **Supracondylar PIM**
Gregory A. Mencio, MD, Nashville, TN

11:15 AM – 11:20 AM **Supracondylar Map**
Michael J. Goldberg, MD, Seattle, WA

11:20 AM – 11:25 AM **SCAMPS / TDABC**
Peter M. Waters, MD, Boston, MA

11:25 AM – 11:40 AM DISCUSSION

11:40 AM – 11:45 AM **NSQIP**
Brian K. Brighton, MD, Charlotte, NC

11:45 AM – 11:50 AM **Trauma**
William L. Hennrikus, MD, Hershey, PA

11:50 AM – 11:55 AM **Infection**
Kevin G. Shea, MD, Boise, ID

11:55 AM – 12:00 PM **Spine**
Michael G. Vitale, MD, New York, NY

12:00 PM – 12:15 PM DISCUSSION

SESSION 5

12:15 PM – 12:30 PM
FUTURE DIRECTIONS
Moderator: *Peter M. Waters, MD, Boston, MA*

12:15 PM – 12:20 PM **What Should We Measure?**
Benjamin J. Shore, MD, MPH, FRCSC, Boston, MA

12:20 PM – 12:25 PM **How Should We Fund This?**
Kit M. Song, MD, Los Angeles, CA

12:25 PM – 12:30 PM **Wrap Up – Future Directions**
Peter M. Waters, MD, Boston, MA

POSNA

2014 OPENING CEREMONY

WEDNESDAY, APRIL 30, 2014

6:30 PM–9:30 PM • Loews Hollywood Hotel • Ray Dolby Ballroom

6:30 – 6:40 PM	**WELCOME** **POSNA President:** *Jack M. Flynn, MD* **Local Host:** *David L. Skaggs, MD*
6:40 – 6:50 PM	**Introductions Distinguished Guests** • International Presidents • New Members • Distinguished Achievement Award Recipient • Presidential Guest Speaker • SLAOTI Traveling Fellows • APPOS Traveling Fellows • COUR Visiting Scholars
6:50 – 6:55 PM	**Presentation of the St. Giles Young Investigator Award** *Donald R. Huene, MD* and *Donald S. Huene, MD*
6:55 – 7:00 PM	**Presentation of the Arthur H. Huene Award** *Donald R. Huene, MD* and *Donald S. Huene, MD*
7:00 – 7:05 PM	**Presentation of Angela S.M. Kuo Memorial Award** *Ken N. Kuo, MD*
7:05 – 7:10 PM	**Presentation of the Humanitarian Award** *Jack M. Flynn, MD*
7:10 – 7:15 PM	**Presentation of the Special Effort and Excellence Award** *Jack M. Flynn, MD*
7:15 – 7:30 PM	**Recognition of Industry Sponsors** *Jack M. Flynn, MD*
7:30 PM	**Introduction Steel Lecturer** *Jack M. Flynn, MD*
7:35 – 8:00 PM	**Steel Lecture** "Live Wisely, Love Well." *Jamie Lee Curtis*
8:00 – 9:30 PM	**Welcome Reception**

Levels of Evidence for Primary Research Questions

Types of Studies				
	Therapeutic Studies—Investigating the Results of Treatment	**Prognostic Studies—Investigating the Effect of a Patient Characteristic on the Outcome of Disease**	**Diagnostic Studies—Investigating a Diagnostic Test**	**Economic and Decision Analyses—Developing an Economic or Decision Model**
Level I	• High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals • Systematic review[2] of Level-I randomized controlled trials (and study results were homogeneous[3])	• High-quality prospective study[4] (all patients were enrolled at the same point in their disease with ≥80% follow-up of enrolled patients) • Systematic review[2] of Level-I studies	• Testing of previously developed diagnostic criteria in series of consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level-I studies	• Sensible costs and alternatives; values obtained from many studies; multiway sensitivity analyses • Systematic review[2] of Level-I studies
Level II	• Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization) • Prospective[4] comparative study[5] • Systematic review[2] of Level-II studies or Level-I studies with inconsistent results	• Retrospective[6] study • Untreated controls from a randomized controlled trial • Lesser-quality prospective study (e.g., patients enrolled at different points in their disease or <80% follow-up) • Systematic review[2] of Level-II studies	• Development of diagnostic criteria on basis of consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level-II studies	• Sensible costs and alternatives; values obtained from limited studies; multiway sensitivity analyses • Systematic review[2] of Level-II studies
Level III	• Case-control study[7] • Retrospective[6] comparative study[5] • Systematic review[2] of Level-III studies	• Case-control study[7]	• Study of nonconsecutive patients (without consistently applied reference "gold" standard) • Systematic review[2] of Level-III studies	• Analyses based on limited alternatives and costs; poor estimates • Systematic review[2] of Level-III studies
Level IV	Case series[8]	Case series	• Case-control study • Poor reference standard	• No sensitivity analyses
Level V	Expert opinion	Expert opinion	Expert opinion	Expert opinion

1. A complete assessment of the quality of individual studies requires critical appraisal of all aspects of the study design.
2. A combination of results from two or more prior studies.
3. Studies provided consistent results.
4. Study was started before the first patient enrolled.
5. Patients treated one way (e.g., with cemented hip arthroplasty) compared with patients treated another way (e.g., with cementless hip arthroplasty) at the same institution.
6. Study was started after the first patient enrolled.
7. Patients identified for the study on the basis of their outcome (e.g., failed total hip arthroplasty), called "cases," are compared with those who did not have the outcome (e.g., had a successful total hip arthroplasty), called "controls."
8. Patients treated one way with no comparison group of patients treated another way.

This chart was adapted from material published by the Centre for Evidence-Based Medicine, Oxford, UK. For more information, please see. www.cebm.net.

Name	Disclosure	Presentation Type
Abbott, Matthew D.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #9
Abel, Mark F.	8 -Gait and Posture; 9-Scoliosis Research Society	Paper #45; E-Poster #56
Abildgaard, Jeffrey	n-none	e-Poster #52
Abzug, Joshua M.	3B-Axogen; 7-Springer	Paper #5; e-Posters #57, 59, 60; Reviewer - Hand Subspecialty Day
Acar, Mehmet	n-none	e-Poster #14
Adler, Lily	n-none	Paper #67
Ahmad, AlaaEldin A.	n-none	COUR Symposium
Ahmad, Christopher S.	3B-Acumed, LLC, Arthrex, Inc; 5-Arthrex, Inc; Major League Baseball, Stryker	Paper #6
Ahmadian, Amir	n-none	e-Poster #13
Aiona, Michael A.	8-Gait and Posture, Journal of Bone and Joint Surgery - American, Journal of Pediatric Orthopedics, CORR, JCO; 9-American Academy for Cerebral Palsy and Developmental Medicine	Paper #64
Akbarnia, Behrooz A.	1-DePuy Spine, Nuvasive; 3B-Nuvasive, K2M, Ellipse, K Spine; 4-Alphatec Spine; Nuvasive, Ellipse, K Spine, Nocimed; 5-DePuy Spine, Nuvasive; 7-Springer; 8-Journal of Orthopaedic Science, Spine, Spine Deformity-SRS Journal; 9-Growing Spine Foundation, San Diego Spine Foundation, Scoliosis Research Society	Papers #7, 40, 43, 44
Aleem, Alexander W.	n-none	Spine Subspecialty Day #1
Ali, Farhan	n-none	e-Poster #10
Alkhelaifi, Khalid Abdulrahman	n-none	Paper #15
Allar, Benjamin	n-none	e-Poster #35
Allgier, Allison	n-none	Hand Subspecialty Day #7

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Allington, Nanni	9-BAPO Belgian Paediatric Orthopaedic Society; SORBCOT Belgian Orthopaedic and Traumatology Society	Paper #25
Alman, Benjamin A.	4-ScarX; 8-Journal of Orthopaedic Research; Journal of Orthopaedic Research, PLoS One; 9-Shriners Research Advisory Board, Orthopaedic Research Society	Moderator - Neuromuscular/Lower Extremity Subspecialty Day; Papers #82, 84
Alzahrani, Mohammad Mesfer	n-none	Paper #15
Amaral, Terry D.	5-DePuy, A Johnson & Johnson Company, Stryker, Medtronic	e-Poster #62
Amir, Dzulkarnain	n-none	Paper #52
Anderson, John T.	9-Mid-Central States Orthopaedic Society, Missouri State Orthopaedic Association	Paper #73
Anderson, Megan E.	9-Musculoskeletal Tumor Society Education Committee, New England Orthopaedic Society Massachusetts Representative	Paper #101
Andras, Lindsay	4-Eli Lilly	Papers #12, 74; e-Posters #67, 83
Andre, Allison M.	n-none	Poster #1
Anissipour, Alireza	n-none	Paper #77
Anthony, Alison	n-none	Hand Subspecialty Day #9
Archibald-Seiffer, Noah	n-none	Poster #1
Ariagno, Jill	n-none	NP/PA Symposium
Arkader, Alexandre	3C-Biomet	Paper #102; e-Poster #83; Reviewer
Armaghani, Sheyan	n-none	Paper #51
Aronsson, David D.	4-Abbott, Bristol-Myers Squibb, Eli Lilly, Johnson & Johnson, Medtronic, Pfizer, Procter & Gamble, Stryker; 8-Journal of Bone and Joint Surgery - American, Journal of Children's Orthopaedics	e-Poster #44
Aruwajoye, Olumide	n-none	Paper #80
Asemota, Anthony Osamudiame	n-none	Poster #5
Ashby, Elizabeth	n-none	e-Posters #12, 17; Hip Subspecialty Day #4
Ashraf, Ali	n-none	Paper #86
Asokan, Ajay	n-none	Paper #28
Atanda, Alfred	3B-Arthrex, Inc	Sports Subspecialty Day #7
Augsburger, Samuel F.	n-none	Papers #20, 68

Name	Disclosure	Presentation Type
Auriemma, Michael	3A-GlaxoSmithKline; 4-GlaxoSmithKline	e-Poster #66
Averill, Lauren	n-none	Sports Subspecialty Day #7
Aydin, Bahattin Kerem	n-none	e-Poster #14
Azzam, Khalid A.	n-none	Paper #110
Baca, Geneva	n-none	Paper #38; e-Posters #25, 27, 29, 32, 33, 34
Bache, Christopher Edward	2-Biomarin	Poster #18
Badrinath, Raghav	n-none	Hip Subspecialty Day #3
Bae, Donald S.	4-DTRX, Johnson & Johnson, VVUS; 7-Lippincott Williams & Wilkins; 9-ASSH; POSNA	Paper #87; e-Poster #85; Hand Subspecialty Day; Sports Subspecialty Day #9
Baghdadi, Yaser M.K.	n-none	e-Poster #63
Bagley, Anita	n-none	Paper #69
Baird, Glen O.	n-none	Poster #19; e-Poster #18
Baker, Markus	n-none	e-Posters #12, 17
Bakhshi, Sameer	n-none	Poster #12
Baldwin, Keith D.	3B-Synthes Trauma; 4-Pfizer; 7-Journal of Bone and Joint Surgery - American	e-Posters #51, 58
Ballock, R. Tracy	5-Musculoskeletal Transplant Foundation; 9-Pediatric Orthopaedic Society of North America, Shriner's Hospitals for Children, Orthopaedic Research and Education Foundation	Program Committee; Moderator
Barad, Justin	n-none	e-Poster #90
Barnes, Douglas A.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #2
Barrett, Kody Kenneth	n-none	Paper #74
Bartley, Carrie	n-none	Paper #52; e-Posters #69, 70
Bartley, Debra	n-none	e-Poster #94
Bastrom, Tracey	n-none	Papers #49, 52; e-Posters #22, 65, 69, 76
Bauer, Andrea S.	8-Journal of Bone and Joint Surgery - American, Techniques in Hand and Upper Extremity Surgery	Hand Subspecialty Day; Hand Subspecialty Day #4
Bear, David	n-none	Paper #92

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Beaty, James H.	7-Saunders/Mosby-Elsevier; 8-Journal of Bone and Joint Surgery; 9-Orthopaedic Research and Education Foundation	Paper #90; e-Poster #36; Young Members Forum
Beaule, Paul E.	1-Wright Medical Technology, Inc.; 2-Smith-Nephew, MEDACTA; 3B-Corin U.S.A., Smith & Nephew, MEDACTA; 5-Corin U.S.A., DePuy, A Johnson & Johnson Company; 7-Journal of Bone and Joint Surgery - American	e-Poster #32
Bebchuk, Judith D.	n-none	e-Poster #23; Hand Subspecialty Day #5; Sports Subspecialty Day #6
Belthur, Mohan	n-none	e-Poster #10
Berggren, Jamie	n-none	Hand Subspecialty Day #1
Betz, Randal R.	1-DePuy Synthes Spine, Medtronic; 2-DePuy Synthes Spine; 3B-DePuy Synthes Spine, Orthocon, SpineGuard, Medtronic, Zimmer; 3C-Advanced Vertebral Solutions, Orthobond; 4-Advanced Vertebral Solutions, SpineGuard, MiMedx, Orthocon, Orthobond, SpineZ; 5-Depuy Synthes Spine; 7-Thieme	Papers #42, 49; e-Poster #66
Bevan, Wesley Paul	n-none	e-Poster #38
Birch, John G.	1-Orthofix, Inc.; 7-Mosby-Elsevier; 8-Journal of Children's Orthopedics	Neuromuscular/Lower Extremity Subspecialty Day #8, #9
Birke, Oliver	3A-Roche; 3C-Orthofix, Inc.; 6-Orthofix, Inc.	Paper #78
Bixby, Sarah	n-none	Paper #101
Blackman, Andrew J.	n-none	e-Poster #79
Blakemore, Laurel C.	3B-K2M Medical; 5-K2M; 8-Associate Editor, Spinal Deformity Journal; 9-Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Poster #11
Blatz, Allison M.	n-none	Paper #1
Blumetti, Francesco Camara	n-none	Paper #65
Blumstein, Gideon W.	n-none	e-Poster #67
Bocahut, Nicolas	n-none	Paper #17
Bohnenkamp, Frank C.	n-none	Paper #38
Bomar, James D.	n-none	e-Poster #30; Hip Subspecialty Day #9
Bompadre, Viviana	n-none	Papers #8, 34; e-Posters #74, 75
Bonner, Bryant	n-none	Paper #109

Name	Disclosure	Presentation Type
Bono, Kenneth	n-none	e-Poster #55
Borlack, Rachel E.	n-none	e-Poster #62
Boskey, Adele L.	3C-Skelescan; 4-Amgen Co, Bristol-Myers Squibb, DePuy, A Johnson & Johnson Company, Eli Lilly, GE Healthcare, Genzyme; GlaxoSmithKline, Johnson & Johnson, Norvartis, Sanofi-Aventis, Wyeth, Zimmer; 8-Journal of Orthopaedic Research, Calcified Tissue International, Bone, J Bone & Mineral Research, J Dental Research, guest editor, Clinical Orthopaedics & Related Research; 9-Orthopaedic Research Society-Women's Leadership Forum	Poster #6
Bovid, Karen M.	n-none	Paper #59; e-Poster #47
Bowen, Richard E.	9-AAOS Pediatric Education Subcommittee	Sports Subspecialty Day #3
Bowles, Austin	n-none	Paper #41
Boyle, Matthew J.	n-none	e-Poster #38
Brambila, Carlos A.	n-none	Paper #
Brighton, Brian K.	9-Pediatric Orthopaedic Society of North America, American College of Surgeons	Poster #3; e-Poster #82
Broom, Alexander M.	n-none	Paper #66
Brown, Drew	n-none	e-Poster #86
Bruce, Robert W.	9-Board of Trustees - Children's Healthcare of Atlanta, Foundation Board - Children's Healthcare of Atlanta	Paper #12; Spine Subspecialty Day #10
Brydges, Ryan	n-none	Poster #10
Buhr, Neeley	n-none	Paper #63
Burgess, Ronald C.	n-none	Hand Subspecialty Day #3
Burke , Bridget	n-none - Submitted on 2/17	Paper #110
Burkette Ikebata, Nicole	n-none	Paper #8
Burns, Joshua	n-none	Neuromuscular/Lower Extremity Subspecialty Day #6
Burr, Sarah	n-none	Spine Subspecialty Day #8
Busch, Michael T.	3B-Orthopediatrics	Sports Subspecialty Day #8
Byington, Kathleen	n-none	Paper #75
Bylski-Austrow, Donita	3C-SpineForm, LLC; 5-SpineForm, LLC, DePuy, A Johnson & Johnson Company	e-Poster #2

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Cabral, Cristina	9-Pediatric Orthopaedic Society of North America	POSNA Staff
Cahill, Patrick J.	2-DePuy Synthes Spine, Medtronic; 3B-DePuy Synthes Spine, Medtronic; 6-DePuy Synthes Spine, Medtronic; 8-Orthopedics; Spine Deformity, Journal of Bone and Joint Surgery - American; 9-AAOS, Scoliosis Research Society, Pediatric Orthopaedic Society of North America	Moderator; e-Poster #66
Caird, Michelle S.	9-Orthopaedic Research and Education Foundation, Pediatric Orthopaedic Society of North America	Reviewer; e-Moderator; Neuromuscular/Lower Extremity Subspecialty Day; Paper #105; e-Poster #53
Campbell, Jr., Robert M.	n-none	Spine Subspecialty Day
Canavese, Federico	n-none	Poster #14
Cannada, Lisa K.	2-Smith & Nephew; 3B-Zimmer; 5-Smith & Nephew, Synthes, Zimmer; 8-Orthopedics Today; 9-AAOS, Orthopaedic Trauma Association, Ruth Jackson Orthopaedic Society	e-Poster #82
Cao, Jessica	n-none	Paper #12
Caprio, Brendan	n-none	Paper #50
Cardoso, Michelle De Oliveira	3A-Pfizer	Paper #65
Carey, Timothy P.	9-Canadian Orthopaedic Association	e-Poster #94
Carrigan, Robert B.	3A-GlaxoSmithKline; 4-GlaxoSmithKline	Hand Subspecialty Day
Carry, Patrick	n-none	Papers #39, 89; e-Posters #28, 73
Carsen, Sasha	n-none	Paper #87
Carter, Cordelia W.	9-Pediatric Orthopaedic Society of North America, AAOS	Reviewer; Presider; Sports Subspecialty Day
Carter, Erin M.	n-none	Poster #6
Casey, Virginia F.	n-none	Paper #35; Poster #3; e-Poster #82
Cashin, Megan S.	n-none	e-Poster #94
Caskey, Paul M.	9-Bone and Joint Decade, U.S.A., Pediatric Orthopaedic Society of North America	Poster #19; e-Poster #18
Caskey, Sean	9-Bone and Joint Decade, U.S.A., Pediatric Orthopaedic Society of North America	e-Poster #18
Cassidy, Jeffrey A.	n-none	Sports Subspecialty Day #5

Name	Disclosure	Presentation Type
Castaneda, Pablo	3C-Orthopediatrics; 8-Revista Mexicana de Ortopedia Pediátrica; 9-Sociedad Mexicana de Ortopedia Pediátrica, Sociedad de Especialistas en Cirugía Ortopédica del Centro Médico ABC	Paper #27; Hip Subspecialty Day
Caudill, Angela	n-none	Paper #77
Cerame, Barbara	n-none	Paper #2
Cervellione, Raimondo M.	n-none	e-Poster #10
Cha, Angela	n-none	e-Poster #89
Chakravarthy, Vikram B.	n-none	e-Poster #71
Chambers, Henry-Hank G.	3B-Allergan Corporation, Orthopediatrics; 5-Allergan Corporation; 8-Developmental Medicine and Child Neurology, Gait and Posture; 9-AAOS, American Academy for Cerebral Palsy and Developmental Medicine, American Academy for Cerebral Palsy and Developmental Medicine, Pediatric Orthopaedic Society of North America	e-Moderator; Sports Subspecialty Day ; Neuromuscular/Lower Extremity Subspecialty Day #5
Chang, Frank M.	n-none	Paper # 23; e-Posters #49, 50; Neuromuscular/Lower Extremity Subspecialty Day #4
Chaudhry, Sonia	n-none	Hand Subspecialty Day #9
Chen, Elena	n-none	e-Poster #1
Cheng, Jack C-Y.	8-Journal of Pediatric Orthopedics	Paper #47
Cheon, Jung-Eun	n-none	Hip Subspecialty Day #8
Cherkashin, Alexander M.	1-Orthofix, Inc.; 3B-Orthofix, Inc.	Neuromuscular/Lower Extremity Subspecialty Day #9

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Cheung, Kenneth M.C.	3B-Ellipse Techonologies; 5-Ellipse Technologies; 8-1. Deputy Editor-in-Chief of Journal of Orthopaedic Surgery-since 2004, 2. Corresponding editor of International Orthopaedics-since 1999, 3. Deputy editor of Spine Deformity, 4. Corresponding editor of US-China International Journal of Traumatology, (since 2003, 5. Editor of INSPINE-since 2004., 6. Member of the medical review panel for Evidence Based Spine Surgery Notes distributed with Spine and European Spine Journal-March 05 – Sept 06., 9. Reviewer for Journal of Orthopaedic Research-since 2007, 10. Review Board member for Orthopedics-since 2007, 11. Editorial Board member for International Journal of Artificial Organs-2009-2011, 12. International Advisory Board of Journal of Orthopaedics, Trauma and Rehabilitation.-since 2010., 13. Regional Editor of Evidence-based Spine-Care Journal-since 2010; 9-Scoliosis Research Society, Hong Kong College of Orthopaedic Surgeons	Paper #43
Chevinsky, Jonathan	n-none	Paper #2
Cho, Robert Hyun	3B-DePuy Spine; Medtronic Sofamor Danek; 8-Orthopedics	Paper #53
Cho, Tae-Joon	n-none	Hip Subspecialty Day #8
Choi, Eun Seok	n-none	Hip Subspecialty Day #8
Choi, In Ho	n-none	Hip Subspecialty Day #8
Chong, David	4-Wheaton Brace Co.	Paper #22; e-Poster #45
Choudhry, Dinesh K.	n-none	e-Poster #72
Chu, Alice	n-none	e-Poster #20
Chukwunyerenwa, Chukwudi K.	n-none	Paper #33
Chung, Chin Youb	n-none	Hip Subspecialty Day #8
Church, Chris	n-none	Paper #62; Neuromuscular/ Lower Extremity Subspecialty Day #3

Name	Disclosure	Presentation Type
Ciccotti, Michael G.	3B-Stryker; 4-Venture MD; 5-Arthrex, Inc; 9-American Orthopaedic Society for Sports Medicine, Major League Baseball Team Physicians Association, Herodicus Research Society	Sports Subspecialty Day #7
Cidambi, Krishna Ravi	n-none	e-Poster #65
Clark, Christian	n-none	Paper #35
Cleary, Mark Xavier	n-none	Paper #94
Clinton, Rebecca E.	4-Abbott, Johnson & Johnson, Medtronic, Procter & Gamble	Neuromuscular/Lower Extremity Subspecialty Day #8
Clohisy, John C.	3B-Biomet, Pivot Medical; 5-Wright Medical Technology, Inc., Zimmer; 8-Journal of Bone and Joint Surgery - American	Paper #37, 38; e-Posters #25, 27, 28, 29, 32, 33, 34; Hip Subspecialty Day #5, 6, 7
Cole, Heather	n-none	e-Poster #5
Collins, Deraan	n-none	e-Poster #88
Conklin, Michael	n-none	Paper #48
Connor, Justin R.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #3
Cook, P. Christopher	3B-Arthrex, Inc; 9-Pediatric Orthopaedic Society of North America	e-Poster #4
Cooper, George	n-none	Poster #18
Cooper, Shannon	n-none	e-Poster #89
Cooper, Trent	n-none	Paper #106
Cooperman, Daniel R.	n-none	Paper #21; e-Poster #4; Hip Subspecialty Day #3
Cordasco, Frank A.	1-CONMED Linvatec; 3B-Arthrex, Inc; 9-AAOS, American Shoulder and Elbow Surgeons, American Orthopaedic Society for Sports Medicine	e-Poster #77
Cornwall, Roger	n-none	Reviewer; e-Moderator; Hand Subspecialty Day; e-Poster #3; Hand Subspecialty Day #8
Cowan, James	n-none	Paper #105
Cram, Peter	n-none	Paper #79

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Crawford, Haemish Alexander	3B-Medtronic Sofamor Danek; 6-Medtronic Sofamor Danek; 9-on Council of New Zealand Orthopaedic Association, President Auckland Medicolegal Society, Pediatric Orthopaedic Society of North America- Travelling Fellowship Committee	e-Poster #38; Spine Subspecialty Day
Crawford, Lindsay M.	n-none	Paper #61
Cyr, Micaela	n-none	e-Poster #73
D'Heurle, Albert	n-none	e-Poster #2
Dabaghi, Alejandro	n-none	e-Poster #53
Dakwar, Elias	n-none	e-Poster #66
Dale, Kevin M.	n-none	Sports Subspecialty Day #5
Dammann, Gregory G.	n-none	Paper #91
Dang, Debbie Yen-Dao	n-none	e-Poster #4
Davids, Jon R.	8-Journal of Pediatric Orthopedics, Gait and Posture; 9-AAOS, Pediatric Orthopaedic Society of North America, Gait & Clinical Movement Analysis Society	Paper #69; Neuromuscular/ Lower Extremity Subspecialty Day
Davidson, Austin	9-Tennessee Orthopaedic Society	e-Poster #68
Davidson, Richard S.	1-Biomet; 2-Biomet; 3B-Biomet; 3C-Medsonics; 4-Abbott, Bristol-Myers Squibb, GlaxoSmithKline, Merck, Pfizer, ZimmerHoldings Inc Com; 8-Journal of Bone and Joint Surgery - American; Journal of Pediatric Orthopedics	e-Poster #42
Davies, Katherine	n-none	Paper #89
Dawson, John Rapier	n-none	Paper #98
Dayanidhi, Sudarshan	n-none	Hand Subspecialty Day #1
De La Rocha, Adriana	n-none	Paper #29, 30, 31, 33, 36, 76; Hip Subspecialty Day #5
De Mattos, Camila B. R.	n-none	Paper #64
Dean, Daniel M.	n-none	Poster #13
Debiparshad, Kevin	n-none	e-Poster #45
Dede, Ozgur	n-none	Paper #41
Deeney, Vincent	n-none	Paper #41
Deignan, Brian J.	n-none	e-Poster #16
Del Balso, Christopher	n-none	e-Poster #94
Demirkiran, Gokhan Halil	n-none	Paper #43
Deo, Nikita	n-none	Paper #81

Name	Disclosure	Presentation Type
Descalzi, Javier F.	n-none	Paper #102
Devito, Dennis P.	1-Medicrea, 3B-Biomet, MAZOR Surgical Technologies, Medicrea; 5-Medicrea, MAZOR Surgical Technologies	Paper #11
Dias, Luciano	n-none	Paper #111
Dietz, Harry	3B-GlaxoSmithKline	Paper #112
Dilorenzo, Michael	n-none	e-Poster #62
Do, K. Patrick	n-none	Paper #64
Doan, Josh	n-none	Papers #9, 58; e-Poster #7
Dobbs, Matthew B.	1-D-Bar Enterprises; 3B-D-Bar Enterprises, Pfizer; 8-Clinical Orthopaedics and Related Research, 9-AAOS, American Orthopaedic Association, Association of Bone and Joint Surgeons, Missouri State Orthopaedic Association, Orthopaedic Research and Education Foundation, Pediatric Orthopaedic Society of North America	Paper #83
Dolan, Lori	9-Scoliosis Research Society	Paper #70
Donnally, Chester John	n-none	Paper #31
Donohue, Kyna Silvana	n-none	Papers #87, 100
Dormans, John P.	7-Elsevier, Mosby, Brooke's Publishing; 8-Journal of Pediatric Orthopedics, Journal of Spine Disorders; 9-SICOT USA, Scoliosis Research Society, SICOT Foundation, World Orthopaedic Concern	Paper #7
Doty, Stephen	n-none	Poster #6
Doyle, J. Scott	n-none	Paper #48
Du, Justin Y.	n-none	Paper #80
Duncan, Stephen T.	3B-Mitek, Smith & Nephew	e-Posters #29, 34; Hip Subspecialty Day #6
Düppe, Katarina Anna Emmy	n-none	Poster #4
Durgut, Fatih	n-none	e-Poster #14
Dworkin, Aviva G.	n-none	e-Poster #62
Eads, Ryan	n-none	e-Poster #97
Easton, Samantha N.	n-none	Paper #2
Eastwood, Deborah	n-none	Poster #18; e-Poster #12, 17

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Edmonds, Eric W.	2-Arthrex, Inc, Orthopediatrics; 5-Inion; 9-AAOS; American Orthopaedic Society for Sports Medicine, Pediatric Orthopaedic Society of North America	Reviewer; Papers #58, 108; Poster #4; e-Posters #7, 22, 76, 98; Hand Subspecialty Day #6; Neuromuscular/Lower Extremity Subspecialty Day #1
Eghbal, Azam	n-none	e-Poster #96
Eismann, Emily A.	n-none	e-Posters #87, 91; Hand Subspecialty Day #8
El-Hawary, Ron	3B-DePuy, A Johnson & Johnson Company, Halifax Biomedical Inc., Medtronic, Synthes; 5-DePuy, A Johnson & Johnson Company, Synthes, Medtronic; 9-Chest Wall and Spine Deformity Foundation	e-Poster #73
Eller, Erik Brian	n-none	Paper #111
Ellington, Matthew D.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #2
Ellis, Henry B.	n-none	Paper #107
Elsebaie, Hazem B.	3B-K Spine,Ellipse	Paper #43
Emans, John B.	1-Synthes; 3B-Medtronic Sofamor Danek, Synthes; 3C-Medtronic Sofamor Danek, Synthes; 8-Journal of Children's Orthopedics	Paper #7, 40, 42, 43, 50, 103
Eng, Renee	n-none	Paper #2
Epps, Howard R.	8-AAOS Now; 9-Pediatric Orthopaedic Society of North America; Texas Orthopaedic Association	Reviewer; e-Poster #39
Erickson, Mark A.	6-Spineform; 9-Pediatric Orthopaedic Society of North America	Paper #7, 50, 54
Erkocak, Omer Faruk	n-none	e-Poster #14
Erwteman, Andrew S.	n-none	e-Poster #80
Escott, Benjamin	n-none	Paper #29
Esposito, Paul W.	9-Board member US Bone and Joint Initiative	Paper #110
Esquivel, Amanda	6-Arthrex, Inc	Poster #7
Evanson, Brian	n-none	Hand Subspecialty Day #3

Name	Disclosure	Presentation Type
Ezaki, Marybeth	7-Journal of Bone and Joint Surgery - American, Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Bone and Joint Surgery - American, Journal of Hand Surgery - American; 9-ABMS, Committee Member; ASSH Committee Member	Hand Subspecialty Day; Hand Subspecialty Day #2
Fabricant, Peter D.	n-none	Paper #6
Farley, Frances A.	4-Medtronic; 5-Medtronic, DJ Orthopaedics, Johnson & Johnson, Genzyme, Pfizer, Stryker, Wright Medical Technology, Inc., Zimmer; Synthes; 8-Journal of Pediatric Orthopedics	e-Poster #53
Farnsworth, Christine L.	n-none	e-Poster #7; Hand Subspecialty Day #6
Faulks, Shawne	n-none	Papers #16, 18
Faust, John R.	n-none	e-Poster #31
Fedorak, Graham	n-none	Paper #53
Felton, Kevin	9-Texas Occupational Therapy Association	Paper #18
Femino, J. Dominic	n-none	Paper #102
Feng, Jing	n-none	Paper #64
Ferrero, Emmanuelle	n-none	Papers #17, 56
Figueiredo, Daniel C.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #5
Fioratos, Natalie	n-none	Poster #20
Fitch, Robert D.	n-none	Paper #57
Flack, Sean	n-none	e-Poster #74
Fletcher, Nicholas D.	2-Biomet, Medtronic Sofamor Danek; 3B-Medtronic, Biomet; 9-Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Papers #11, 12; Spine Subspecialty Day #10
Flores, Erica	n-none	Papers #30 76
Flynn, John (Jack) M.	1-Biomet; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Orthopedics Today; 9-Pediatric Orthopaedic Society of North America, Scoliosis Research Society, AAOS	POSNA President; Paper #7, 26, 42, 74; e-Poster #26, 51, 58, 73; Young Member Forum; Spine Subspecialty Day #4
Formoso, Nicole D.	n-none	Paper #2
Fornari, Eric D.	9-Pediatric Orthopaedic Society of North America	COUR Symposium

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Frampton, Chris	n-none	e-Poster #38
Franklin, Corinna C.D.	n-none	Spine Subspecialty Day #7
Fraser, Bob	n-none	Poster #20
Fredrick, Amy	3A-EOS Imaging	Paper #58
Freese, Krister P.	n-none	Paper #96
Frick, Steven L.	9-J. Robert Gladden Society; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	Moderator; Poster #3; e-Poster #82
Friel, Nicole A.	n-none	Paper #
Fuhrhop, Sara Kathleen	n-none	Paper #
Fujimori, Takahito	n-none	e-Poster #69; Spine Subspecialty Day #9
Fujino, Marcelo Hideki	n-none	Paper #65
Funk, Shawn Sheldon	n-none	Poster #2
Fusman, Lior	n-none	Paper #2
Gabel, Leigh	n-none	Paper #97
Gabos, Peter G.	3B-DePuy, A Johnson & Johnson Company	e-Posters #64, 84
Gamradt, Seth C.	2-Biomet; 3B-Biomet; 8-Techniques in Shoulder and Elbow Surgery, JBJS	Sports Subspecialty Day
Ganley, Theodore J.	n-none	e-Poster #58; Sports Subspecialty Day
Gans, Itai	n-none	Paper #32; e-Poster #26, 51, 58
Gantsoudes, George Damon	9-American Academy for Cerebral Palsy and Developmental Medicine, Pediatric Orthopaedic Society of North America	Poster #15
Garcia, Michael J.	2-Auxillium	Hand Subspecialty Day
Garg, Sumeet	3B-DePuy, A Johnson & Johnson Company	Paper #50, 54; e-Poster #73; Spine Subspecialty Day #7
Garibay, Erin J.	n-none	Sports Subspecialty Day #4
Gaston, R. Glenn	1-Biomet; 2-Auxillium, Biomet; 3B-Biomet; 8-Journal of Hand Surgery - American; 9-American Society for Surgery of the Hand	e-Poster #82
Gaumetou, Elodie	n-none	Paper #56
Gdalevitch, Marie	1-Pega Medical; 3B-Smith & Nephew	Paper #15; Neuromuscular/ Lower Extremity Subspecialty Day #6

Name	Disclosure	Presentation Type
Geddes, Benjamin	n-none	Paper #11, 12; Spine Subspecialty Day #10
Gelfer, Yael	n-none	Paper #28
Gheen, William T.	n-none	Paper #88
Giampetruzzi, Nicholas Gary	n-none	Sports Subspecialty Day #4
Gibbons, Paul J.	n-none	Paper #78; Neuromuscular/ Lower Extremity Subspecialty Day #6
Gilbert, Shawn R.	9-AAOS, POSNA	Paper #48
Gill, Corey S.	n-none	e-Poster #88
Gillespie, Catherine W.	n-none	Paper #67
Givon, Uri	6-Medison Israel, representing Accorda and Biogen Idec	e-Poster #37
Glaser, Diana A.	4-Mako, Mankind, Alphatec, NuVasive; 5-EOS Imaging, Scoliosis Research Society, Growing Spine Foundation, KCI, K2M, Naval Medical Center San Diego, Pediatric Orthopaedic Society of North America	Paper #58; e-Poster #7; Spine Subspecialty Day #9
Glassman, Steven D.	1-Medtronic; 5-Nuvasive - Institutional research support paid directly to database company; 9-Scoliosis Research Society	Paper #7
Glos, David	n-none	e-Poster #2
Glotzbecker, Michael P.	5-Synthes, Via Chest Wall and Spinal Deformity Study Group	Papers #7, 42, 93, 100, 103; e-Poster #73
Goldstein, Rachel Y.	n-none	e-Poster #20
Gomez, Jaime A.	n-none	Paper #103
Goodbody, Christine	n-none	Paper #74
Goodwin, Ryan C.	3B-Stryker	Spine Subspecialty Day #7
Gordon, Andi	n-none	Poster # 19
Gordon, J. Eric	1-Orthopediatrics; 3B-Orthopediatrics; Smith & Nephew; 9-Pediatric Orthopaedic Society of North America	Reviewer ; Paper # 73
Gorton, George E.	n-none	Paper # 69
Gourineni, Prasad V.	4-G2Healthcare	e-Poster #40

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/ committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Green, Daniel W.	1-Pega Medical; 2-Arthrex, Inc; 7-Current Opinion in Pediatrics; 8-Current Opinion in Pediatrics; 9-AAOS, American College of Surgeons, New York County Medical Society, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	e-Poster #77
Gross, Richard H.	8-Journal of Children's Orthopaedics; Journal of Childrens Orthopaedics; Journal of Pediatric Orthopedics; 9-American Orthopaedic Association	Moderator; COUR Symposium
Guffey, Danielle	n-none	e-Poster #39
Gunderson, Melissa	n-none	e-Poster #26
Guo, Jing	n-none	Paper #47
Guo, Nai-Wen	n-none	e-Poster #92
Gustavsson, Nicole A.	n-none	Poster #4
Gutowski, Christina J.	n-none	e-Poster #84
Halanski, Matthew A.	3C-Orthopaediatrics this was over a year ago nothing since May 2011; 5-Biomet, Stryker, Medtronic; 7-MTDS-educational material; 8-Pediatric section review board for OKU.,Previous reviewer for CORR, Associate contributing editor JBJS Highlights:Spine	Paper #4; e-Posters #19, 24; Neuromuscular/Lower Extremity Subspecialty Day; Sports Subspecialty Day #5
Hale, Holly Bee	n-none	Hand Subspecialty Day #4
Hall, Randon	n-none	Paper #14
Hammerberg, Kim W.	8-Spine	Paper #77
Hardesty, Christina Kay	3B-Medtronic	Paper #40
Harnden, Jay	n-none	Paper #55
Harris, Liam	n-none	e-Poster #67
Hassani, Sahar	n-none	Paper #77
Hayes, Christopher B.	n-none	e-Poster #21
Hedequist, Daniel J.	9-AAOS, Pediatric Orthopaedic Society of North America	Papers #93, 103
Heidenreich, Mark	n-none	e-Poster #63
Henley, John D.	1-motion analysis	Paper #62; Neuromuscular/ Lower Extremity Subspecialty Day #3
Hennessey, Theresa A	n-none	Paper #22
Hennrikus, William L.	9-Pediatric Orthopaedic Society of North America, Society of Military Orthopaedic Surgeons	Presider; e-Poster #48
Herman, Amir	n-none	e-Poster #37

Name	Disclosure	Presentation Type
Herman, Martin J.	7-Springer, Jaypee Publishing; 8-Journal of Pediatric Orthopedics; 9-AAOS, Pediatric Orthopaedic Society of North America	Moderator
Herrera Soto, Jose A.	1-Biomet Spine and Biomet Trauma; Biomet; 2-Biomet Spine, Biomet; 3B-Biomet Spine, Biomet; 9-Pediatric Orthopaedic Society of North America, Scoliosis Research Society, Spine Form Device Monitoring Committee	Paper #61
Herzog, Mackenzie M.	n-none	Paper #13; Sports Subspecialty Day #8
Heyworth, Benton E.	9-Pediatric Orthopaedic Society of North America - Trauma Committee; Research in Osteochondritis Dissecans of the Knee - Member	Papers #87, 100, 101, 109; Sports Subspecialty Day #9
Hill, Mary Katherine	n-none	Paper #95
Hilmes, Melissa A.	n-none	Paper #3
Ho, Christine Ann	n-none	Papers #88, 91; e-Poster #95
Ho, James Eric	3A-Neurotherapeutics Pharmaceuticals; 4-Jazz Pharmaceuticals, Gilead Pharmaceuticals	e-Poster #40
Ho-Fung, Victor M.	n-none	e-Poster #42
Hoernschemeyer, Daniel G.	1-Orthopediatrics; 2-Orthopediatrics; 3B-Orthopediatrics; 4-Orthopediatrics	Paper #73
Hogue, Grant D.	n-none	e-Poster #88
Holmes, Laurens	n-none	e-Poster #64
Holmes, Stephanie M.	n-none	Paper #55
Hood, Kenneth A.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #1
Hooft, Lahoma	n-none	Poster #1
Hopyan, Sevan	9-Pediatric Orthopaedic Society of North America	Hand Subspecialty Day #9
Horn, Bernard David	4-Johnson & Johnson; 7-JayPee Brothers Medical Publishing Comapny; 9-AAOS	e-Poster #42

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Hosseinzadeh, Pooya	n-none	Reviewer; Presider; Paper #19; e-Posters #21, 97, 99; Hand Subspecialty Day #3; Neuromuscular/Lower Extremity Subspecialty Day #10; Spine Subspecialty Day #3
Hoversten, Liliana	4-Dendreon and Seattle Genetics	Paper #23
Hoy, Christa	n-none	Paper #97
Hresko, Michael T.	3B-Abbott; 4-Johnson and Johnson; 6-Biogen Idec; 7-New England Journal of Medicine, Up to Date; 9-American College of Rheumatology, Arthritis Foundation, Scoliosis Research Society	Paper #103
Hu, Liangjun	n-none	e-Poster #3
Huang, Ming-Tung	n-none	e-Poster #92
Humphreys, Rebecca	n-none	Poster #1
Humphries, Paul	8-British Journal of Radiology, Pediatric Radiology	Paper #28
Hung, Alec Lik Hang	n-none	Paper #47
Hyman, Joshua E.	5-OMEGA, OREF, SRS, CPIRF; 9-La Societe Internationale de Chirurgie Orthopedique et de Traumatologie, American Academy for Cerebral Palsy and Developmental Medicine	COUR Symposium; Paper #72
Hymes, Robert	4-Johnson & Johnson	e-Poster #82
Ibrahim, David	n-none	Paper #102
Ibrahim, Kamal N.	1-DePuy, A Johnson & Johnson Company, SpineCraft; 4-SpineCraft; 9-Scoliosis Research Society	Paper #7
Ilharreborde, Brice	2-Zimmer	Papers #17, 56
Irwin, Todd A.	3B-Smith & Nephew; 7-Saunders/Mosby-Elsevier; 9-American Orthopaedic Foot and Ankle Society	Paper #105
Ishiguro, Naoki	n-none	e-Posters #6, 46
Ishkhanian, Rita M.	n-none	Sports Subspecialty Day
Israelsen, Stanford T.	4-Kalyra Pharmaceuticals	e-Poster #99

Name	Disclosure	Presentation Type
Iwinski, Henry J.	n-none	Paper #19, 20, 63, 68; e-Poster #21; Neuromuscular/Lower Extremity Subspecialty Day #10; Spine Subspecialty Day #3
Izuka, Byron H.	n-none	Paper #96; e-Poster #86
Jackson, James B.	5-Synthes	Poster #3
Jacobs, John Christopher	n-none	Poster #1; e-Poster #23; Hand Subspecialty Day #5; Sports Subspecialty Day #6
Jacquet, Robin	n-none	Sports Subspecialty Day #2
Jaglowicz, Ashley	n-none	e-Poster #97
James, Kyle	n-none	Paper #78
James, Michelle A.	8-Journal of Bone and Joint Surgery - American; 9-American Board of Orthopaedic Surgery, Inc.; Ruth Jackson Orthopaedic Society, Perry Initiative	Reviewer
Janicki, Joseph A.	4-Pfizer; 9-Pediatric Orthopaedic Society of North America	Poster #13; Hip Subspecialty Day #1
Jennings, Jonathan K.	n-none	Paper #48
Jeong, Chang-Hoon	n-none	e-Poster #9
Jepsen, Karl J.	8-Journal of Bone and Mineral Research	Poster #6
Jeray, Kyle J.	2-AONA/Synthes; 3B-Zimmer; 4-Emerge; 5-Synthes; 7-Journal of Bone and Joint Surgery - American Newsletter; 8-Journal of Bone and Joint Surgery - American, Journal of Orthopaedic Trauma; 9-AAOS, American Orthopaedic Association, Orthopaedic Trauma Association, South Carolina Orthopedic Association	e-Poster #82
Jichi, Fatima	n-none	Paper #28
Jo, Chan-Hee	n-none	Papers #29, 76
Johnson, Jeffrey S.	n-none	Sports Subspecialty Day #2
Johnston, Charles E.	1-Medtronic Sofamor Danek; 7-Saunders/ Mosby-Elsevier; 8-Orthopedics, Journal of Childrens Orthopedics; 9-Scoliosis Research Society, Pediatric Orthopaedic Society of North America	Paper #43; Spine Subspecialty Day

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/ committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Joiner, Elizabeth	n-none	Paper #102; e-Poster #83
Jones, Kerwyn	3B-Orthopediatrics	e-Poster #96; Reviewer; Presider; Sports Subspecialty Day #2
Jordan, Connor	n-none	Paper #2
Kadhim, Muayad	n-none	e-Poster #58
Kalantre, Sarika	n-none	e-Poster #62
Kalish, Leslie A.	n-none	Sports Subspecialty Day #1
Kamiya, Nobuhiro	n-none	Paper #80; e-Poster #1
Kaneko, Hiroshi	n-none	e-Posters #6, 46
Kaplan, Sheldon L.	5-Cubist, Pfizer; 7-Elsevier, UpToDate; 9-American Board of Pediatrics-Infectious Disease Subboard, Infectious Diseases Society of America	e-Poster #39
Karlin, Lawrence I.	6-K2M - paid for housing and transportation for research meeting	Paper #103
Karol, Lori A.	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	Moderator; Papers #16, 31; e-Poster #88
Kattan, Jaffer M.	n-none	e-Poster #90
Kawamura, Catia Miyuki	n-none	Paper #65
Kay, Robert M.	4-Medtronic, Zimmer, Johnson & Johnson, Pfizer; 9-Pediatric Orthopaedic Society of North America	Paper #66; Reviewer; Neuromuscular/Lower Extremity Subspecialty Day
Keeler, Kathryn A.	n-none	Paper #73
Keith, Angela D.	n-none	e-Posters #27, 29; Hip Subspecialty Day #6
Kelley, Simon	3B-Genzyme, Smith & Nephew; 9-International Hip Dysplasia Institute	Hip Subspecialty Day
Kelly, Brian A.	n-none	e-Poster #85
Kelly, Derek M.	7-Elsevier Health; 9-Pediatric Orthopaedic Society of North America	Paper #90; e-Poster #36, 68
Kemppainen, John W.	n-none	e-Poster #65; Neuromuscular/Lower Extremity Subspecialty Day #1
Kessler, Jeffrey I.	9-Pediatric Orthopaedic Society of North America	e-Poster #23; Hand Subspecialty Day #5; Sports Subspecialty Day #6

Name	Disclosure	Presentation Type
Khan, Shah Alam	n-none	Poster #12
Khan, Tahir	n-none	e-Poster #10
Kho, Jenniefer Y.	n-none	Paper #79
Khoshbin, Amir	n-none	e-Poster #93
Khoury, Joseph G.	n-none	Paper #48
Kim, Harry K.W.	5-Ipsen; 6-Pfizer, Medtronic	Reviewer ; Paper #36, 76, 80; e-Poster #1
Kim, Jung-Ryul	n-none	Poster #16; e-Poster #8
Kim, Young Jo	2-Synthes; 3B-Smith & Nephew; 3C-Siemens Heath Care; 6-Siemens Health Care; 8-Osteoarthritis and Cartilage; 9-Pediatric Orthopaedic Society of North America	Paper #37, 39, 101; e-Poster #28, 32, 34, 35; Hip Subspecialty Day #5, #7
Klingele, Kevin E.	n-none	Presider; Paper #106
Klonk, Christopher Jude	n-none	Sports Subspecialty Day #2
Knapp, D. Raymond	1-Biomet	Paper #61
Knott, Jon	n-none	Paper #55
Kobayashi, Daisuke	n-none	e-Posters #41, 43; Hip Subspecialty Day #2
Kocher, Mininder S.	1-Biomet; 3B-Best Doctors, Biomet, Gerson Lehrman Group, OrthoPediatrics, Smith & Nephew; 4-Fixes 4 Kids, Pivot Medical; 7-Saunders/Mosby-Elsevier; 9-AAOS, ACL Study Group, American Orthopaedic Society for Sports Medicine, Harvard Medical School, Harvard School of Public Health, Herodicus Society, Pediatric Orthopaedic Society of North America, PRISM, Steadman Philippon Research Institute	Papers #60, 87, 100, 104, 109; e-Poster #81; Sports Subspecialty Day #1, 9; Young Members Forum
Kolmodin, Joel	n-none	Spine Subspecialty Day #7
Kothari, Alpesh	n-none	Paper #24
Kovach, III, Stephen J.	n-none	e-Poster #51
Krahe, Amy	n-none	e-Poster #55
Kramer, Dennis E.	n-none	Paper #87, 94; Sports Subspecialty Day #9

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Krengel, Walter F.	4- Amgen Co, Bristol-Myers Squibb, Edwards Life Sciences, GNC, HCA, MAKO, TIva Pharmaceuiticals, Vertex; 8-Evidence Based Spine Journal-Ad Hoc Reveiwer, Clinical Journal of Pain-Ad Hoc Reviewer, CORR (Ad Hoc Reviewer)	Paper #8
Krzak, Joseph	3B-NeuroCom - a Division of Natus	Paper #7
Kuba, Megan H.M.	n-none	Paper #96; e-Poster #86
Kuester, Victoria J.	n-none	Paper #9
Kumar, Sita	n-none	Paper #58
Kunkel, Philip	3C-Medtronic, Medtronic Sofamor Danek, Synthes	Spine Subspecialty Day #6
Kweon, Christopher Y.	n-none	e-Poster #75
Laham, Susan	n-none	Sports Subspecialty Day #5
Lam, Tsz Ping	5-Pfizer	Paper #47
Landis, William J.	n-none	Sports Subspecialty Day #2
Laor, Tal	n-none	Hand Subspecialty Day #8
Lark, Robert K.	3C-Orthopaedic Innovations; 4-Nuvasive	Paper #57
Larson, A. Noelle	9-Scoliosis Research Society	Presider; Papers #10, 86; e-Posters #54, 63
Larson, Christopher M.	3B-Smith & Nephew, A3 Surgical; 4-A3 Surgical; 5-Educational support: Smith & Nephew	e-Poster #25
Larson, Jill E.	n-none	Hip Subspecialty Day #1
Lattanza, Lisa L.	2-Acumed, LLC; 3B-Tornier, Acumed, LLC; 4-Mylad; 9-Perry Initiative, Ruth Jackson Orthopaedic Society, American Society for Surgery of the Hand	Hand Subspecialty Day
Law, Peggy W.	n-none	e-Poster #93
Lazarus, David E.	n-none	Papers #11, 12; Spine Subspecialty Day #10
Leamon, Julia	n-none	Spine Subspecialty Day #8
Leathers, Michael	n-none	e-Poster #90
Lebel, David	n-none	Paper #84
Leblanc, Elisabeth	n-none	Paper #15
Lee, Ben	n-none	Paper #2
Lee, Jared T.	n-none	Paper #60
Lee, Kwong Man	n-none	Paper #47
Lehman, Wallace B.	n-none	e-Poster #20
Lehmann, Charles L.	n-none	Paper #73

Name	Disclosure	Presentation Type
Lemos, Stephen E.	5-Arthrex, Inc., Smith & Nephew, DePuy, A Johnson & Johnson Company; 8-American Journal of Sports Medicine; The Journal of Arthroscopy and Related Research; 9-CORD - AOA; Michigan Orthopaedic Society	Poster #7
Lenhart, Rachel L.	n-none	Paper #4
Lenke, Lawrence G.	1-Medtronic; 2-DePuy, A Johnson & Johnson Company, K2M, 3B-DePuy, A Johnson & Johnson Company, K2M, Medtronic; 5-DePuy, A Johnson & Johnson Company, Axial Biotech; 7-Quality Medical Publishing; 8-Spine, Journal of Spinal Disorders & Techniques, Scoliosis, Backtalk-Scoliosis Assn, Journal of Neurosurgery: Spine, Spine Deformity Journal, www.iscoliosis.com, www.spineuniverse.com	Paper #7; Spine Subspecialty Day
Lennon, Diana	n-none	e-Poster #38
Leroux, Timothy S.	n-none	e-Poster #93
Levin, L. Scott	1-KLS Martin, L.P.	e-Poster #51
Levy, Jeffrey	n-none	Paper #91
Lewin, Eleanor	n-none	e-Poster #84
Lewis, Stephen J.	2-Medtronic Sofamor Danek, Stryker; 3B-Medtronic Sofamor Danek, Stryker; 6-Medtronic Sofamor Danek, Stryker; 9-Scoliosis Research Society	Paper #7; Spine Subspecialty Day
Li, G. Ying	9-Pediatric Orthopaedic Society of North America	e-Poster #53
Liang, Fu-Wen	n-none	e-Poster #92
Liberman, Boaz	n-none	e-Poster #3
Light, Terry R.	8-Journal of Bone and Joint Surgery - American; 9-American Orthopaedic Association	Hand Subspecialty Day
Lightdale - Miric, Nina R.	n-none	e-Poster #83; Hand Subspecialty Day #1, 4
Lightner, Tammy S.	n-none	e-Poster #71
Lin, Cheng-Li	n-none	e-Poster #92
Lin, Chii Jeng	n-none	e-Poster #92
Lindberg, Antoinette W.	3A-Oppo Medical	Paper #34
Link, Corrine	n-none	e-Poster #16

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Linton, Judith	n-none	Neuromuscular/Lower Extremity Subspecialty Day #2
Lisle, Jennifer	n-none	e-Poster #44
Little, David G.	2-Eli Lilly, Amgen Co; 5-Amgen Co, Celgene, N8 Medical, Norvartis; 7-IBMS BoneKey; 8-IBMS BoneKey, Journal of Children's Orthopaedics; 9-Australain Orthopaedic Research Foundation	Papers #78, #81
Little, Kevin J.	7-Oakstone Publishing. Honorarium for board certification course.	e-Poster #91
Little, Stephen	n-none	e-Poster #31
Liu, King Lok	n-none	Paper #47
Liu, Raymond W.	6-Orthopediatrics: Royalties paid to my institution; 9-POSNA: OKO Committee	Paper #21
Livermore, Andrew T.	n-none	Sports Subspecialty Day #5
Livingston, Kristin O.	n-none	Paper #93
Lloyd, Augusta	n-none	Paper #29, 30, 76
Loeffler, Bryan J.	n-none	e-Poster #82
Logan, Karl	n-none	Poster #20
Loiselle, Jennifer	n-none	Hand Subspecialty Day #1
Lonner, Baron	1-DePuy, A Johnson & Johnson Company; 2-DePuy, A Johnson & Johnson Company; 3B-DePuy, A Johnson & Johnson Company; 4-K2M, Paradigm, Depuy Spine; 5-DePuy, A Johnson & Johnson Company; 8-SRS Spine Deformity Journal; 9-Depuy Spine	Paper #49, 71
Lopes, Jose Augusto Fernandes	n-none	Paper #65
Lorenzana, Daniel J.	n-none	Poster #17
Louden, Emily	n-none	Hand Subspecialty Day #7
Lovejoy, John F.	9-Pediatric Orthopaedic Society of North America	Reviewer
Lovejoy, Steven A.	n-none	Papers #3, 51, 75; Poster #2
Loveland, Kerry Lee	n-none	e-Poster #64
Lu, Tsung-Hsueh	n-none	e-Poster #92

Name	Disclosure	Presentation Type
Luhmann, Scott J.	1-Globus Medical; 2-Medtronic Sofamor Danek, Stryker, 3B-DePuy, A Johnson & Johnson Company, Medtronic Sofamor Danek; Orthofix, Inc.; Stryker; 9-Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Reviewer; Paper #7, 10, 73; e-Poster #73, 78, 79; Spine Subspecialty Day #1
Luo, Tianyi David	n-none	Paper #86; e-Poster #54
Lupo, Charles	n-none	Paper #92
Luxenberg, Sherri	n-none	Paper #2
Lyon, Roger M.	n-none	Sports Subspecialty Day
Ma, Julie	n-none	Paper #23; Neuromuscular/ Lower Extremity Subspecialty Day #4
Maatta, Mikko	n-none	Paper #97
Macdonald, Heather	n-none	Paper #97
Mackenzie, William G.	2-Biomarin; 3C-DePuy, A Johnson & Johnson Company; 9-Pediatric Orthopaedic Society of North America	e-Poster #13, 16; Reviewer; Spine Subspecialty Day
MacWilliams, Bruce A.	8-Gait and Posture	Paper #22
Mahdavi, Saboura	n-none	Paper #28
Mahomed, Nizar	2-Smith & Nephew; 5-Bayer, Smith and Nephew, Biomet, Stryker; 9-Ontario Orthopaedic Association	e-Poster #93
Málaga-Shaw, Olivia	n-none	Paper #28
Maloney, Brigid N.	n-none	Papers #30, 31, 33, 36, 76
Mandelbaum, Bert	1-Arthrex, Inc; 3B-Exactech, Inc; Johnson & Johnson; Genzyme, Zimmer, Smith and Nephew, Arthrex, Alter G, Game Ready; 8-AJSM, Cartilage; 9-ICRS	Paper #6; Sports Subspecialty Day
Mankin, Keith P.	2-Transgenomic	Paper #46
Mansour, Alfred A.	n-none	e-Poster #49
Marino, Josephine	n-none	Poster #6
Marks, David S.	1-DePuy Synthes; 2-DePuy Synthes, Medtronic, Stryker, K2M; 3B-DePuy Synthes, Medtronic, 5-Medtronic; 7-DePuy Synthes; 8-Spine and Spine Deformity; 9-Scoliosis Research Society	Paper #40

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/ committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Marks, Michelle	3B-DePuy, A Johnson & Johnson Company; 5-DePuy, A Johnson & Johnson Company; 9-Scoliosis Research Society; Setting Scoliosis Straight Foundation-FKA Harms Study Group Foundation	Paper #49
Martin, Daniel	n-none	Sports Subspecialty Day #9
Martus, Jeffrey E.	9-AAOS; Pediatric Orthopaedic Society of North America	Papers #3, 51, 75; Poster #2
Mason, Edward O.	3B-GlaxoSmithKline	e-Poster #39
Matheney, Travis H.	9-Pediatric Orthopaedic Society of North America	Paper #37; e-Poster #35; Hip Subspecialty Day #7
Matsumoto, Hiroko	n-none	Papers #7, 72; Spine Subspecialty Day #4
Matsushita, Masaki	n-none	e-Posters #6, 46
Matthews, Allison	n-none	Papers #1, 67
May, Collin J.	n-none	Papers #87, 101
Mayer, Emily	n-none	e-Poster #87
Mayer, Stephanie W.	n-none	Paper #57
Mayne, Ian	n-none	Poster #10
Mazda, Keyvan	3B-Zimmer	Papers #17, 56
McCalla, Daren	n-none	Spine Subspecialty Day #4
McCarthy, James J.	3B-Synthes; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins, Orthopedics; 9-Limb Lengthening Research Society, Pediatric Orthopaedic Society of North America	Paper #7; e-Moderator; e-Poster #2; Spine Subspecialty Day #7
McCarthy, Moira M.	n-none	e-Poster #77
McCarthy, Richard E.	1-Medtronic; 2-Medtronic; 3B-Medtronic; 7-Medtronic	Paper #40; Spine Subspecialty Day #2
McClelland, Christine R.	n-none	Poster #20
McClung, Anna	n-none	e-Posters #11; 61
McCullough, Frances	n-none	Spine Subspecialty Day #2
McElroy, Mark J.	n-none	Paper #112
McIntosh, Amy L.	3B-Synthes	Reviewer; Presider; Paper #86; e-Poster #54, 63
McKay, Heather	8-British Journal of Sports Medicine	Paper #97
McKinney, Kaitlin	n-none	POSNA Staff

Name	Disclosure	Presentation Type
McLaren, Alexander C.	4-Sonoran Biosciences; 5-Astellas Pharma; 6-Synthes, Research Recovery Institute, Stryker, Smith and Nephew; 9-Musculoskeletal Infection Society member-at-large, Arizona Orthopaedic Society Vice President	e-Poster #52
McMulkin, Mark	n-none	Poster #19
McNeil,	n-none	Hand Subspecialty Day #6
Mednick, Rachel E.	n-none	Paper #111; Poster #13
Mehlman, Charles T.	3C-Stryker; 7-Oakstone Medical Publishing; 8-Journal of Bone and Joint Surgery - American; Journal of Orthopaedics and Traumatology, Journal of Pediatric Orthopedics, Saunders/Mosby-Elsevier, Spine, Wolters Kluwer Health - Lippincott Williams & Wilkins, 9-AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	e-Poster #87; Hand Subspecialty Day #7
Mencio, Gregory A.	8-Saunders/Mosby-Elsevier; 9-AAOS, Board of Specialty Societies, Pediatric Orthopaedic Society of North America, Tennessee Orthopaedic Society	Papers #3, 51, 75; Poster #2
Menendez, Mariano E.	n-none	e-Poster #4
Menga, Emmanuel Nganku	n-none	Poster #5
Menge, Travis J.	n-none	Paper #51
Meyer, Carissa L.	n-none	e-Poster #57
Michaud, Linda J.	n-none	Hand Subspecialty Day #7
Micheli, Lyle J.	3C-Carticel-Scientific Board; 5-Genzyme; 9-International Federation of Sports Medicine-FIMS Secretary General	Paper #109
Mignemi, Megan	n-none	Paper #75; Poster #2
Mignemi, Nicholas	5-ISIS Pharmaceuticals Inc.	Paper #85
Milbrandt, Todd A.	9-AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Program Committee; Paper #19, 20, 63, 68; e-Poster #21; Neuromuscular/Lower Extremity Subspecialty Day #10; Spine Subspecialty Day #3

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Milewski, Matthew	8-Journal of Bone and Joint Surgery - American, Elsevier, Inc.; 9-Pediatric Orthopaedic Society of North America	Paper #4; e-Poster #80
Miller, Freeman	1-Motion Analysis Corp; 7-Springer; 8-Gait and Posture, Journal Children's Orthopedics, Journal of Pediatric Orthopedics	Paper #62; Neuromuscular/ Lower Extremity Subspecialty Day
Miller, Mark L.	n-none	e-Poster #33
Miller, Nancy H.	8-Spine; Spine Deformity	Paper #89; e-Poster #49
Miller, Patricia	n-none	Papers #7, 93, 94, 103; e-Posters #35, 85
Millis, Michael B.	7-Saunders/Mosby-Elsevier; 8-Saunders/ Mosby-Elsevier, Springer	Paper #37, 39, 101, 109; e-Poster #28, 32, 34; Hip Subspecialty Day #7
Mills, Janith Kay	n-none	Hand Subspecialty Day #2
Milone, Michael T.	n-none	e-Poster #42
Minard, Charles Gene	n-none	e-Poster #39
Minkowitz, Barbara	n-none	Paper #2
Misaghi, Amirhossein	n-none	Spine Subspecialty Day #9
Mishima, Kenichi	n-none	e-Poster #6, 46
Mistry, Raakhi M.	n-none	e-Poster #38
Mitchell, Phillip	n-none	Paper #11; Spine Subspecialty Day #10
Miyanji, Firoz	3B-DePuy, A Johnson & Johnson Company; 5-DePuy, A Johnson & Johnson Company	Papers #45, 49, 97; e-Poster #56; Spine Subspecialty Day
Mo, Andrew	n-none	Poster #5
Moen, Susan M.	n-none	Sports Subspecialty Day#2
Moisan, Alice	n-none	Paper #74, 90; e-Poster #36
Monazzam, Shafagh	n-none	e-Poster #30
Monier, Bryan	n-none	e-Poster #44
Monsell, Fergal	2-Novartis <$10K, Smith & Nephew <$10K; 8-Editoria Board, Bone Joint Journal (unpaid); 9-President British Limb Reconstruction Society (unpaid)	Hip Subspecialty Day
Morais Filho, Mauro Cesar	n-none	Paper #65
Morakis, Emmanouil	n-none	e-Poster #10
Moraleda, Luis	n-none	Poster #15
Morscher, Melanie	n-none	e-Poster #55, 96; Sports Subspecialty Day #2

Name	Disclosure	Presentation Type
Mosca, Vincent S.	8-Clinical Orthopaedics and Related Research, Journal of Bone and Joint Surgery - American, Journal of Pediatric Orthopedics, Journal of Children's Orthopaedics	Neuromuscular/Lower Extremity Subspecialty Day
Moseley, Colin F.	3B-Orthopaediatrics; 9-International Pediatric Orthopaedic Think Tank	Hip Subspecialty Day
Motoyama, Etsuro	n-none	Paper #41
Mridha, Asit Ranjan	n-none	Poster #12
Mubarak, Scott J.	4-Rhino Pediatric Orthopedic Designs, Inc.	Poster #15; e-Poster #70; Reviewer; e-Moderator; Neuromuscular/Lower Extremity Subspecialty Day
Muchow, Ryan D.	n-none	Paper #19, 20, 68; e-Poster #21; Neuromuscular/Lower Extremity Subspecialty Day #10; Spine Subspecialty Day #3
Mueske, Nicole	n-none	Poster #17; Hand Subspecialty Day #1
Mulpuri, Kishore	5-DePuy, A Johnson & Johnson Company; 9-Canadian Orthopaedic Association, International Hip Dysplasia Institute, Pediatric Orthopaedic Society of North America	Reviewer; Paper #97
Mundis, Gregory M.	1-Nuvasive, K2M; 2-Nuvasive, K2M; 3B-K2M, Nuvasive; 5-Nuvasive, DePuy, A Johnson & Johnson Company, OREF	Paper #43, 44
Murnaghan, M. Lucas	n-none	Reviewer; Presider; Poster #10
Murphy, Robert F.	9-AAOS	e-Poster #68
Murphy, Ryan P.	n-none	Paper #90
Murr, Kevin A.	n-none	e-Poster #21; Neuromuscular/Lower Extremity Subspecialty Day #10
Musial, Scott	n-none	Paper #2
Mutich, Rebecca	n-none	Paper #41
Nagda, Taral	n-none	COUR Symposium
Nance, Michael L.	4-Johnson & Johnson, Medtronic, Isis, Celsion	e-Poster #51

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Nasreddine, Adam	n-none	Paper #60, 104; e-Poster #81; Sports Subspecialty Day #1
Nawabi, Danyal	n-none	e-Poster #77
Nazarian, Levon N.	7-American Institute of Ultrasound in Medicine; 8-Journal of Ultrasound in Medicine; 9-American Institute of Ultrasound in Medicine	Sports Subspecialty Day #7
Neiss, Geraldine	n-none	Paper #72; e-Poster #64
Nelson, Susan	n-none	Sports Subspecialty Day
Nemeth, Blaise A.	6-Biomet	Paper #4; e-Poster #19, 24; Sports Subspecialty Day #5
Nepple, Jeffrey	n-none	Paper #104; e-Poster #33
Nettlefold, Lindsay	n-none	Paper #97
Neves, Daniella	n-none	Paper #65
Newland, Jason	5-Pfizer Grant for 673,000	NP/PA Symposium
Newton, Peter O.	1,2,3B,5-DePuy, A Johnson & Johnson Company; 3B-Cubist; Ethicon Endosurgery; 4-ElectroCore; 5-EOS Imaging, Orthopedic Research & Education Foundation, Pediatric Orthopedic Society of North America, Scoliosis Research Society, Harms Study Group Foundation, Setting Scoliosis Straight Foundation, Childrens Specialist Foundation; 7-Theime Publishing; 9-Pediatric Orthopaedic Society of North America; Setting Scoliosis Straight Foundation formerly known as Harms Study Group Foundation, Childrens Specialist Foundation	Papers #7, 4, 45, 49, 52; e-Posters #56, 65, 69, 70; Spine Subspecialty Day #9
Ng, Bobby Kin Wah	n-none	Paper #47
Nguyen, Stacie	n-none	Paper #44
Nicholson, Allen	n-none	Paper #21
Niiler, Timothy	n-none	Neuromuscular/Lower Extremity Subspecialty Day #3
Nikizad, Hooman	n-none	e-Poster #23; Hand Subspecialty Day #5; Sports Subspecialty Day #6
Nikolaou, Athanasia	n-none	e-Poster #3
Nishnianidze, Tristan	n-none	Paper #71
Nissen, Carl W.	n-none	e-Poster #80; Sports Subspecialty Day #4

Name	Disclosure	Presentation Type
Niswander, Cameron R.	n-none	Paper #50, 54
Njoku, Dolores	5-DePuy, A Johnson & Johnson Company; 7-McGraw-Hill Education	Poster #5
Noonan, Ken J.	1-Biomet; 3B-Biomet; 5-Biomet; 9-Pediatric Orthopaedic Society of North America	Paper #4; e-Poster #19, 24; Sports Subspecialty Day #5
Noordeen, Hilali H.	2-K2M, Ellipse Technologies, KSpine; 3B-Baxter, K2M, Ellipse Technologies, KSpine; 8-Spine, Spine Deformity	Paper #43
Noriega, Valentin	n-none	Paper #27
Novacheck, Tom F.	9-Commission on Motion Lab Accreditation	Neuromuscular/Lower Extremity Subspecialty Day
Novais, Eduardo N.	n-none	Papers #23, 39, 95; e-Poster #28; Neuromuscular/Lower Extremity Subspecialty Day #4
O'Donnell, Courtney M.	n-none	Paper #8
O'Donnell, June C.	n-none	Paper #73; e-Posters #78, 79
O'Halloran, Conor P.	n-none	e-Posters #19, 24
O'Malley, Michael P	n-none	e-Poster #80
O'Toole, Robert V.	3B-iMDS; Smith & Nephew; 5-Synthes; Stryker; 9-Orthopaedic Trauma Association	e-Posters #59, 60
Oeffinger, Donna Jean	n-none	Papers #63, 69
Oetgen, Matthew	9-AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Papers #1, 67; Poster #11
Ohba, Tetsuro	n-none	e-Poster #5
Oishi, Scott	n-none	Hand Subspecialty Day #2
Olsen, Erik	n-none	e-Poster #91
Olson, Doug	n-none	e-Poster #97
Omar, Rumana	8-Wiley, Journal of Colorectal diseases	Paper #28
Onnen, Jeremy D.	n-none	Paper #55
Orlando, Giuseppe	n-none	e-Poster #66
Oswald, Timothy S.	2-Medtronic; 3B-Medtronic	Paper #12
Ounpuu, Sylvia	8-Gait and Posture; 9-Gait and Clinical Movement Analysis Society	Neuromuscular/Lower Extremity Subspecialty Day #7; Sports Subspecialty Day #4

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Owen, Robert	n-none	Papers #11, 12; Spine Subspecialty Day #10
Owings, F. Patterson	n-none	Spine Subspecialty Day #10
Pace, Gregory I.	n-none	Paper #7
Pace, J. Lee	2-Arthrex, Inc; 3B-Arthrex, Inc; 9-Pediatric Orthopaedic Society of North America	e-Poster #81, 83
Pacicca, Donna M.	9-AAOS	Presider
Padberg, Anne	4-Pfizer	Spine Subspecialty Day #1
Pahys, Joshua	3B-DePuy, A Johnson & Johnson Company	e-Poster #66, 73
Paley, Dror	1-Smith & Nephew, Ellipse Technologies, Inc, Pega Medical; 3B-Ellipse Technologies; 7-Springer	e-Poster #45
Pan, Zhaoxing	n-none	Papers #23, 50, 54, 89, 95; e-Poster #49, 50; Neuromuscular/Lower Extremity Subspecialty Day #4
Paraison, Lauren	n-none	Papers #29, 30, 76
Park, Howard Y.	n-none	Spine Subspecialty Day #4
Park, Kwan	n-none	Spine Subspecialty Day #2
Park, Moon Seok	n-none	Hip Subspecialty Day #8
Paryavi, Ebrahim	n-none	e-Poster #57, 59
Pashos, Gail	4-GlaxoSmithKline	Paper #38; e-Poster #29; Hip Subspecialty Day #6
Patrick, Brittany	n-none	Hip Subspecialty Day #1
Patten, Ian Sean	n-none	Poster #11
Pawelek, Jeff	n-none	Papers #40, 43, 44
Peljovich, Allan E.	n-none	Hand Subspecialty Day
Pennecot, G.F.	n-none - Submitted on 2/17	Paper #56
Pennock, Andrew T.	n-none	e-Posters #30, 76
Persinger, Freddie D.	n-none	Hip Subspecialty Day #10
Petcharaporn, Maty	n-none	Paper #49
Peters, Christopher L.	1-Biomet; 2-Biomet; 3B-Biomet; 8-Journal of Arthroplasty; 9-AAOS, American Association of Hip and Knee Surgeons	e-Poster #32
Peterson, Erik D.	n-none	Paper #19
Peterson, Michelle	n-none	e-Poster #55
Philbrick, Joshua	n-none	Spine Subspecialty Day #3

Name	Disclosure	Presentation Type
Phillips, Jonathan H.	1-Biomet; 2-Biomet; 3B-Synthes, Biomet; 5-Biomet; 8-Journal of the Southern Orthopedic Association; 9-Scoliosis Research Society, OrthoPaediatrics	Paper #61
Phillips, William A.	4-Orthologic-spouse 75 shares at $0.23 per share on 10/18/11; 7-Up to Date- section editor; 9-American Society of Plastic Surgery-spouse, American Association of Plastic Surgery-spouse	Paper #98
Phisitkul, Phinit	3B-Arthrex, Inc; 4-MTP Solutions; 9-American Orthopaedic Foot and Ankle Society: Research Committee	Paper #79
Pierce, Rosemary	n-none	Paper #64
Pierz, Kristan A.	7-UpToDate; 8-Residency Review-online publication by POSNA; 9-AAOS, Gait and Clinical Movement Analysis Society; Pediatric Orthopaedic Society of North America, Pediatric Society of North America, CT State Medical Society - Committee on the Medical Aspect of Sports	Neuromuscular/Lower Extremity Subspecialty Day #7
Pinnamaneni, Sridhar	n-none	Spine Subspecialty Day #8
Pitetti, Raymond	n-none	Paper #92
Plantikow, Carla	n-none	Paper #14
Pleshko, Nancy	9-Orthopaedic Research Society	Poster #6
Podeszwa, David A.	9-Pediatric Orthopaedic Society of North America; AAOS	e-Moderator; Paper #31, 33, 88, 91; e-Poster #25, 34; Hip Subspecialty Day #5
Poe-Kochert, Connie	n-none	Paper #40
Pohlman, Amy E.	n-none	Spine Subspecialty Day #7
Poletick, Eileen	n-none	Paper #2
Polly, David W	9-Scoliosis Research Society	Paper #7, 10
Polousky, John D.	4-Abbott, Johnson & Johnson, Norvartis, Organovo, Procter & Gamble	Sports Subspecialty Day
Pomerantz, Michael L.	4-Stryker	Paper #58
Potter, Gorden D.	n-none	e-Poster #28
Potty, Anish G.	n-none	Poster #8
Poudel, Rishi	n-none	Poster #12
Prasad, Nandan	n-none	e-Poster #78

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Pritchard, Breanna	n-none	e-Poster #49, 50
Protopapa, Evangelia	n-none	Paper #28
Pruszczynski, Blazej A.	n-none	Papers #62, 71; e-Poster #13
Puvanesarajah, Varun	n-none	e-Poster #15
Qiu, Xing	n-none	e-Poster #4
Qiu, Yong	n-none	Paper #47
Quinn, John R.	n-none	Paper #9
Race, Douglas	n-none	Paper #97
Raggio, Cathleen L.	5-Amgen Co; 9-Orthopaedic Research Society, Pediatric Orthopaedic Society of North America, Scoliosis Research Society, OIF	Poster #6
Raney, Ellen M.	9-AAP SoOR, WOA, Bone and Joint Decade, U.S.A.	e-Moderator
Rastogi, Shishir	n-none	Poster #12
Rathjen, Karl E.	3C-Orthopaediartrics; 8-Clinical Orthopaedics and Related Research, Journal of Pediatric Orthopedics, Spine; 9-Limb Lengthening Research Society, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Papers #18, 33
Razzano, Andrew J.	n-none	e-Poster #96
Redler, Lauren H.	n-none	Paper #6
Reighard, Fredrick G.	n-none	Paper #9; e-Poster #65
Reilly, Christopher W.	6-DePuy, a Johnson & Johnson Company	Paper #97
Rethlefsen, Susan A.	n-none	Paper #66
Reyes, Bryan	n-none	e-Poster #95
Rhodes, Jason T.	3B-Orthopediatrics; 9-Pediatric Orthopaedic Society of North America	e-Poster #49, 50; Neuromuscular/Lower Extremity Subspecialty Day
Riccio, Anthony I.	n-none	Reviewer; Presider; Paper #88; e-Poster #88
Richards, B. Stephens	4-Pfizer; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Pediatric Orthopedics; 9-Scoliosis Research Society	Papers #7, 16, 18; Reviewer; Spine Subspecialty Day
Ridderbusch, Karsten	3B-Synthes	Spine Subspecialty Day #6
Rife, Lauren	n-none	e-Poster #55
Riis, Jacob	n-none	Paper #9
Riley, Jaren M.	n-none	Sports Subspecialty Day

Name	Disclosure	Presentation Type
Riley, Scott A.	n-none	e-Poster #97, 99; Hand Subspecialty Day #3
Ritzl, Eva Katharina	9-ACNS-American Clinical Neurophysiology Society, ASNM-American Society of Neurophysiological Monitoring	Poster #5
Roberts, David W.	n-none	Paper #36
Rocha, Jorge Luis	n-none	e-Poster #39
Rogers, Kenneth J.	n-none	Papers #62, 71; e-Posters #13, 16, 64, 72;
Roocroft, Joanna H.	n-none	Paper #108; e-Poster #22, 76, 98; Neuromuscular/ Lower Extremity Subspecialty Day #1
Roof, Amanda C.	n-none	Paper #34
Rooney, Deborah M.	n-none	Paper #105
Roposch, Andreas	9-European Paediatric Orthopaedic Society	Paper #28; Hip Subspecialty Day #4
Rosenfeld, Scott B.	3C-Orthopediatrics; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins, UpToDate; 9-Pediatric Orthopaedic Society of North America	Paper #99; Reviewer; Hip Subspecialty Day
Ross, James	n-none	e-Poster #25; Hip Subspecialty Day #6
Ross, Patrick	n-none	e-Poster #67
Roy, David	n-none	e-Poster #50
Roye, Benjamin D.	3B-Stryker; 5-SRS, POSNA, OMeGA, OREF, CWSDSG	Paper #72
Roye, David P.	3B-Stryker; 5-OREF, CWSDRF, SRS, POSNA, CPIRF; 6-OMeGA, Biomet; 8-Journal of Bone and Joint Surgery - American; Journal of the American Academy of Orthopaedic Surgeons; 9-La Societe Internationale de Chirurgie Orthopedique et de Traumatologie	Paper #7, 72; Spine Subspecialty Day #4
Rupprecht, Martin	n-none	Spine Subspecialty Day #6
Ryan, Deirdre D.	n-none	Poster #17; e-Poster #83

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/ committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Sabharwal, Sanjeev B.	8-Journal of Bone and Joint Surgery - American, Clinical Orthopaedics and Related Research; 9-Pediatric Orthopaedic Society of North America, Limb Lengthening & Reconstruction Society	Reviewer; COUR Symposium
Sacks, Karen	n-none	e-Poster #72
Saglam, Yavuz	n-none	Paper #33, 36; e-Poster #11
Sala, Debra A.	n-none	e-Poster #20
Saluan, Paul M.	2-Arthrex, Inc; 3C-Triatrix, LLC; 5-Zimmer	Sports Subspecialty Day
Samchukov, Mikhail L.	1-Orthofix, Inc.; 3B-Orthofix, Inc.	Neuromuscular/Lower Extremity Subspecialty Day #9
Samdani, Amer	3B-DePuy Synthes Spine, SpineGuard, Zimmer, Stryker	Paper #45, 49; e-Poster #66
Samora, Walter P.	n-none	Paper #106; Hip Subspecialty Day #10
Sampath Kumar, Venkatesan	n-none	Poster #12
Sanders, James O.	4-Abbott, Abbvie, GE Healthcare, Hospira; 8-Journal of Pediatric Orthopedics; 9-AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Papers #7, 21; e-Posters #4, 64; Moderator; Spine Subspecialty Day
Sankar, Wudbhav N.	7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 9-Pediatric Orthopaedic Society of North America	Paper #26, 32; Reviewer; Hip Subspecialty Day ; Spine Subspecialty Day #7
Sarkissian, Eric J.	n-none	Paper #26; e-Poster #26
Sarwahi, Vishal	3B-DePuy, A Johnson & Johnson Company, Medtronic; 5-DePuy, A Johnson & Johnson Company	e-Poster #62
Sassoon, Adam	n-none	Paper #38
Satchell, Emma K.	n-none	Papers #8, 34
Sato, Shingo	n-none	Paper #82
Satsuma, Shinichi	n-none	e-Posters #41, 43; Hip Subspecialty Day #2
Sawyer, Jeffrey R.	7-Mosby; Wolters Kluwer Health - Lippincott Williams & Wilkins; 9-AAOS, Pediatric Orthopaedic Society of North America, Campbell Foundation	Paper #74, 90; e-Poster #36, 68, 73
Scannell, Brian	n-none	e-Posters #56, 70, 82

Name	Disclosure	Presentation Type
Scarcella, Nicholas	n-none	e-Poster #86
Scerpella, Tamara A.	n-none	Sports Subspecialty Day #5
Schaffzin, Joshua K.	n-none	NP/PA Symposium
Scherl, Susan A.	7-UpToDate; Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-POSNA Resident Review; 9-AAOS; American Orthopaedic Association; Pediatric Orthopaedic Society of North America	Program Committee
Schindeler, Aaron	5-N8 Medical; 6-Celgene Ltd; 8-Journal of Tissue Science & Engineering, Editorial Board member	Paper #81
Schindler, Amos	n-none	e-Poster #37
Schlechter, John A.	2-Arthrex, Inc	Neuromuscular/Lower Extremity Subspecialty Day #1
Schmale, Gregory A.	n-none	e-Posters #74, 75; COUR Symposium
Schmitz, Michael L.	3B-Stryker; 9-Pediatric Orthopaedic Society of North America	Paper #11
Schoenecker, Jonathan G.	5-ISIS pharmaceuticals	e-Poster #5; Paper #3, 75, 85; Poster #2
Schoenecker, Perry L.	8-Journal of Pediatric Orthopedics, Journal of Children's Orthopaedics; 9-Pediatric Orthopaedic Society of North America	Paper #73; e-Poster #25, 27, 28, 29, 32, 34; Hip Subspecialty Day #6
Schrader, Tim	9-AAOS	Paper #13, 59; e-Poster #31, 47; Hip Subspecialty Day
Schueler, Beth	n-none	e-Poster #54
Schwartz, Brandon	n-none	Paper #5
Schwend, Richard M.	2-Medtronic; 9-Pediatric Orthopaedic Society of North America, American Academy of Pediatrics, Project Perfect World, Miracle Feet	e-Poster #71; Spine Subspecialty Day
Scott, Allison C.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #2
Seehausen, Derek A.	n-none	e-Posters #20, 67
Seeley, Mark	n-none	Paper #105
Sees, Julieanne P.	n-none	Paper #62

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Segal, Lee S.	8-Clinical Orthopaedics and Related Research; 9-Pediatric Orthopaedic Society of North America	Paper #14; Poster #9; e-Poster #52
Seiter, Max	n-none	Paper #107
Senaran, Hakam	n-none	e-Poster #14
Serletti, Joseph C.	n-none	e-Poster #51
Shah, Apurva	9-Pediatric Orthopaedic Society of North America; American Society for Surgery of the Hand	Paper #79; Hand Subspecialty Day
Shah, Suken A.	1-Arthrex, Inc., DePuy Synthes Spine; 3B-DePuy Synthes Spine; 3C-K Spine, Inc., OrthoPediatrics; 4-Globus Medical; 5-DePuy Synthes Spine; 9-AAOS, Scoliosis Research Society, Pediatric Orthopaedic Society of North America, Setting Scoliosis Straight Foundation	Paper #7, 10, 45, 49, 71, 72; e-Poster #56, 64, 72, 84; Spine Subspecialty Day
Shannon, Claire	3A-Zimmer	Paper #40
Shapiro, Jay R.	n-none	e-Poster #15
Sharps, Chester H.	1-Doctors' Research Group, Amedica; 3C-Amedica, Doctors' Research Group; 4-Amedica, Doctors' Research Group	Paper #9
Shaughnessy, William J.	8-Journal of the American Academy of Orthopaedic Surgeons	Paper #86; e-Poster #63
Shea, Kevin G.	9-AAOS; American Orthopaedic Society for Sports Medicine; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	Poster #1; e-Poster #23; Hand Subspecialty Day; Sports Subspecialty Day #6
Shenava, Vinitha V.	n-none	Paper #98
Shinada, Yoshiyuki	n-none	e-Poster #41
Shore, Benjamin J.	9-American Academy for Cerebral Palsy and Developmental Medicine; Pediatric Orthopaedic Society of North America	Paper #93, 94, 100; e-Poster #35, 85
Shrader, M. Wade	3B-Orthopediatrics; 9-Arizona Medical Association, American Academy for Cerebral Palsy and Developmental Medicine, Scoliosis Research Society, Pediatric Orthopedic Society of North America	Paper #14; Poster #9; e-Poster #52; Reviewer
Shufflebarger, Harry L.	1-DePuy Spine, A Johnson & Johnson Company; 2-DePuy Spine; 3B-DePuy Spine; 5-DePuy Spine; 8-Journal of Pediatric Orthopedics; Spine	e-Poster #56; Spine Subspecialty Day

Name	Disclosure	Presentation Type
Shymon, Stephen J.	n-none	Paper #108
Sielatycki, John	n-none	e-Poster #48
Sierra, Rafael J.	1-Biomet; 2-Biomet; 3B-Biomet; 5-DePuy, A Johnson & Johnson Company, Zimmer, Stryker, Biomet; 8-Journal of Arthroplasty; 9-Midamerica Orthopedic Society, Maurice Mueller Foundation, American Association of Hip and Knee Surgeons	e-Poster #28
Silva, Mauricio	9-World Federation of Hemophilia	e-Poster #89, 90; Reviewer
Simoni, Michael K.	n-none	e-Poster #81
Sink, Ernest L.	3B-Pivot	Program Committee; Moderator; Paper #89; e-Poster #34; Hip Subspecialty Day #5
Sison-Williamson, Mitell	n-none	Paper #69
Sitoula, Prakash	n-none	e-Poster #64
Skaggs, David L.	1-Biomet; 2-Medtronic, Stryker, Biomet; 3B-Medtronic, Biomet; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Childrens Orthopaedics; Spine Deformity; 9-Growing Spine Foundation; Growing Spine Study Group, Medtronic Strategic Advisory Board, Scoliosis Research Society	Papers #7, 12, 43, 74; e-Posters #67, 83
Smith, Brian G.	2-Stryker; 3B-Stryker; 9-American Academy of Pediatrics Orthopaedic Section, Pediatric Orthopaedic Society of North America	Young Members Forum
Smith, John T.	1-Synthes; 3B-Ellipse Technologies, Spineguard, Synthes; 5-Chest Wall and Spine Deformity Research Foundation; 9-Chest Wall and Spine Deformity Research Foundation	Papers #7, 42; e-Poster #73; Spine Subspecialty Day #5
Smith, Peter A.	n-none	Paper #77
Smith-Whitley, Kimberly	n-none	Poster #8
Snyder, Brian	9-Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Paper #103

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Solomito, Matthew J.	n-none	e-Poster #80; Neuromuscular/Lower Extremity Subspecialty Day #7
Song, Kit M.	7-Hanley and Belfus; 9-AAOS, Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Reviewer; Spine Subspecialty Day
Souchet, Philippe	n-none	Paper #17
Souder, Christopher D.	n-none	e-Poster #98; Hand Subspecialty Day #6; Hip Subspecialty Day #9
Southorn, Tom	n-none	Poster #18
Spanos, Stephen	2-KCI	Paper #55
Spence, David D.	n-none	Paper #90; e-Poster #36, 68
Spinal Deformity Study Group,	n-none	Paper #54
Sponseller, Paul D.	1-Globus Medical, DePuy, A Johnson & Johnson Company; 3B- DePuy, A Johnson & Johnson Company; 5-DePuy, A Johnson & Johnson Company; 7-Journal of Bone and Joint Surgery, Oakstone Medical; 8-Journal of Bone and Joint Surgery; 9- Scoliosis Research Society	Moderator; Papers #7, 43, 45, 112; Poster #5; e-Posters #15, 56
Sridhar, Manasa	n-none	Neuromuscular/Lower Extremity Subspecialty Day #3
St. Hilaire, Tricia	n-none	e-Poster #73
Stanley, Philip	n-none	Paper #102
Stans, Anthony A.	9-Pediatric Orthopaedic Society of North America	Paper #86; e-Posters #54, 63
Starke, Matthew C.	n-none	Paper #98
Stebbins, Julie	8-Gait and Posture; 9-European Society of Movement Analysis in Adults and Children	Paper #24
Stech, Teri	n-none	POSNA Staff
Steiner, Richard	n-none	e-Poster #96
Stenquist, Nicole J.	n-none	Paper #60
Stephens, Byron Fitzgerald	n-none	e-Poster #36
Sterling, Robert S.	9-AAOS; American Orthopaedic Association; Maryland Orthopaedic Association	e-Posters #59, 60

Name	Disclosure	Presentation Type
Stevens, Peter M.	1-Orthofix, Inc.; 2-Orthofix, Inc.; 3B-Orthofix, Inc.; 8-Wolters Kluwer Health - Lippincott Williams & Wilkins =Journal of Pediatric Orthopaedics	Papers #22, 55
Stone, Joseph D.	n-none	Paper #95
Stork, Natalie	n-none	Paper #4
Stringer, Keith	n-none	e-Poster #2
Stuart, Emily	n-none	Poster #9
ANCHOR Study Group	n-none	Paper #37; Hip Subspecialty Day #7
BrAIST Study Group	n-none	Paper #70
Chest Wall and Spine Deformity Study Group	5-DePuy Synthes Spine	Spine Subspecialty Day #4
Children's Spine Study Group	5-DePuy, A Johnson & Johnson Company	e-Poster #73
Growing Spine Study Group	5-Growing Spine Foundation	Paper #43, 44; Spine Subspecialty Day #4
Harms Study Group	5-DePuy, A Johnson & Johnson Company; OREF	Paper #44; e-Poster #56
Spinal Deformity Study Group	n-none	Paper #50
Stuecker, Ralf	3B-Synthes	Spine Subspecialty Day #6
Stuedemann, Anne	9-Pediatric Orthopaedic Practitioner's Society	e-Poster #71
Stutz, Christopher M.	n-none	Paper #3, 75; Hand Subspecialty Day
Sucato, Daniel J.	3C-Orthopaediatrics; 7-Saunders/Mosby-Elsevier; 9-AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society	Reviewer; Moderator; Papers #7, 29, 30, 31; e-Posters #11, 25, 32, 61; Hip Subspecialty Day #5
Sun, Dan	n-none	Paper #57
Sun, Michael	n-none	e-Poster #44
Sund, Sarah A.	n-none	Paper #4
Suprenant, Danielle	n-none	Sports Subspecialty Day #4
Swaroop, Vineeta T.	7-Up to Date-online publication; 9-Pediatric Orthopaedic Society of North America	Paper #111
Swart, Eric F.	n-none	Paper #6
Swindell, Hasani	n-none	Spine Subspecialty Day #4

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Talwalkar, Vishwas R.	n-none	Paper #19, 20, 63, 68; e-Poster #21; Spine Subspecialty Day #3; Neuromuscular/Lower Extremity Subspecialty Day #10
Taylor, Daveda	n-none	Neuromuscular/Lower Extremity Subspecialty Day #3
Tenfelde, Allison	n-none	Poster #7
Teske, Noelle	n-none	Paper #22
Thacker, Mihir	9-Pediatric Orthopaedic Society of North America	e-Poster #16
Theologis, Tim	7-Gait and Posture; 8-Gait and Posture; 9-British Orthopaedic Association	Paper #24
Thomas, Valorie K.	n-none	e-Poster #71; Spine Subspecialty Day #8
Thompson, George H.	3A-Son - representative for NuSpine Medical Technologies; 3C-OrthoPediatrics; SpineForm; 6-Son - representative for NuSpine Medical Technologies; 7-Lippincott; 8-Journal of Pediatric Orthopedics; 9-Societe Internationale de Chirurgie Orthopedique et de Traumatologie	Paper #40, 43
Thompson, Norfleet B.	n-none	Paper #90
Thomson, Karen M.	n-none	Paper #677
Thuet, Earl David	n-none	Spine Subspecialty Day #1
Tolo, Vernon T.	7-Journal of Bone and Joint Surgery - American, Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Bone and Joint Surgery - American	Young Members Forum
Tompkins, Bryan J.	9-Pediatric Orthopaedic Society of North America,; AAOS	Poster #19; e-Poster #18
Toy, Kristin A.	n-none	Sports Subspecialty Day #3
Trousdale, Robert T.	1-DePuy, A Johnson & Johnson Company, Wright Medical Technology, Inc., MAKO; 3B-DePuy, A Johnson & Johnson Company, Wright Medical Technology, Inc., MAKO	e-Poster #25, 28, 34
Troy, Michael J.	n-none	Paper #103
Trupia, Evan Paul	n-none	Spine Subspecialty Day #4
Tsai, Min-Fnag	n-none	e-Poster #92

Name	Disclosure	Presentation Type
Tuten, Hans Robert	1-Amedica; 4-Amedica, Doctors Research Group	Paper #9
Upasani, Vidyadhar V.	n-none	Paper #42
Urrutia, Megan	n-none	Paper #18
Valero-Cuevas, Francisco	n-none	Hand Subspecialty Day #1
Vanderhave, Kelly L.	n-none	e-Poster #82
Venkatesan, Arun	n-none	Poster #5
Verma, Kushagra	n-none	e-Poster #64, 84
Verma, Satyendra	n-none	e-Poster #64
Virostek, Donald D.	9-American Board for Certification in Orthotics, Prosthetics, and Pedorthics inc.	Paper #18
Vitale, Michael G.	1-Biomet; 3B-Biomet; Stryker; 5-Biomet; Childrens Spine Foundation; OREF; 9-Childrens Spine Foundation; IPOS; Pediatric Orthopaedic Society of North America	e-Moderator; Paper #7, 72; e-Poster #73; Spine Subspecialty Day #4; Neuromuscular/Lower Extremity Subspecialty Day #10;
Vuillermin, Carley	n-none	Hand Subspecialty Day #2
Walker, Janet	n-none	Paper #19, 20, 63, 68; e-Poster #21, 99; Spine Subspecialty Day #3
Wall, Lindley B.	n-none	Hand Subspecialty Day
Wallace, Juanita Jean	n-none	Paper #20, 68
Wang, Claire	n-none	Paper #6
Wang, Peter	n-none	Sports Subspecialty Day #3
Ward, W. Timothy	n-none	Paper #92
Warner, William C.	3C-Medtronic Sofamor Danek, Medtronic Sofamor Danek; 7-Saunders/Mosby-Elsevier, Saunders/Mosby-Elsevier; 9-Clinical Orthopaedic Society	Paper #90; e-Poster #36, 68; Spine Subspecialty Day
Warnick, Drew Eugene	n-none	Sports Subspecialty Day #8
Wasser, Aubrey M.	n-none	Paper #100
Wasserstein, David	n-none	e-Poster #93

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Waters, Peter M.	4-Celgene, Sangamo; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins, Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Wolters Kluwer Health - Lippincott Williams & Wilkins; 9-American Society for Surgery of the Hand, Pediatric Orthopaedic Society of North America	e-Poster #85; Hand Subspecialty Day #4
Watkins, Summer	n-none	e-Poster #40
Wattenbarger, J. Michael	2-K2M; 9-Scoliosis Research Society; Pediatric Orthopaedic Society of North America	Paper #35
Watts, Hugh G.	n-none	COUR Symposium
Weatherford, Brian M.	n-none	Hip Subspecialty Day #1
Wei, Quingxia	n-none	Paper #82
Weinstein, Stuart L.	7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Bone and Joint Surgery - American	Paper #70
Weiss, Jennifer M.	9-AAOS, AAOS, California Orthopedic Association, Pediatric Orthopaedic Society of North America	Reviewer; Moderator; Sports Subspecialty Day; e-Poster #23; Hand Subspecialty Day #5; Sports Subspecialty Day #6
Welling, Benjamin D.	n-none	Paper #99
Wells, Lawrence	9-Philadelphia Orthopaedic Society	e-Moderator; Poster #8
Wenger, Dennis R.	3B-OrthoPediatrics; 4-Rhino Pediatric Orthopedic Designs; 7-Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Pediatric Orthopedics,Journal of Children's Orthopedics	Moderator; Hip Subspecialty Day #9
Wheeler, Lesley	n-none	Hand Subspecialty Day
White, Hank	n-none	Paper #20, 68
White, Klane K.	2-Shire HGT, Biomarin Pharmaceuticals, Genzyme; 5-Biomarin Pharmaceuticals; 7-UptoDate; 8-Journal of Pediatric Orthopedics; 9-Pediatric Orthopaedic Society of North America	Reviewer; Paper #8, 34; e-Poster #13
Wilcox, Melissa J.	n-none	e-Poster #22
Willimon, Samuel Clifton	3B-Smith & Nephew Endoscopy	Sports Subspecialty Day #8
Wilson, David Joseph	n-none	e-Poster #18
Wilson, Kristina	n-none	Paper #14; Poster #9
Wilson, Philip L.	7-Elsevier	Paper #107

Name	Disclosure	Presentation Type
Wimberly, Robert L.	n-none	Paper #88; e-Poster #88
Wingerter, Scott A.	n-none	e-Poster #27
Winkler, Jennifer A.	n-none	e-Poster #54
Wise, Kelsey	n-none	Paper #107
Wolfstadt, Jesse Isaac	n-none	e-Poster #93
Wong, Man Sang	n-none	Paper #47
Woods, Jessica R.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #7; Sports Subspecialty Day #4
Worrall, Douglas M.	n-none	Poster #8
Wren, Tishya	4-Arthrocare; 5-Ultraflex, National Institutes of Health-NIAMS & NICHD; 9-Gait and Clinical Movement Analysis Society	Paper #66; Poster #17; Hand Subspecialty Day #1
Wright, James G.	7-Journal of Bone and Joint Surgery - American; Saunders/Mosby-Elsevier; 8-Journal of Bone and Joint Surgery - American	Reviewer; e-Moderator; e-Poster #93
Wright, Margaret	n-none	Paper #7, 72
Wu, Shi-Liang	n-none	e-Poster #92
Yang, Charles Inshik	n-none	Paper #41
Yaszay, Burt	1-Orthopediatrics, K2M; 2-DePuy, A Johnson & Johnson Company, K2M; 3B-K2M, Orthopaediatrics, DePuy, A Johnson & Johnson Company, Medtronic Sofamor Danek; 5-DePuy, A Johnson & Johnson Company, Harms Study Group; 8-Spine Deformity; 9-Scoliosis Research Society, POSNA, AAOS	Paper #44, 45, 52; e-Poster #56, 65, 69, 70; Spine Subspecialty Day
Yazici, Muharrem	2-Ellips Technologies, DePuy Synthes; 3B-None; 8-Acta Orthopedica Traumatologica e Turcica, Spine Deformity Surgery, Journal of Children's Orthopedics; 9-European Pediatric Orthopaedic Society, Immediate Past-President	Paper #43; Spine Subspecialty Day
Yen, Yi-Meng	3A-Agios Pharmaceuticals; 3B-Smith & Nephew, Orthopediatrics, Arthrex, Inc; 4-Agios Pharmaceuticals	Paper #94, 101, 109
Yilmaz, Guney	n-none	e-Poster #14
Yoo, Won Joon	8-Clinics in Orthopedic Surgery	Hip Subspecialty Day #8

Disclosure Key: The codes are identified as: 1-Royalties from a company or supplier; 2-Speakers bureau/paid presentation for a company or supplier; 3-(a) paid employee or (b) paid consultant or (c) unpaid consultant for a company or supplier; 4-Stock or stock options in a company or supplier; 5-Research support from a company or supplier as a PI; 6-Other financial or material support from a company or supplier; 7-Royalties, financial or material support from publishers; 8-Medical/orthopaedic publications editorial/governing board; 9-Board member/committee appointments for a society; n-no conflicts. **Boldface** indicates member of POSNA Board of Directors. For full information, refer to page 7.

Name	Disclosure	Presentation Type
Yorgova, Petya	n-none	Paper #71, 72; e-Poster #64
Young, Megan L.	n-none	Paper #33
Young Calandra, Valerie	n-none	e-Poster #76
Yu, Fiona Wai Ping	n-none	Paper #47
Yuasa, Masato	n-none	Paper #85
Zaltz, Ira	3B-Pivot Medical; 5-DePuy, A Johnson & Johnson Company	Paper #37; e-Poster #25, 32, 34; Hip Subspecialty Day #5, 7
Zavatsky, Amy Beth	8-Clinical Biomechanics-Elsevier	Paper #24
Zeller, Reinhard	1-Spinevision; 3C-Paradigm Spine; 8-Journal of Children's Orthopaedics, Maitrise Orthopedique, Spine Deformity, European Spine Journal, Spine Deformity; 9-Scoliosis Research Society-Historical Committee; Scoliosis Research Society	Paper #7
Zhang, Wei	n-none	Paper #98, 99
Zimmerman, Catherine	n-none	e-Poster #19, 24
Zurakowski, David	n-none	Paper #37; e-Poster #81; Hip Subspecialty Day #7

POSNA

2014 SCIENTIFIC PROGRAM

WEDNESDAY, APRIL 30, 2014

1:30 PM–1:39 PM **INTRODUCTION AND OPENING REMARKS**

QSVI

Moderator: *James O. Sanders, MD*
Presider: *Kerwyn C. Jones, MD*
e-Moderator: *James G. Wright, MD*

1:40 PM–1:44 PM
1 *(page 87)*

Impact of Clinical Practice Guidelines on the Treatment of Pediatric Femur Fractures

Matthew E. Oetgen, MD*; Allison M. Blatz, BA; Allison Matthews, MSCR*

Children's National Medical Center, Washington, DC

1:45 PM–1:49 PM
2 *(page 89)*

Association of Pediatric Fractures with Serum Vitamin D Levels Compared To Non-fracture Community Controls

Barbara Minkowitz, MD*; Barbara Cerame; Eileen Blechman Poletick, RN, DNP; Sherri Luxenberg; Nicole Danielle Formoso; Renee Eng; Samantha Nicole Easton; Jonathan Chevinsky; Scott Musial; Lior Fusman; Connor Jordan; Ben H. Lee, MD, MPH, MSc*

Atlantic Health System, Morristown, NJ

1:50 PM–1:54 PM
3 *(page 90)*

Radiation Exposure During Fixation of Pediatric Supracondylar Humerus Fractures: Are Lead Shields Important?

Jeffrey E. Martus, MD, MS*; Melissa A. Hilmes; Christopher M. Stutz, MD; Jonathan G. Schoenecker, MD, PhD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD*

Vanderbilt Children's Hospital, Nashville, TN

1:55 PM–2:03 PM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

See pages 17 - 62 for financial disclosure information.

†LOE - Level of Evidence - Please see page 16 for details.

2:04 PM – 2:08 PM
4 *(page 92)*

To Cast, to Saw, and Not to Injure: Can Safety Strips Decrease Cast Saw Injuries?

Natalie C. Stork, MD; Rachel L. Lenhart, MS; Blaise A. Nemeth, MD, MS; Kenneth J. Noonan, MD; Sarah A. Sund, BS;
Matthew A. Halanski, MD

University of Wisconsin Madison, School of Medicine and Public Health, Madison, WI

2:09 PM – 2:13 PM
5 *(page 93)*

Appropriateness and Adequacy of Splints Applied for Pediatric Fractures in an Emergency Department/Urgent Care Environment

Brandon S. Schwartz, MPH; ***Joshua M. Abzug, MD***

University of Maryland School of Medicine, Baltimore, MD

2:14 PM – 2:18 PM
6 *(page 94)*

Prevention and Screening Programs for Anterior Cruciate Ligament Injuries in Young Athletes: A Cost-Effectiveness Analysis

Eric F. Swart, MD; Lauren H. Redler, MD;
Peter D. Fabricant, MD, MPH*; Bert R. Mandelbaum, MD; Christopher S. Ahmad, MD; Y. Claire Wang, MD, ScD*

Columbia University Medical Center and Mailman School of Public Health of Columbia University, New York, NY

2:19 PM – 2:27 PM DISCUSSION

2:28 PM – 2:32 PM
7 *(page 95)*

Creation of a Consensus-Based Checklist for the Response to Intraoperative Neuromonitoring Changes in Pediatric Spine Surgery

Michael G. Vitale, MD*; Gregory I. Pace, BA; Margaret L. Wright, BS; Hiroko Matsumoto, MA; Behrooz A. Akbarnia, MD; John P. Dormans, MD; John B. Emans, MD; Mark A. Erickson, MD; John (Jack) M. Flynn, MD; Steven D. Glassman, MD; Michael P. Glotzbecker, MD; Kamal N. Ibrahim, MD; Stephen J. Lewis, MD; Scott J. Luhmann, MD; James J. McCarthy, MD; Peter O. Newton, MD; David W. Polly, Jr, MD; B. Stephens Richards, III, MD; James O. Sanders, MD; Suken A. Shah, MD; David L. Skaggs, MD; John T. Smith, MD; Paul D. Sponseller, MD; Daniel J. Sucato, MD, MS; Reinhard D. Zeller, MD, DSc, FRCSC; David P. Roye, Jr, MD; Lawrence G. Lenke, MD*

Morgan Stanley Children's Hospital of New York Presbyterian

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

2:33 PM – 2:37 PM
8 *(page 97)*

Effectiveness of the "Spine At Risk" Safety Program

Walter F. Krengel, III, MD; Courtney M. O'Donnell, MD; Nicole Burkette-Ikebata, MPH; Emma K. Satchell, BA; Viviana Bompadre, PhD; ***Klane K. White, MD, MSc***

Seattle Children's Hospital, Seattle, WA

2:38 PM – 2:42 PM
9 *(page 99)*

Comparison of Imaging Methods and Radiation Exposure in Posterior Spinal Fusions for Scoliosis

Victoria Kuester, MD*; Hans Robert Tuten, MD; Chester Howard Sharps, MD; Jacob Riis, MD; John Ryan Quinn, MSIV*

Virginia Commonwealth University Health System, Richmond, VA

2:43 PM – 2:51 PM DISCUSSION

2:52 PM – 2:56 PM
10 *(page 100)*

What is the Anticipated U.S. Cost of Pedicle Screw vs. Luque Wire Instrumentation for Neuromuscular Scoliosis Surgery?

A. Noelle Larson, MD*; Suken A. Shah, MD; Scott J. Luhmann, MD; David W. Polly Jr, MD*

Multicenter Study (Mayo Clinic; A. I. DuPont; Washington University; U. of Minnesota)

2:57 PM – 3:01 PM
11 *(page 102)*

Clinical Impact of Adopting a Novel Post Operative Pathway on Post Operative Stay Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

David E. Lazarus, MD; Benjamin L. Geddes, BS; Robert J. Owen, BS; Phillip M. Mitchell, MD; Michael L. Schmitz, MD; Dennis P. Devito, MD; ***Nicholas D. Fletcher, MD***

Emory University, Atlanta, GA

3:02 PM – 3:06 PM
12 *(page 103)*

Implementation of an Accelerated Discharge Pathway Reduced Hospital Stay Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis by Nearly 50%: A Multicenter Comparative Study

Nicholas D. Fletcher, MD*; Lindsay M. Andras, MD; David E. Lazarus, MD; Robert J. Owen, BS; Benjamin J. Geddes, BS; Jessica Cao, BS; David L. Skaggs, MD; Timothy S. Oswald, MD; Robert W. Bruce, MD*

Emory University, Atlanta, GA

3:07 PM – 3:15 PM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

3:16 PM–3:20 PM
13 *(page 104)*
Improving the Process of Care for Developmental Dysplasia of the Hip
Mackenzie M. Herzog, BA; ***Tim Schrader, MD***
Children's Healthcare of Atlanta

3:21 PM–3:25 PM
14 *(page 105)*
Evaluation of Patient Satisfaction Scores in Pediatric Orthopaedics
Lee S. Segal, MD*; Carla Plantikow, M.Sc.; Randon Hall, MD, MBA; Kristina Wilson, MD, MPH; M. Wade Shrader, MD*
Phoenix Children's Hospital, Phoenix, AZ

3:26 PM–3:30 PM
15 *(page 106)*
The Use of 6 Axis External Fixation is Overall More Cost-effective than Ilizarov for Canadian Health Care Centers
Elisabeth Leblanc, MD*; Khalid Alkhelaifi, MD; Mohammad Alzahrani, MD; Marie Gdalevitch, MD*
Shriners Hospital for Children, Montreal, QB, CANADA

3:31 PM–3:39 PM DISCUSSION

3:40 PM–4:00 PM BREAK

FOOT/ANKLE

Moderator: *Steven L. Frick, MD*
Presider: *Pooya Hosseinzadeh, MD*
e-Moderator: *Scott J. Mubarak, MD*

4:01 PM–4:05 PM
16 *(page 107)*
Ponseti Corrected Clubfeet At Age Two Years: Is the Story Finished?
B. Stephens Richards III, MD*; Shawne Faulks, MSN, RN, CNS; Lori A. Karol, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

4:06 PM–4:10 PM
17 *(page 108)*
Surgical Treatment of Congenital Idiopathic Clubfoot After "French" Functional Treatment: Outcome in a 10-Year Pro Study
Nicolas Bocahut; ***Dr. Philippe Souchet****; Brice Ilharreborde, MD; Keyvan Mazda, MD*
Robert Debre Hospital, Paris, FRANCE

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

4:11 PM–4:15 PM
18 *(page 109)*

Objective Measurement of Brace Compliance in Idiopathic Clubfoot Treatment

Donald D. Virostek, CPO; Kevin Felton, CPO; Megan Urrutia, MPO; Shawne Faulks, RN; ***Karl E. Rathjen, MD****; B. Stephens Richards III, MD*

Texas Scottish Rite Hospital for Children, Dallas, TX

4:16 PM–4:24 PM DISCUSSION

4:25 PM–4:29 PM
19 *(page 110)*

Recurrent Forefoot Adductus is a Predictor of Future Surgery in Clubfeet Treated by Ponseti Casting

Pooya Hosseinzadeh, MD; Erik D. Peterson, MD; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet L. Walker, MD; Vishwas R. Talwalkar, MD; ***Todd A. Milbrandt, MD, MS***

Lexington Shriners Hospital for Children, Lexington, KY

4:30 PM–4:34 PM
20 *(page 112)*

Is the Anterior Tibialis Weaker After Transfer in Children with Clubfeet?

Hank White, PT, PhD; Juanita J. Wallace, MS; Samuel F. Augsburger, MS; ***Todd A. Milbrandt, MD, MS****; Vishwas R. Talwalkar, MD; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet Walker, MD*

Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington KY

4:35 PM–4:39 PM
21 *(page 113)*

Determination of Peak Growth Acceleration from Ossification of the Calcaneal Apophysis

Allen Nicholson, BS; Raymond W. Liu, MD; James O. Sanders, MD; ***Daniel Cooperman, MD***

Yale School of Medicine, New Haven, CT

4:40 PM–4:48 PM DISCUSSION

4:49 PM–4:53 PM
22 *(page 114)*

Prospective Comparison of Subtalar Arthroereisis to Lateral Column Lengthening for Painful Flatfeet

David Chong, MD*; Bruce A. MacWilliams; Theresa A. Hennessey, MD; Noelle Teske, MSc; Peter M. Stevens, MD*

University of Utah, Salt Lake City, UT

4:54 PM–4:58 PM
23 *(page 116)*

Rate of Correction and Recurrence of Ankle Valgus in Children using a Transphyseal Medial Malleolar Screw

Frank M. Chang, MD*; Julie Ma, BA; Zhaoxing Pan, MB, PhD; Liliana Hoversten, BA; Eduardo N. Novais, MD*

Children's Hospital Colorado, Aurora, CO

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

4:59 PM–5:03 PM
24 *(page 117)*
Using the Oxford Ankle Foot Questionnaire to Evaluate Children with Flexible Flatfeet. A Comparison with Typically Developing Feet and Cerebral Palsy
Alpesh Kothari, MD; Julie Stebbins, PhD; Amy Beth Zavatsky, PhD; ***Tim Theologis, MSc, PhD, FRCS***
Nuffield Orthopaedic Centre, Oxford, UNITED KINGDOM

5:04 PM–5:12 PM DISCUSSION

THURSDAY, MAY 1, 2014

8:00 AM–8:04 AM **WELCOME AND REMARKS**

HIP

Moderator: *Ernest L. Sink, MD*
Presider: *Kevin E. Klingele, MD*
e-Moderator: *David A. Podeszwa, MD*

8:04 AM–8:08 AM
25 *(page 118)*
Successful Pavlik Harness Treatment for Developmental Dysplasia of the Hip and Normal X-Ray at Age Two: Is a Longer Follow-up Necessary?
Nanni J. Allington, MD
CHR Citadelle, Liège, BELGIUM

8:09 AM–8:13 AM
26 *(page 119)*
Radiographic Follow-up for DDH after 6 Months of Age: Are X-Rays Necessary after a Normalized Ultrasound?
Eric J. Sarkissian, BS; John (Jack) M. Flynn, MD; ***Wudbhav N. Sankar, MD***
The Children's Hospital of Philadelphia, Philadelphia, PA

8:14 AM–8:18 AM
27 *(page 120)*
The Complication Rate for Treatment of Developmental Dysplasia of the Hip with the Pavlik Harness
Valentin Noriega, Sr, MD; Carlos Alejandro Brambila, MD; ***Pablo Castañeda, MD***
Shriners Hospital for Children, Mexico City, MEXICO

8:19 AM–8:27 AM DISCUSSION

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

8:28 AM–8:32 AM
28 *(page 121)*

A Re-evaluation of Commonly Accepted Risk Factors for Developmental Dysplasia of the Hip: Population-based Cohort Study

Andreas Roposch, MD, MSc, FRCS*; Evangelia Protopapa, MSc; Saboura Mahdavi; Olivia Málaga-Shaw; Yael Gelfer, MD; Ajay Asokan; Paul Humphries, MBBS; Fatima Jichi; Rumana Omar*

Great Ormond Street Hospital for Children, UCL Institute of Child Health, London, UNITED KINGDOM

8:33 AM–8:37 AM
29 *(page 122)*

Association between Referral Pattern and Prevalence of Developmental Dysplasia of the Hip (DDH): A Prospective Cohort Study

Benjamin Escott, MBBS, MSc*; Augusta Lloyd, MS; Lauren Paraison, BA; Chan-Hee Jo, PhD; Adriana De La Rocha, MS; Daniel J. Sucato, MD, MS*

Texas Scottish Rite Hospital for Children, Dallas, TX

8:38 AM–8:42 AM
30 *(page 123)*

Referral for Breech Presentation does Not Correlate with a Diagnosis of DDH in Children Less than One Year of Age

Daniel J. Sucato, MD, MS*; Augusta Lloyd, MS; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Erica Flores, RN MSN; Lauren Paraison, BA*

Texas Scottish Rite Hospital for Children, Dallas, TX

8:43 AM–8:51 AM DISCUSSION

8:52 AM–8:56 AM
31 *(page 124)*

Residual Dysplasia after Treatment with Pemberton vs. Salter Osteotomy for DDH: Mean 10-Year Follow-up

Daniel J. Sucato, MD, MS*; Adriana De La Rocha, MS; Chester J. Donnally, III, BS; Brigid N. Maloney, MS; David A. Podeszwa, MD; Lori A. Karol, MD*

Texas Scottish Rite Hospital for Children, Dallas, TX

8:57 AM–9:01 AM
32 *(page 125)*

The Medial Dye Pool Revisited: Correlation Between Arthrography and MRI in Closed Reductions for DDH

Itai Gans, BS; ***Wudbhav N. Sankar, MD***

Children's Hospital of Philadelphia, Philadelphia, PA

9:02 AM–9:06 AM
33 *(page 126)*

Age at Presentation does Not Influence Failure Rate of Open Reduction of an Idiopathic Dislocated Hip

Chukwudi K. Chukwunyerenwa, MD; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Yavuz Saglam, MD; Megan Lynn Young, MD; David A. Podeszwa, MD; ***Karl E. Rathjen, MD***

Texas Scottish Rite Hospital for Children, Dallas, TX

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

9:07 AM – 9:15 AM DISCUSSION

9:16 AM – 9:20 AM
34 *(page 127)*
Patient Factors Associated with Delayed Diagnosis of Developmental Dysplasia of the Hip
Antoinette W. Lindberg, MD*; Klane K. White, MD; Viviana Bompadre, PhD; Amanda Celest Roof, MD; Emma K. Satchell, BA*
Seattle Children's Hospital, Seattle, WA

9:21 AM – 9:25 AM
35 *(page 128)*
Efficacy and Satisfaction Comparing Two Braces in the Treatment of DDH: A Randomized Clinical Pilot
Virginia F. Casey, MD*; J. Michael Wattenbarger, MD; Christian Clark, MD*
OrthoCarolina, Charlotte, NC

9:26 AM – 9:30 AM
36 *(page 129)*
Long-term Outcomes of Operative and Nonoperative Treatment of Congenital Coxa Vara
David W. Roberts, MD*; Yavuz Saglam, MD; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Harry Kwang-Woo Kim, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

9:31 AM – 9:39 AM DISCUSSION

9:40 AM – 9:44 AM
37 *(page 130)*
Severity of Dysplasia and Patient Activity Predict Age of Presentation for Periacetabular Osteotomy for Symptomatic Hip Dysplasia
Travis Matheney, MD*; Young Jo Kim, MD, PhD; Ira Zaltz, MD; John C. Clohisy, MD; David Zurakowski, PhD; Michael B. Millis, MD; The ANCHOR Study Group*
Boston Children's Hospital, Boston, MA

9:45 AM – 9:49 AM
38 *(page 132)*
Total Hip Arthroplasty in Patients 21 and Younger Using Highly Cross Linked Polyethylene: Excellent Survivorship at 5 Years
Frank C. Bohnenkamp, MD; Gail Pashos; Adam Sassoon, MD; Geneva Baca, BA; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

9:50 AM–9:54 AM
39 *(page 133)*

Periacetabular Osteotomy for the Treatment of Acetabular Dysplasia Secondary to Charcot-Marie-Tooth Disease is Associated with Similar Clinical Improvement but Higher Complication Rate when Compared to Developmental Dysplasia of the Hip

***Eduardo N. Novais, MD**; Young Jo Kim, MD, PhD; Patrick M. Carry; Michael B. Millis, MD*

Boston Children's Hospital, Boston, MA

9:55 AM–10:03 AM DISCUSSION

10:04 AM–10:19 AM **DISTINGUISHED ACHIEVEMENT AWARD**

10:20 AM–10:34 AM BREAK

CONCURRENT SESSION I: SPINE

Moderator: *Daniel J. Sucato, MD, MS*
Presider: *A. Noelle Larson, MD*
e-Moderator: *Michael G. Vitale, MD*

10:35 AM–10:39 AM
40 *(page 134)*

♦ **Final Fusion after Growing Rod Treatment for Early Onset Scoliosis: Is it Really Final?**

*Connie Poe-Kochert, CNP; Claire Shannon, MD; Jeff B. Pawelek, BS; George H. Thompson, MD; **Christina K. Hardesty, MD**; David S. Marks, FRCS; Behrooz A. Akbarnia, MD; Richard E. McCarthy, MD; John B. Emans, MD*

Rainbow Babies and Children's Hospital, Cleveland, OH

10:40 AM–10:44 AM
41 *(page 135)*

Pulmonary Outcomes of VEPTR Expansion Thoracoplasty in Early Onset Scoliosis

***Vincent F. Deeney, MD**; Ozgur Dede, MD; Etsuro K. Motoyama; Charles I. Yang, BS, MD, MS; Rebecca Mutich, BS; Austin Bowles, MS*

Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA

10:45 AM–10:49 AM
42 *(page 136)*

Delayed VEPTR Implantation Results in Similar Radiographic Outcomes with Fewer Complications

***Vidyadhar S.V. Upasani, MD**; John B. Emans, MD; John T. Smith, MD; Randal R. Betz, MD; John (Jack) M. Flynn, MD; Michael P. Glotzbecker, MD*

Boston Children's Hospital, Boston, MA

10:50 AM–10:58 AM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

10:59 AM–11:03 AM
43 *(page 137)*

♦ **Traditional Growing Rods versus Magnetically Controlled Growing Rods in Early Onset Scoliosis: A Case-matched Two-Year Study**

Behrooz A. Akbarnia, MD*; Kenneth M.C. Cheung, MD; Gokhan H. Demirkiran, MD; Hazem B. Elsebaie, MD; John B. Emans, MD; Charles E. Johnston II, MD; Gregory M. Mundis, MD; Hilali H. Noordeen, FRCS; Jeff B. Pawelek, BS; David L. Skaggs, MD; Paul D. Sponseller, MD; George H. Thompson, MD; Muharrem Yazici, MD; Growing Spine Study Group*

San Diego Center for Spinal Disorders, La Jolla, CA

11:04 AM–11:08 AM
44 *(page 139)*

♦ **Case-matched Comparison of Spinal Fusion versus Growing Rods for the Surgical Treatment of Progressive Idiopathic Scoliosis in Skeletally Immature Patients**

Jeff B. Pawelek, BS; ***Burt Yaszay, MD****; Stacie Nguyen, MPH; Peter O. Newton, MD; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD; Harms Study Group; Growing Spine Study Group*

Rady Children's Hospital, San Diego, CA

11:09 AM–11:13 AM
45 *(page 140)*

A Prospective Multi-center Study of Neuromonitoring for Cerebral Palsy Scoliosis: The Nature and Rate of Alerts and Recovery of Changes

Suken A. Shah MD*; Paul D. Sponseller, MD; Peter O. Newton, MD; Burt Yaszay, MD; Firoz Miyanji, MD; Amer F. Samdani, MD; Mark F. Abel, MD; The Harms Study Group*

Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

11:14 AM–11:22 AM DISCUSSION

11:23 AM–11:27 AM
46 *(page 141)*

Genetic Test for Progression of Adolescent Idiopathic Scoliosis: Clinical Experience versus Historical Controls

Keith P. Mankin MD

Raleigh Orthopaedic Clinic, Raleigh, NC

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

11:28 AM–11:32 AM
47 *(page 142)*

Effectiveness of Spinecor Brace versus Rigid Brace for Treatment of Adolescent Idiopathic Scoliosis: A Prospective Randomized Controlled Trial using the Scoliosis Research Society Standardized Criteria

Jing Guo; Tsz Ping Lam, MBBS, FRCSE; Man Sang Wong, CPO, PhD; ***Bobby Kin Wah Ng, MD****; Kwong Man Lee; King Lok Liu; Alec Lik Hang Hung; Fiona Wai Ping Yu; Yong Qiu; Jack C-Y Cheng, MD*

Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Shatin, HONG KONG

11:33 AM–11:37 AM
48 *(page 143)*

The Use of Chewing Gum Postoperatively in Pediatric Scoliosis Patients Facilitates an Earlier Return to Normal Bowel Function

Jonathan K. Jennings, MD; J. Scott Doyle, MD; Shawn R. Gilbert, MD; Michael J. Conklin, MD; ***Joseph G. Khoury, MD***

Children's of Alabama, Birmingham, AL

11:38 AM–11:46 AM DISCUSSION

11:47 AM–11:51 AM
49 *(page 144)*

The Effect of Time and Fusion Length on Motion of the Un-fused Lumbar Segments in Adolescent Idiopathic Scoliosis

Michelle Marks, PT, MA*; Tracey Bastrom, MA; Maty Petcharaporn, BS; Suken A. Shah, MD; Amer Samdani, MD; Randal R. Betz, MD; Baron Lonner, MD; Firoz Miyanji, MD; Peter O. Newton, MD*

Setting Scoliosis Straight Foundation, San Diego, CA

11:52 AM–11:56 AM
50 *(page 145)*

A Prospectively Collected Multi-center Cohort Analysis of Anterior versus Posterior Spinal Fusion for Lenke 5 (Thoracolumbar/Lumbar) Adolescent Idiopathic Scoliosis

Mark A. Erickson, MD; Brendan Caprio, BS; ***Sumeet Garg, MD****; Cameron R. Niswander, BA; Zhaoxing Pan, MB, PhD; John B. Emans, MD; Spinal Deformity Study Group*

Children's Hospital Colorado, Aurora, CO

11:57 AM–12:01 PM
51 *(page 147)*

♦ **Safety of Topical Vancomycin for Pediatric Spinal Deformity: Non-Toxic Serum Levels with Supratherapeutic Drain Levels**

Sheyan J. Armaghani, MD; Travis J. Menge, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD, MS***

Vanderbilt Children's Hospital, Nashville, TN

12:02 PM–12:10 PM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

12:11 PM–12:15 PM
52 *(page 149)*
Does Leveling the Upper Thoracic Spine have any Impact on Post-operative Clinical Shoulder Balance in Lenke 1 and 2 Patients?
Dzulkarnain Amir, MD; ***Burt Yaszay, MD****; Carrie E. Bartley, MA; Tracey P. Bastrom, MA; Peter O. Newton, MD*
Rady Children's Hospital, San Diego, CA

12:16 PM–12:20 PM
53 *(page 150)*
Complications Associated with Temporary Internal Distraction in Severe Scoliosis
Graham T. Fedorak, MD, FRCSC; ***Robert H. Cho, MD***
Shriner's Hospital for Children, Los Angeles, CA

12:21 PM–12:25 PM
54 *(page 151)*
Do Crosslinks Improve Clinical or Radiographic Outcomes of Posterior Spinal Fusion with Pedicle Screws in Adolescent Idiopathic Scoliosis? A Multi-center Cohort Study
Sumeet Garg, MD*; Cameron R. Niswander, BA; Zhaoxing Pan, MB, PhD; Mark A. Erickson, MD; Spinal Deformity Group*
Children's Hospital Colorado, Aurora, CO

12:26 PM–12:34 PM DISCUSSION

CONCURRENT SESSION II: LE/NM

Moderator: *Lori A. Karol, MD*
Presider: *Amy L. McIntosh, MD*
e-Moderator: *Henry (Hank) G. Chambers, MD*

10:35 AM–10:39 AM
55 *(page 152)*
Epidural Anesthesia versus Continuous Peripheral Nerve Blocks for Pain Management Following Lower Extremity Long Bone Osteotomies in Pediatric Patients
Jeremy D. Onnen, MD*; Jonathan R. Knott, BS, MS; Stephanie M. Holmes, MD; Stephen P. Spanos, MD; Jay Harnden, MD; Peter M. Stevens, MD*
University of Utah School of Medicine, Primary Children's Hospital, Salt Lake City, UT

10:40 AM–10:44 AM
56 *(page 154)*
Results of Tibial Epiphysiodesis using Eight-Plate in Leg Length Discrepancy
Elodie Gaumétou; Brice Ilharreborde; G.F. Penneçot; ***Keyvan Mazda***
Robert Debre Hospital, Paris, FRANCE

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

10:45 AM–10:49 AM **Circular External Fixation for Correction of Deformity in**
57 *(page 155)* **Blount Disease**

Stephanie W. Mayer, MD*; Dan Sun, BS; Robert K. Lark, MD; Robert D. Fitch, MD*

Duke University Medical Center, Durham, NC

10:50 AM–10:58 AM DISCUSSION

10:59 AM–11:03 AM **EOS as a New Means of Accessing Femoral Version:**
58 *(page 156)* **A Comparision Study of EOS versus Computed Tomography**

M. Lucius Pomerantz, MD; Diana A. Glaser, PhD; Amy Fredrick; Josh Doan, MEng; Sita Kumar; ***Eric W. Edmonds, MD***

Rady Children's Hospital, San Diego, CA

11:04 AM–11:08 AM **Core Decompression and Bone Marrow Aspirate Concentrate**
59 *(page 158)* **for Treatment of Perthes Disease**

Karen Bovid, MD*; Tim Schrader, MD*

Children's Orthopaedics of Atlanta, Atlanta, GA

11:09 AM–11:13 AM **Efficacy of the Modified Bröstrom Repair for Adolescent**
60 *(page 159)* **Patients with Chronic Lateral Ankle Instability**

Jared T. Lee, MD; Adam Y. Nasreddine, MA; Nicole J. Stenquist, BA; ***Mininder S. Kocher, MD, MPH***

Boston Children's Hospital, Boston, MA

11:14 AM–11:22 AM DISCUSSION

11:23 AM–11:27 AM **The Fate of the Neuromuscular Hip after**
61 *(page 160)* **Spinal Fusion**

Lindsay M. Crawford, MD*; Jose A. Herrera-Soto, MD; Jonathan H. Phillips, MD; Dennis R. Knapp, Jr, MD*

Arnold Palmer Children's Hospital, Orlando, FL

11:28 AM–11:32 AM **Effect of Continuous Intrathecal Baclofen Therapy on Walking**
62 *(page 161)* **Children with Cerebral Palsy**

Blazej A. Pruszczynski, MD; ***Julieanne P. Sees, DO****; John D. Henley, PhD; Chris Church, PT; Kenneth J. Rogers, PhD; Freeman Miller, MD*

Department of Orthopedics, Nemours Alfred I. DuPont Hospital for Children, Wilmington, Delaware, USA

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

11:33 AM – 11:37 AM
63 *(page 162)*

Body Composition in Ambulatory Children with Cerebral Palsy is Related to Health and Environmental Factors

Donna J. Oeffinger, PhD; Neeley Buhr, MS; Janet Walker, MD; Todd A. Milbrandt, MD, MS; Vishwas R. Talwalkar, MD; ***Henry J. Iwinski, MD***

Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington, KY

11:38 AM – 11:46 AM DISCUSSION

11:47 AM – 11:51 AM
64 *(page 164)*

Comparison of Hamstring Lengthening with Hamstring Lengthening Plus Transfer for Treatment of Flexed Knee Gait in Ambulatory Patients with Cerebral Palsy

Camila B. R. De Mattos, MD; K. Patrick Do; Rosemary Pierce, PT; Jing Feng, PhD; Michael D. Aiona, MD; ***Michael D. Sussman, MD***

Shriners Hospitals for Children, Portland, OR

11:52 AM – 11:56 AM
65 *(page 166)*

The Role of Rectus Femoris Transfer in the Development of Crouch Knee Gait in Cerebral Palsy

Mauro C. De Morais Filho, MD*; Francesco C. Blumetti, MD; Cátia M. Kawamura, PT; Michelle De Oliveira Cardoso, MD; Daniella L. Neves, MD; Marcelo H. Fujino; José Augusto F. Lopes, MSc*

AACD, São Paulo, BRAZIL

11:57 AM – 12:01 PM
66 *(page 167)*

Lower Extremity Malrotation Recurrence in Ambulatory Children with Cerebral Palsy

Alexander M. Broom, BA; Susan A. Rethlefsen, DPT; Tishya Wren, PhD; ***Robert M. Kay, MD***

Children's Hospital Los Angeles, Los Angeles, CA

12:02 PM – 12:10 PM DISCUSSION

12:11 PM – 12:15 PM
67 *(page 168)*

Assessment of the Predictors of Post-Operative Length of Stay in Neuromuscular Patients Undergoing Reconstructive Hip Surgery

Matthew E. Oetgen, MD*; Lily Adler; Catherine W. Gillespie, MPH, PhD; Allison Matthews, MSCR; Karen M. Thomson, MD*

Children's National Medical Center, Washington, DC

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

12:16 PM–12:20 PM **Solid versus Floor Reaction Ankle-Foot-Orthoses for Children with Cerebral Palsy**
68 *(page 170)*

Hank White, PT, PhD; Juanita J. Wallace, MS; Samuel F. Augsburger, MS; Todd A. Milbrandt, MD, MS; Vishwas R. Talwalkar, MD; ***Ryan D. Muchow, MD****; Henry J. Iwinski, MD; Janet Walker, MD*

Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington KY

12:21 PM–12:25 PM **Relationship of Strength, Weight, Age, and Function in Ambulatory Children with Cerebral Palsy**
69 *(page 171)*

Jon R. Davids, MD*; Donna J. Oeffinger, PhD; Anita M. Bagley, PhD; Mitell Sison-Williamson, AB; George E. Gorton III, MS*

Shriners Hospital for Children, Sacramento, CA

12:26 PM–12:34 PM DISCUSSION

FRIDAY, MAY 2, 2014

8:00 AM–8:04 AM **WELCOME AND UPDATES**

CLINICAL AWARD PAPERS

Moderator: *Dennis R. Wenger, MD*
Presider: *William L. Hennrikus, MD*
e-Moderator: *James McCarthy, MD*

8:05 AM–8:09 AM **To Brace or Not? The Answer is "It Depends." Preliminary Results from BrAIST**
70 *(page 172)*

Lori A. Dolan, PhD*; Stuart L. Weinstein, MD; BrAIST Study Group*

University of Iowa, Iowa City, IA

8:10 AM–8:14 AM DISCUSSION

8:15 AM–8:19 AM **Higher Implant Density does Not Result in Increased Curve Correction or Improved Clinical Outcomes in Adolescent Idiopathic Scoliosis (AIS)**
71 *(page 173)*

Tristan Nishnianidze, MD; Kenneth J. Rogers, PhD; Blazej A. Pruszczynski, MD; Petya Yorgova, MS; Baron S. Lonner, MD; ***Suken A. Shah, MD***

Nemours - Alfred I duPont Hospital for Children, Wilmington, DE

8:20 AM–8:24 AM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

8:25 AM–8:29 AM
72 *(page 174)*

An Evaluation of the Validity of a DNA-Based Prognostic Test for Adolescent Idiopathic Scoliosis

Benjamin D. Roye, MD, MPH*; Margaret L. Wright, BS; Hiroko Matsumoto, MA; Petya Yorgova, MS; Geraldine Neiss, PhD; Joshua E. Hyman, MD; David P. Roye, Jr, MD; Suken A. Shah, MD; Michael G. Vitale, MD, MPH*

Morgan Stanley Children's Hospital of New York Presbyterian, New York, NY

8:30 AM–8:34 AM DISCUSSION

8:35 AM–8:39 AM
73 *(page 175)*

Treatment of Femur Fractures in Children Ages 2–6: A Multi-Center Prospective Trial

Charles L. Lehmann, MD; John T. Anderson, MD; Daniel G. Hoernschemeyer, MD; Kathryn A. Keeler, MD; Matthew B. Dobbs, MD; Scott J. Luhmann, MD; June C. O'Donnell, MPH; Perry L. Schoenecker, MD; ***J. Eric Gordon, MD***

Washington University School of Medicine, St. Louis, MO

8:40 AM–8:44 AM DISCUSSION

8:45 AM–8:49 AM
74 *(page 176)*

Supracondylar Fractures with Isolated Anterior Interosseous Nerve Injuries: Are they Urgent Cases?

Kody K. Barrett, BA; ***David L. Skaggs, MD****; Jeffrey R. Sawyer, MD; Lindsay Andras, MD; Alice Moisan, BSN, RN, CCRP; Christine Goodbody, BS; John (Jack) M. Flynn, MD*

Children's Hospital Los Angeles, Los Angeles, CA

8:50 AM–8:54 AM DISCUSSION

8:55 AM–8:59 AM
75 *(page 177)*

Screening Inflammation and Coagulation Activity Allows for Rapid Risk Stratification in Children Presenting with Symptoms of Musculoskeletal Infection

Megan Mignemi, MD; Kathleen Byington, NP; Jeffrey E. Martus, MD, MS; Christopher M. Stutz, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jonathan G. Schoenecker, MD***

Vanderbilt University Medical Center, Nashville, TN

9:00 AM–9:04 AM DISCUSSION

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

9:05 AM – 9:09 AM
76 *(page 179)*

Pavlik Harness Treatment may not be Necessary for All Newborns with Ultrasonic Hip Dysplasia

Harry K.W. Kim, MD*; Augusta Lloyd, MS; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Erica Flores, RN MSN; Chan-Hee Jo, PhD; Lauren Paraison, BA*

Texas Scottish Rite Hospital for Children, Dallas, TX

9:10 AM – 9:14 AM DISCUSSION

9:15 AM – 9:19 AM
77 *(page 180)*

Natural History of Scoliosis in Osteogenesis Imperfecta

Peter A. Smith, MD*; Alireza Anissipour, DO; Joseph Krzak, PhD; Angela Caudill, MPT; Sahar Hassani, MS; Kim W. Hammerberg, MD*

Shriners Hospitals for Children, Chicago, IL

9:20 AM – 9:24 AM DISCUSSION

9:25 AM – 9:29 AM
78 *(page 182)*

The Diagnostic Value of Intra-operative Monitoring and Early Post-operative Spect-bonescan in the Assessment of Femoral Head Vascularity after Surgical Dislocation for Slipped Capital Femoral Epiphysis

Oliver Birke, MD*; Kyle James, FRCS (Ortho), MBBS; Paul Gibbons, MD; David G. Little, MD, PhD*

The Children's Hospital at Westmead, Sydney, AUSTRALIA

9:30 AM – 9:34 AM DISCUSSION

9:35 AM – 9:39 AM
79 *(page 183)*

Time and Money: Do Medicare RVUs Match Physician Time Requirements for Orthopaedic Procedures?

Apurva S. Shah, MD, MBA*; Jenniefer Y. Kho, MD; Phinit Phisitkul, MD; Peter Cram, MD, MBA; Alison L. Klaassen, MA*

University of Iowa Hospitals and Clinics, Iowa City, IA

9:40 AM – 9:44 AM DISCUSSION

9:45 AM – 10:05 AM BREAK

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

BASIC SCIENCE AWARD PAPERS

Moderator: *R. Tracy Ballock, MD*
Presider: *Donna M. Pacicca, MD*
e-Moderator: *Roger Cornwall, MD*

10:06 AM–10:10 AM
80 *(page 184)*
♦ **Local Administration of BMP-2 and Ibandronate Improves Bone Healing During Non-weight Bearing Treatment of Ischemic Osteonecrosis of the Femoral Head in Immature Pigs**
Harry K.W. Kim, MD*; Olumide Aruwajoye, MS; Justin Y. Du; Nobuhiro Kamiya*
Center for Excellence in Hip Disorders, Texas Scottish Rite Hospital for Children, Dallas, TX

10:11 AM–10:15 AM
81 *(page 185)*
♦ **RhBMP-2 and Zoledronic Acid Treatment in an Animal Model of Congenital Pseudarthrosis/NF1**
David G. Little, MBBS, PhD*; Nikita Deo, BMedSci/Hons; Aaron Schindeler, PhD*
The Children's Hospital at Westmead, Sydney, AUSTRALIA

10:16 AM–10:20 AM
82 *(page 186)*
Pericytes as the Cell of Origin for Pediatric Osteosarcoma: Implications for the Development of a New Approach to Therapy
Shingo Sato, MD, PhD; Quingxia Wei, PhD; ***Benjamin A. Alman, MD, FRCSC***
Hospital for Sick Children, Toronto, ON, CANADA and Duke University, Durham, NC

10:21 AM–10:29 AM DISCUSSION

10:30 AM–10:34 AM
83 *(page 187)*
Increased Incidence of Private Variants in the Marfan Syndrome Fibirillin-1 Gene in Adolescent Idiopathic Scoliosis Patients
Matthew B. Dobbs, MD
Washington University School of Medicine, St. Louis, MO

10:35 AM–10:39 AM
84 *(page 188)*
Direct Growth Stimulation Using Local Growth Hormone: A Proof of Principle Study
David Lebel, MD; ***Benjamin A. Alman, MD, FRCSC***
Hospital for Sick Children, Toronto, ON, CANADA and Duke University, Durham, NC

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

10:40 AM–10:44 AM **The Development of Vascularity in a Healing Fracture**
85 *(page 189)* *Masato Yuasa, PhD; Nicholas Mignemi, BS;* ***Jonathan G. Schoenecker, MD***
Vanderbilt University Medical Center, Nashville, TN

10:45 AM–10:53 AM DISCUSSION

10:54 AM–10:56 AM **INTRODUCTION OF PRESIDENTIAL SPEAKER**
10:57 AM–11:17 AM **PRESIDENTIAL SPEAKER –** ***Charles T. Price, MD***
"Pediatric Orthopedics and You: How to Survive the Next Ten Years"
11:18 AM–11:23 AM **POSNA ANNUAL MEETING 2015 - ATLANTA**
11:24 AM–11:29 AM **BEST PAPER/POSTER/ePOSTER AWARDS PETER ARMSTRONG, MD - SHRINER'S HOSPITAL FOR CHILDREN AWARD**
11:30 AM–12:00 PM **PRESIDENTIAL TRANSFER**

12:01 PM–1:00 PM LUNCH

SATURDAY, MAY 3, 2014

7:45 AM–7:49 AM **WELCOME AND REMARKS**

TRAUMA

Moderator: *Martin J. Herman, MD*
Presider: *Anthony I. Riccio, MD*
e-Moderator: *Ellen M. Raney, MD*

7:50 AM–7:54 AM **Adult Trauma Surgeons More Frequently Offer Surgery**
86 *(page 191)* **to Adolescents with Displaced Clavicle Fractures**
T. David Luo, BS; Ali Ashraf, MD; ***A. Noelle Larson, MD****; Amy L. McIntosh, MD; Anthony A. Stans, MD; William J. Shaughnessy, MD*
Mayo Clinic, Rochester, MN

7:55 AM–7:59 AM **Outcomes of Operative and Non-operative Treatment of**
87 *(page 193)* **Adolescent Mid-Diaphyseal Clavicle Fractures**
Benton E. Heyworth, MD; ***Sasha Carsen, MD, MBA****; Collin J. May, MD; Kyna S. Donohue, BA; Dennis E. Kramer, MD; Mininder S. Kocher, MD, MPH; Donald S. Bae, MD*
Boston Children's Hospital, Boston, MA

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

8:00 AM–8:04 AM
88 *(page 194)*

Severity of Soft Tissue Injury is Associated with Neurovascular Injury in Pediatric Supracondylar Humerus Fractures

Christine Ann Ho, MD*; David A. Podeszwa, MD; Anthony I. Riccio, MD; Robert L. Wimberly, MD; William T. Gheen, BA*

Texas Scottish Rite Hospital-Children's Medical Center Dallas, Dallas, TX

8:05 AM–8:13 AM DISCUSSION

8:14 AM–8:18 AM
89 *(page 195)*

Clinical and Radiographic Outcomes after Submuscular Plating (SMP) of Pediatric Femoral Shaft Fractures

Jason W. Stoneback, MD; *Katherine Davies; Patrick Carry; Zhaoxing Pan, MB, PhD; Ernest L. Sink, MD; Nancy H. Miller, MD*

University of Colorado, Children's Hospital Colorado, Aurora, CO

8:19 AM–8:23 AM
90 *(page 197)*

Transverse Femoral Shaft Fractures are a Better Predictor of Non-accidental Trauma than Spiral Fractures in Young Children

Ryan P. Murphy, MD; Derek M. Kelly, MD; William C. Warner, Jr, MD; Alice Moisan, RN; Norfleet B. Thompson, MD; David D. Spence, MD; James H. Beaty, MD; ***Jeffrey R. Sawyer, MD***

Le Bonheur Children's Hospital; University of Tennessee/Campbell Clinic Department of Orthopaedic Surgery, Memphis, TN

8:24 AM–8:28 AM
91 *(page 199)*

Tibial Shaft Fractures in Adolescents: Analysis of Cast Treatment Successes and Failures

Christine Ann Ho, MD*; Gregory G. Dammann, MD; Jeffrey Levy, MD; David A. Podeszwa, MD*

Texas Scottish Rite Hospital-Children's Medical Center Dallas, Dallas, TX

8:29 AM–8:37 AM DISCUSSION

8:38 AM–8:42 AM
92 *(page 200)*

Hematoma Block versus Conscious Sedation: A Prospective Study Comparing Methods of Analgesia Used for the Reduction of Distal Radius Fractures in Children

Nicole A. Friel, MD; Charles Lupo, MD; David Bear, MD; Raymond Pitetti, MD, MPH; ***W. Timothy Ward, MD***

University of Pittsburgh Medical Center, Pittsburgh, PA

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

8:43 AM–8:47 AM
93 *(page 201)*

Pediatric Non Fracture Related Compartment Syndrome: A Review of 39 Cases

Kristin O. Livingston, MD; Patricia Miller, MS; Michael P. Glotzbecker, MD; Daniel J. Hedequist, MD; ***Benjamin J. Shore, MD, MPH, FRCSC***

Boston Children's Hospital, Harvard Medical School, Boston, MA

8:48 AM–8:52 AM
94 *(page 202)*

Syndesmosis Injuries in the Pediatric Population: An Analysis of Risk Factors Related to Operative Intervention

Benjamin J. Shore, MD, MPH, FRCSC; Mark X. Cleary, BS; Patricia Miller, MS; ***Yi-Meng Yen, MD, PhD****; Dennis E. Kramer, MD*

Boston Children's Hospital, Harvard Medical School, Boston, MA

8:53 AM–9:01 AM DISCUSSION

9:02 AM–9:06 AM
95 *(page 203)*

Open Reduction of Fully Displaced Pediatric Femoral Neck Fractures Results in Higher Quality of Reduction and Lower Rates of Osteonecrosis than Closed Reduction

Eduardo N. Novais, MD*; Joseph D. Stone, MD; Mary K. Hill, BA; Zhaoxing Pan, MB, PhD*

Department of Orthopaedic Surgery, Children's Hospital Colorado - University of Colorado School of Medicine, Aurora, Colorado

9:07 AM–9:11 AM
96 *(page 204)*

One Brace, One Visit: Treatment of Distal Radius Buckle Fractures in Children with a Removable Wrist Brace and No Follow-up Visit

Megan H.M. Kuba, MD; Krister P. Freese, MD; ***Byron H. Izuka, MD***

Kapi'olani Medical Center for Women and Children, Honolulu, HI

9:12 AM–9:16 AM
97 *(page 205)*

Lower Bone Strength, Density and Trabecular Microstructure at the Distal Radius is Associated with Increased Risk of Forearm Fracture in Young Girls

Mikko Määttä, PhD; Christa Hoy, MSc; Douglas Race, MA; Lindsay Nettlefold, PhD; Leigh Gabel, MSc; Kishore Mulpuri, MD; ***Firoz Miyanji, MD****; Christopher W. Reilly, MD; Heather M. Macdonald, PhD; Heather A. McKay, PhD*

BC Children's Hospital, Vancouver, BC, CANADA

9:17 AM–9:25 AM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

SPORTS

Moderator: *Jennifer M. Weiss, MD*
Presider: *M. Lucas Murnaghan, MD*
e-Moderator: *Lawrence Wells, MD*

9:26 AM–9:30 AM
98 *(page 206)*
Reconstruction of Symptomatic Congenital Anterior Cruciate Ligament Insufficiency
Jeffrey Nepple, MD; Adam Y. Nasreddine, BS, MA; ***Mininder S. Kocher, MD, MPH***
Boston Children's Hospital, Boston, MA

9:31 AM–9:35 AM
99 *(page 207)*
Computer-Simulated Arthroscopic Knee Surgery: Effects of Distraction
James B. Cowan, MD; Mark A. Seeley, MD; Todd A. Irwin, MD; Deborah M. Rooney, PhD; ***Michelle S. Caird, MD***
University of Michigan Hospital, Ann Arbor, MI

9:36 AM–9:40 AM
100 *(page 208)*
Prevalance of Bilateral JOCD of the Knee and Associated Risk Factors
Trent Cooper, DO, MS; Walter P. Samora, III, WP, MD; ***Kevin E. Klingele, MD***
Nationwide Children's Hospital, Columbus OH

9:41 AM–9:49 AM
DISCUSSION

9:50 AM–9:54 AM
101 *(page 209)*
Glenoid Bone Loss in Traumatic Glenohumeral Instability in the Adolescent Population
Henry B. Ellis, Jr*; Kelsey Wise, BA; Max Seiter, BS; Philip L. Wilson, MD*
Children's Medical Center Dallas, Dallas, TX

9:55 AM–9:59 AM
102 *(page 210)*
Traumatic Anterior Instability of the Adolescent Shoulder: A Comparison of Arthroscopic and Open Bankart Repairs
Stephen J. Shymon, BA; Joanna H. Roocroft, MA; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

10:00 AM–10:04 AM **Results of Non-operative and Operative Management of Apophyseal Avulsion Fractures of the Hip and Pelvis in Adolescent Athletes**
103 *(page 211)*

Benton E. Heyworth, MD*; Bryant Bonner, MD; Yi-Meng Yen, MD; Michael B. Millis, MD; Mininder S. Kocher, MD, MPH; Lyle J. Micheli, MD*

Boston Children's Hospital, Boston, MA

10:05 AM–10:13 AM DISCUSSION

10:14 AM–10:34 AM BREAK

INFECTIONS/TUMORS

Moderator: *Benjamin A. Alman, MD*
Presider: *Cordelia W. Carter, MD*
e-Moderator: *Michelle S. Caird, MD*

10:35 AM–10:39 AM **Risk Factors for Multiple Surgeries to Treat Musculoskeletal Infections in Children**
104 *(page 212)*

Matthew C. Starke, BS; Wei Zhang, PhD; John R. Dawson, MD; William A. Phillips, MD; ***Vinitha R. Shenava, MD***

Texas Childrens Hospital, Houston, TX

10:40 AM–10:44 AM **Validating an Algorithm to Predict Adjacent Musculoskeletal Infections in Septic Arthritis**
105 *(page 213)*

Benjamin D. Welling, BS; Wei Zhang, PhD; ***Scott B. Rosenfeld, MD***

Texas Children's Hospital, Houston, TX

10:45 AM–10:49 AM **Management of Pediatric Hip Synovial Fluid WBC Values Between 25,000–75,000 following Aspiration**
106 *(page 215)*

Benton E. Heyworth, MD; ***Michael P. Glotzbecker, MD****; Kyna S. Donohue, BS; Aubrey M. Wasser, MPH; Mininder S. Kocher, MD, MPH; Benjamin J. Shore, MD, FRCSC*

Boston Children's Hospital, Boston, MA

10:50 AM–10:58 AM DISCUSSION

10:59 AM–11:03 AM **Osteoid Osteoma about the Hip in Children and Adolescents**
107 *(page 216)*

Collin J. May, MD*; Sarah Bixby, MD; Megan E. Anderson, MD; Young Jo Kim, MD, PhD; Yi-Meng Yen, MD; Michael B. Millis, MD; Benton E. Heyworth, MD*

Children's Hospital Boston, Boston, MA

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

11:04 AM–11:08 AM **108** *(page 217)*
CT-Guided Radiofrequency Thermoablation in the Treatment of Osteoid Osteoma in Children
Elizabeth R.A. Joiner, BS; David Ibrahim, MD; Philip Stanley, MD; Javier F. Descalzi, MD; J. Dominic Femino, MD; ***Alexandre Arkader, MD***
Children's Hospital Los Angeles, Los Angeles, CA

11:09 AM–11:13 AM **109** *(page 218)*
Can You Retain Spinal Hardware in Acute Post-operative Infections?
Michael P. Glotzbecker, MD; ***Jaime A. Gomez, MD****; M. Timothy Hresko, MD; Michael J. Troy, BS; Patricia Miller, MS; Brian Snyder, MD, PhD; Lawrence I. Karlin, MD; John B. Emans, MD; Daniel J. Hedequist, MD*
Boston Childrens Hospital, Boston, MA

11:14 AM–11:22 AM DISCUSSION

CONGENITAL/SYNDROMES

11:23 AM–11:27 AM **110** *(page 219)*
Mid-term Results of Percutaneous Osteotomies and Fassier-Duval Nailing in Children with Osteogenesis Imperfecta
Khalid Azzam, MD, Bridget Burke, PA-C, Aleisha Menning, BS, ***Paul W. Esposito MD***
Childrens Hospital and Medical Center and the University Nebraska Medical Center, Omaha, NE

11:28 AM–11:32 AM **111** *(page 220)*
Outcomes of Tibial Derotational Osteotomies in Patients with Myelodysplasia
Erik B. Eller, MD; ***Vineeta T. Swaroop, MD****; Luciano Dias, MD; Rachel E. Mednick, MD*
Ann and Robert H. Lurie Childrens Hospital of Chicago, Chicago, IL

11:33 AM–11:37 AM **112** *(page 221)*
High Incidence of Cervical Deformity and Instability Requires Surveillance in Loeys-Dietz Syndrome
Sara K. Fuhrhop, BS; Mark J. McElroy, BS, MS; Harry C. Dietz, MD; ***Paul D. Sponseller, MD***
Johns Hopkins University, Baltimore, MD

11:38 AM–11:46 AM DISCUSSION

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Impact of Clinical Practice Guidelines on the Treatment of Pediatric Femur Fractures

Matthew E. Oetgen, MD*; Allison M. Blatz, BA; Allison Matthews, MSCR*
Children's National Medical Center, Washington, DC

†**LOE-Economic & Decision - Level IV**

Purpose: Clinical practice guidelines (CPG) are increasingly becoming important in the practice of clinical medicine. The AAOS approved a CPG on the treatment of pediatric diaphyseal femur fractures in June 2009 consisting of 14 recommendations on a variety of topics related to the treatment of these fractures. Despite the development of CPGs, there is little data on the clinical impact of these guidelines. We aimed to assess the impact on clinical practice of the CPG on the treatment of pediatric femur fractures.

Methods: We performed a retrospective chart review of all patients presenting to a single pediatric tertiary care hospital for treatment of a diaphyseal femur fracture between 2007 and 2012. CPG recommendations lacking sufficient data for definitive clinical recommendation were excluded. The patients were divided into a pre-CPG group (treated before June 2009) and a post-CPG group (treated after June 2009). The treatment of each patient was compared against the CPG to determine if the treatment recommendations had been followed. The groups were compared using the Fisher's exact test to determine if a significant change in treatment approach was found after the CPG was published.

Results: A total of 361 patients were treated for a diaphyseal femur fracture during this time frame and were included in this study (143 in pre-CPG groups and 218 in post-CPG group). Average age of total group was 64 months (range 0-16.1 yrs). The % treated per the suggested and optional CPG recommendations are shown in the table.

Recommendation	**% treated per recommendation pre-CPG group**	**% treated per recommendation in post CPG group**	**p-value**
Age <36 months get NAT workup	55.5%	48%	0.40
Pavlik or spica cast for <6 months age	90%	100%	0.36
Spica cast for age 6mn-5yo	95%	84%	0.07
Alter tx for >2cm shortening in spica	0%	22%	0.09
Flex nails age 5-11yo	**66%**	**43%**	**0.03**
Nail or plate age >11yo	96%	94%	0.63
Regional pain mgmt. an option post-op	0.7%	0%	0.40

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Conclusion: In most situations the treatment of pediatric diaphyseal femur fractures did not significantly change after the pediatric femur fracture CPGs were published. It is unclear if this lack of clinical impact of the CPGs was due to surgeon disapproval of the CPGs, surgeon ignorance of the CPGs, or poor guideline development.

Significance: Assessment of the clinical impact of CPGs is needed to determine the usefulness of the current CPG process and improve the CPG development process in the future.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Association of Pediatric Fractures with Serum Vitamin D Levels Compared To Non-fracture Community Controls

Barbara Minkowitz, MD*; Barbara Cerame; Eileen Blechman Poletick, RN, DNP; Sherri Luxenberg; Nicole Danielle Formoso; Renee Eng; Samantha Nicole Easton; Jonathan Chevinsky; Scott Musial; Lior Fusman; Connor Jordan; Ben H. Lee, MD, MPH, MSc*
Atlantic Health System, Morristown, NJ

†**LOE-Prognostic - Level III**

Background: There is increasing concern about vitamin D (VitD) deficiency in children. Our preliminary study reported significantly decreased VitD levels in children with surgical fractures.

Purpose: Compare VitD levels and lifestyle characteristics of children with fractures to non-fracture controls.

Methods: Case control IRB approved study included 379 fracture patients age ≤ 21 years from 6/1/12-7/31/13. A self-reported survey and abstracted medical data were used. 13 pediatric practices contributed 754 non-fracture controls. Studied parameters included VitD, serum calcium, PTH levels, age/gender, fracture severity, location, mechanism, ethnicity, skin tone, multivitamin intake, diet and breast feeding history, sunscreen use and outdoor time. Population and subgroup analyses were performed using ANOVA with Tukey HSD. Multivariate analyses adjusted for selected confounders associating VitD with fractures.

Results: 1,133 patients were included in this study. Study and control subjects were mirrored populations for age and VitD with overall serum VitD 27.7 ± 9.3 ng/mL . In both populations specific subgroups had a higher prevalence of VitD deficiency. The age group with the highest mean VitD levels were those under 5 years old, reported as "healthy eaters" (30.7 ± 9.3 ng/mL). The groups with the lowest VitD levels were Hispanics (23.1 ± 7.3 ng/mL), African-American (20.76 ± 7.9 ng/mL), and dark skin tone children (22.2 ± 8.7 ng/mL). Children under 5 years had particularly low VitD levels when identified by parent as "poor eater" versus those not so identified and to the total study population (23.1 ± 9.2 ng/mL, $p<.01$). Non-breast fed children had lower VitD than breast fed children (24.9 ± 8.6 ng/mL, $p<.01$). VitD levels were higher with multivitamin use (29.0 ± 9.3 ng/mL, $p<.05$) compared to all other non-multivitamin takers in study and control groups. Sunscreen use and outdoor time was not correlated to VitD status. Patients with surgical fractures had lowest VitD compared to children in all other fracture severity groups (23.4 ± 8.6 ng/mL, $p<.05$). Past history of fracture and mechanism of injury were not correlated to VitD levels. Children with femur fractures tended to have lower VitD levels (statistically nonsignificant).

Conclusions/Significance: Given that subgroups of pediatric patients had marked VitD deficiency and increased risk for surgical fractures, the data suggest that all children be routinely screened for VitD status, particularly specific high risk groups: children less than 5 years old, Hispanics, African-Americans, dark skinned children, and surgical fracture patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Radiation Exposure During Fixation of Pediatric Supracondylar Humerus Fractures: Are Lead Shields Important?

Jeffrey E. Martus, MD, MS*; Melissa A. Hilmes; Christopher M. Stutz, MD; Jonathan G. Schoenecker, MD, PhD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD*
Vanderbilt Children's Hospital, Nashville, TN

†**LOE-Diagnostic - Level IV**

Purpose: The intensity of radiation decreases with the square of the distance from the radiation source, however, the radiosensitive organs of children may be at risk during fluoroscopic guided extremity procedures. Our goal was to quantify the radiation dose at the thyroid and gonads during fixation of supracondylar humerus (SCH) fractures and to delineate the need for lead shielding.

Methods: A prospective study of radiation exposure during percutaneous fixation of SCH fractures was performed over a 2 month period. The c-arm image intensifier was used as the operating table and radiation dosimeters were positioned over the thyroid and gonadal lead shields. Fluoroscopy times were recorded, doses were calculated, and the dosimeters were analyzed. To assure that the prospective cohort was representative of a larger population of SCH fractures, parameters from the prospective cohort (n=18) were compared to a 12 month retrospective cohort in which dosimetry was not performed (n=163).

Results: The prospective cohort dosimeters measured minimal radiation indicating equivalent doses of less than 0.01 mSv. The data from the prospective and retrospective cohorts are presented in the table below. There were no significant differences between the cohorts.

Conclusion: The equivalent dose to the thyroid and gonads during fluoroscopic assisted fixation of SCH fractures is minimal and approximates daily background radiation (0.0065 mSv / day). The smaller prospective cohort had similar fluoroscopy times and radiation doses as the larger retrospective cohort, suggesting that the dosimeter measurements are representative.

Significance: The radiation dose to the patient's radiosensitive organs during fixation of SCH fractures is minimal. Shielding of radiosensitive organs may still be appropriate to minimize radiation exposure, particularly in smaller patients and if longer fluoroscopy times are anticipated.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

	Prospective Cohort (n=18)	Retrospective Cohort (n=163)	p-value
Age (years)	4.9 (1.9 – 9.5)	5.5 (0.02 – 13.7)	0.27
Weight (kg)	21.4 (13 – 34)	21.6 (2.0 – 72)	0.92
Type 2 / Type 3 fractures	8 / 10	60 / 63	0.55
Fluoroscopy Time (s)	65.0 (25 - 168)	74.1 (10 - 289)	0.36
Absorbed Skin Dose at Elbow (mGy)	9.4 (3.7 - 24.4)	10.7 (1.5 - 41.9)	0.36
Equivalent Dose at Elbow (mSv)	0.11 (0.04 - 0.26)	0.13 (0.01 - 1.39)	0.16
Equivalent Dose at Thyroid / Gonads (mSv)	< 0.01	NA	NA

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

To Cast, to Saw, and Not to Injure: Can Safety Strips Decrease Cast Saw Injuries?

Natalie C. Stork, MD; Rachel L. Lenhart, MS; Blaise A. Nemeth, MD, MS; Kenneth J. Noonan, MD; Sarah A. Sund, BS; ***Matthew A. Halanski, MD***
University of Wisconsin Madison, School of Medicine and Public Health, Madison, WI

†**LOE-Therapeutic - Level II**

Purpose: To evaluate the ability of a safety strip in providing a physical barrier during the removal of a cast. The safety strip will decrease blade to skin contact, with prevention of blade to skin contact, minimize heat transfer, and will not inhibit cast separation after valving the cast.

Methods: Thirty-five participants removed standard long-arm fiberglass casts from life-sized pediatric models; each removed one cast and one without a safety strip present. The long-arm models were constructed for use with a dedicated cast saw, DC power source, and voltage recorder. A DC circuit was completed when the cast saw blade touched the model's surface which led to a change in voltage, a "touch." The number and duration of touches were compared between attempts with and without the strip. To assess the safety strip's ability to dissipate heat transfer, the cast saw blade was connected to a heat source, allowing adjustment of the blade temperature. Temperature data was recorded at the saw-padding/strip interface and the skin-surface interface via T-type thermocouples. To assess if the strip would inhibit cast separation, pressure sensors were applied to the model's surface and data collected after cast application, uni-valving, bi-valving, and removal, of ten casts with and ten casts without the safety strip present.

Results: The average number of blade to skin contact events with no safety strip present was independent of experience level, mean ratio 0.94 (95% CI 0.38, 2.32), p-value 0.893. The average number of times the blade contacted the skin significantly decreased with the presence of the strip placed between two layers of padding, mean ratio 0.05 (95%CI 0.02, 0.11), p-value <0.001. Blade to skin contact lasting 1 second or greater also decreased, mean ratio 0.018 (95% CI 0.008, 0.039), p-value <0.001. The safety strip effectively minimized heat transfer; at extreme blade tooth temperatures (80 – 100^{0}C), temperatures never exceeded 40^{0}C at the skin/padding interface. The strip did not inhibit cast spreading as the percent change in pressure after uni-valving and bi-valving was not significantly different with or without the strip present.

Conclusion: The safety strip was effective in decreasing blade to skin contact, minimized heat transfer, and did not adversely affect cast separation. Although blade to skin contact was not eliminated, the safety strip shows promise as an effective tool to minimize these injuries.

Significance: This is the first study demonstrating the potential effectiveness of casting safety strips to reduce cast saw injuries.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Appropriateness and Adequacy of Splints Applied for Pediatric Fractures in an Emergency Department/Urgent Care Environment

Brandon S. Schwartz, MPH; ***Joshua M. Abzug, MD***
University of Maryland School of Medicine, Baltimore, MD

†**LOE-Therapeutic - Level II**

Purpose: Numerous healthcare professionals are involved in the immediate evaluation and treatment of children with possible fractures and similar injuries. Initial treatment consists of placement of a splint on the affected extremity. However, some of these splints may be placed incorrectly causing an adverse outcome such as rubbing, stiffness, or inadequate immobilization, among others. The purpose of this study is to evaluate all patients presenting in a splint for initial evaluation at a pediatric orthopaedic practice to assess the adequacy of the splint and any adverse outcomes that may have occurred.

Methods: All pediatric patients who presented to the pediatric orthopaedic clinic for evaluation, with a splint in place, were enrolled in the study after obtaining consent. Demographic information, type of splint applied, facility type placing the splint, practitioner type placing the splint, and time from splint application to orthopaedic evaluation were recorded. Following splint removal, the patient was examined and any adverse findings were documented.

Results: Splints were placed improperly in 93% (139/150) of the patients evaluated. The most prevalent factor contributing to poor splint placement involved application of an ACE bandage directly on the skin leading to excessive swelling, seen in 83% (125/150) of patients evaluated. Additionally, 40% (60/150) of splints were not in a position of function, 39% (58/150) of splints were the improper length, and excessive plantar flexion was seen in 68% (21/31) of lower extremity splints. Complications of improperly placed splints included significant edema in 26% (39/150), areas of pressure on the skin beneath the splint in 20% (30/150), and other skin concerns in 16% (24/150). Fortunately, no patients required additional intervention, other than local wound care, due to inadequate splint placement.

Conclusion: A significant number of splints are placed improperly in pediatric emergency departments and urgent care settings. This inadequate placement may lead to several adverse outcomes, including edema, skin concerns, and stiffness.

Significance: Healthcare professionals in urgent care settings and emergency departments may need formal education in appropriate splint application from the orthopaedic community. The results of inappropriate splint placement may result in adverse events for the patient.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Prevention and Screening Programs for Anterior Cruciate Ligament Injuries in Young Athletes: A Cost-Effectiveness Analysis

Eric F. Swart, MD; Lauren H. Redler, MD; ***Peter D. Fabricant, MD, MPH****;*
Bert R. Mandelbaum, MD; Christopher S. Ahmad, MD; Y. Claire Wang, MD, ScD
Columbia University Medical Center and Mailman School of Public Health of Columbia University, New York, NY

†**LOE- Economic & Decision - Level I**

Purpose: There has been a recent emphasis on value and cost effectiveness in orthopedic surgery. Anterior cruciate ligament (ACL) injuries are common among young athletes, and represent a significant source of morbidity and financial expense. In vivo biomechanical studies have led to the development of training programs to improve neuromuscular control and reduce ACL injury rates as well as screening tools to identify athletes at higher risk for ACL injury. It is unclear, however, to what extent and in whom these programs should be utilized. The purpose of this study was to evaluate the cost-effectiveness of these training methods and screening strategies in preventing ACL injuries, and to develop an ideal, cost-effective algorithm for screening and training in this cohort.

Methods: A decision-analysis model was created to evaluate three potential strategies for screening and training in a population of young athletes participating in organized sports: 1) no training or screening, 2) universal neuromuscular training, and 3) universal screening, with neuromuscular training for identified high-risk athletes only. Risk of injury, risk reduction from training, and sensitivity and specificity of screening were based on published data from clinical trials and metaanalyses. Costs of training and screening programs were calculated from existing literature. Sensitivity analyses were performed on key model parameters to evaluate their effect on base case conclusions.

Results: Neuromuscular training of all athletes (without antecedent screening) was the most cost-effective strategy evaluated, and universally superior to screening. On average, the implementation of a universal training program would save $275 per player per season, and would reduce the incidence of ACL injury by 66% from 0.03 to 0.01 per player per season. Screening programs were not cost effective within the range of reported costs and sensitivity and specificity values.

Conclusion: Given its low cost per increase in quality-adjusted life year and ease of implementation, neuromuscular training of all young athletes represents a highly cost effective strategy for reducing costs and morbidity from ACL injuries.

Significance: While continued innovations on screening methods to identify high-risk athletes remain of interest to researchers, the results of current study indicate that resources should be preferentially devoted to widely implementing neuromuscular training protocols for all young athletes, rather than screening strategies aimed at detecting high-risk children and adolescents.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Creation of a Consensus-Based Checklist for the Response to Intraoperative Neuromonitoring Changes in Pediatric Spine Surgery

Michael G. Vitale, MD*; Gregory I. Pace, BA; Margaret L. Wright, BS; Hiroko Matsumoto, MA; Behrooz A. Akbarnia, MD; John P. Dormans, MD; John B. Emans, MD; Mark A. Erickson, MD; John (Jack) M. Flynn, MD; Steven D. Glassman, MD; Michael P. Glotzbecker, MD; Kamal N. Ibrahim, MD; Stephen J. Lewis, MD; Scott J. Luhmann, MD; James J. McCarthy, MD; Peter O. Newton, MD; David W. Polly, Jr, MD; B. Stephens Richards, III, MD; James O. Sanders, MD; Suken A. Shah, MD; David L. Skaggs, MD; John T. Smith, MD; Paul D. Sponseller, MD; Daniel J. Sucato, MD, MS; Reinhard D. Zeller, MD, DSc, FRCSC; David P. Roye, Jr, MD; Lawrence G. Lenke, MD*
Morgan Stanley Children's Hospital of New York Presbyterian

†**LOE-Diagnostic - Level V**

Purpose: Neurologic injury during pediatric spinal deformity surgery is a rare but devastating complication. No widely accepted guidelines exist for the response to changes in intraoperative neuromonitoring (IOM) in pediatric spine surgery. The purpose of this initiative is to develop a consensus-based checklist to guide surgeon responses to changes in IOM for stable spine patients.

Methods: After a thorough literature review identifying risk factors and current recommendations for responding to IOM changes a series of surveys was administered to 25 experienced pediatric spine surgeons assessing areas of equipoise and consensus in surgical team responses to changes in IOM. The results were then presented to all participants and the nominal group process was used to determine the checklist items to be included. The working group re-evaluated the consensus based work product at three different face-to-face meetings over the course of 12 months. Agreement over 80% was considered consensus and items near consensus were re-discussed and followed by repeated nominal group technique.

Results: Consensus was reached for the creation of five headings containing relevant items to consider in response to IOM changes. These headings are: gain control of room, anesthetic and systemic considerations, technical and neurophysiologic considerations, mechanical considerations, and ongoing considerations, which are items to be considered throughout the entire response. Additionally, the checklist includes considerations if IOM changes improve and considerations if IOM changes persist (see figure).

Conclusion: The result of this project represents the consensus of several leading pediatric spine surgeons as to the most important and high yield items to consider when responding to IOM changes for pediatric stable spine patients. The final checklist contains 5 headings with 28 total items to consider in response to IOM changes.

Significance: This is an initial tool to reduce variability in surgical team responses to intraoperative neuromonitoring changes and reduce neurologic injury in our patient population. Future efforts will study the effect of its implementation on patient outcomes.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Gain Control of Room	Anesthetic/Systemic	Technical/Neurophysiologic	Mechanical
◻ Intraoperative Pause-Stop case and announce to room ◻ Eliminate extraneous stimuli (music, conversations, etc.) ◻ Summon **ATTENDING** anesthesiologist and **SENIOR** neurophysiologist/ neurologist support ◻ Anticipate need for intraoperative imaging if not readily available	◻ Optimize MAP ◻ Optimize Hematocrit ◻ Optimize blood pH ◻ Seek normothermia ◻ Discuss **POTENTIAL** need for eventual wake-up test with **ATTENDING** anesthesiologist	◻ Discuss status of inhalational agents with anesthesia ◻ Check extent of neuromuscular blockade ◻ Check electrode placement ◻ Determine pattern and timing of signal changes ◻ Check limb/neck positioning; check limb position on table especially in unilateral loss	◻ Discuss events and actions just prior to signal loss and consider reversing actions, e.g. ◻ Remove traction (if applicable) ◻ Decrease distraction ◻ Remove rods ◻ Remove screws/probe for breech ◻ Evaluate for spinal cord compression and examine osteotomy/laminotomy sites

Ongoing Considerations

◻ Consider consultation with a colleague

◻ Revisit systemic considerations and confirm that they are optimized

If changes improve, Consider:

◻ Whether to continue surgery vs. staging and continuing another day

◻ Discussion of this decision with another attending surgeon

If changes persist, Consider:

◻ IV steroid protocol: 30 mg/kg in 15 min for 1st hour, then 5.4 mg/kg/hr for 23 hrs

◻ IV lidocaine 2 mg/kg if blood flow to the spinal cord is the suspected reason for IOM changes

◻ Wake-up test

◻ Post-op imaging (CT, MRI, CT Myelography)

Date of Creation: 10/4/2013

†LOE - Level of Evidence - Please see page 16 for details.

See pages 17 - 62 for financial disclosure information.

Effectiveness of the "Spine At Risk" Safety Program

Walter F. Krengel, III, MD; Courtney M. O'Donnell, MD; Nicole Burkette-Ikebata, MPH; Emma K. Satchell, BA; Viviana Bompadre, PhD; ***Klane K. White, MD, MSc***
Seattle Children's Hospital, Seattle, WA

†**LOE-Diagnostic - Level IV**

Purpose: Patients with unrecognized cervical or thoracolumbar spinal instability or severe stenosis (e.g. skeletal dysplasia) are at risk for spinal cord injury during anesthesia. We developed the "Spine At Risk" (SAR) safety program, in which patients with qualifying diagnosis of potential critical spine instability or stenosis are identified by electronic medical record (EMR) prior to any anesthetic. Evaluation and completion of a spine precaution form by neurosurgical or orthopedic staff is required (Fig 1). We aim to describe the process and its results two years after implementation.

Methods: Diagnoses with a SAR designation were identified by members of the spine team at our institution. Patients with these designated diagnoses, by ICD-9 coding were automatically flagged by the EMR as SAR. Each patient identified as SAR then had a review by a member of the spine team, with recommendations made prior to undergoing general anesthetic for any procedure. In this study, a chart review of patients potentially affected by SAR from April 2011 to June 2012 was performed. Informal cost evaluation was also performed.

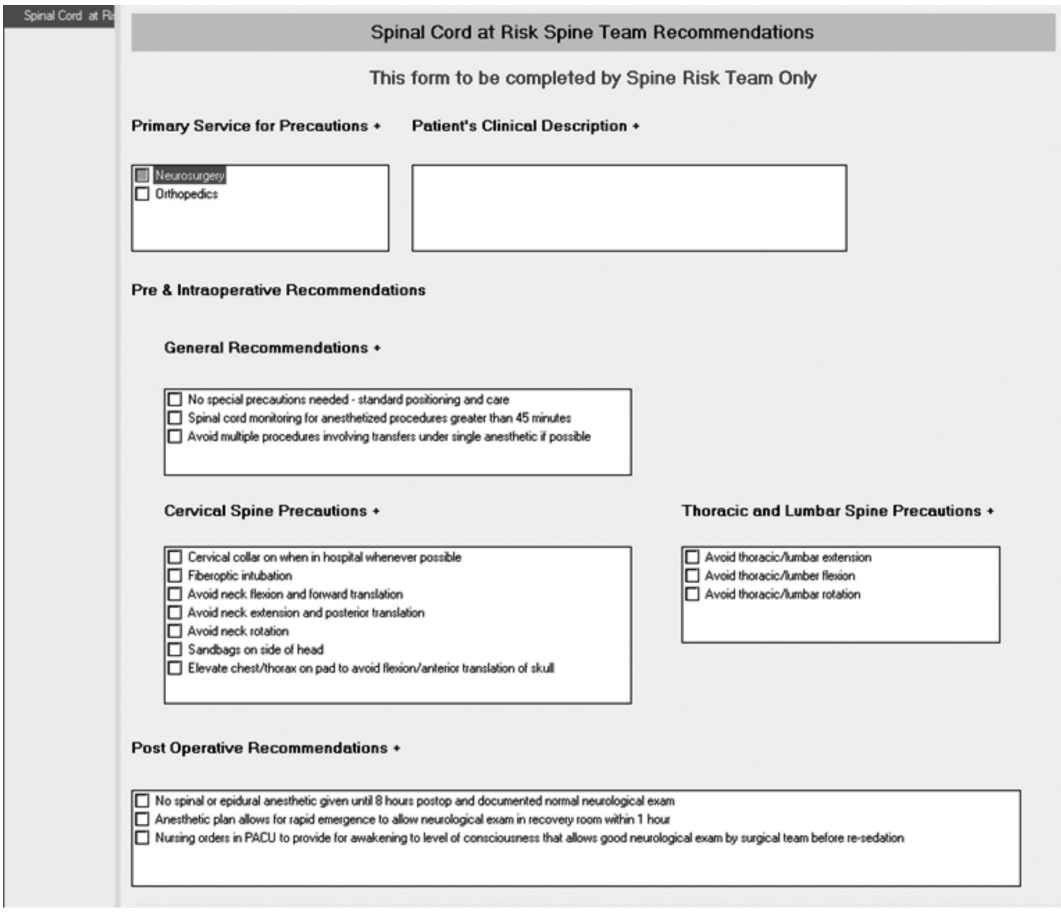
Results: 920 patients carried a diagnosis qualifying them for a SAR alert. 315 had a precaution form completed. Of these, 190 (60%) needed "no special precautions" and 125 (40%) had at least one precaution checked (general, cervical, thoracolumbar or post op). 84 (27%) suggested spinal cord monitoring be utilized; 142 (45%) suggested cervical spine precautions; 98 (30%) suggested thoracolumbar precautions; and 145 (46%) required special post operative evaluation. No patient had spinal cord injury in the period of study. 35% of precautions forms were filled out separately from any billable consultation by orthopedics or neurosurgery staff. Estimates for the program including evaluation, time, inconvenience for families and pro fees are $9M over 10 years. This cost is similar to a lifetime cost of a single cervical spine injury ($3.5M to $9M).

Conclusion: The SAR program is effective in identifying surgical patients who require extra attention to prevent spinal cord injury. Clinical and cost-benefit analyses are being performed. Despite automated EMR identification, large amounts of uncompensated work, particularly by neurosurgical and orthopedic staff is required.

Significance: The estimated cost of a single avoidable spine injury is similar to the cost of SAR over 10 years. Practical concerns when implementing safety programs need further considerations.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Fig 1 Spine at Risk Precaution Form



Spinal Cord at Risk Spine Team Recommendations

This form to be completed by Spine Risk Team Only

Primary Service for Precautions +

- ☐ Neurosurgery
- ☐ Orthopedics

Patient's Clinical Description +

Pre & Intraoperative Recommendations

General Recommendations +

- ☐ No special precautions needed - standard positioning and care
- ☐ Spinal cord monitoring for anesthetized procedures greater than 45 minutes
- ☐ Avoid multiple procedures involving transfers under single anesthetic if possible

Cervical Spine Precautions +

- ☐ Cervical collar on when in hospital whenever possible
- ☐ Fiberoptic intubation
- ☐ Avoid neck flexion and forward translation
- ☐ Avoid neck extension and posterior translation
- ☐ Avoid neck rotation
- ☐ Sandbags on side of head
- ☐ Elevate chest/thorax on pad to avoid flexion/anterior translation of skull

Thoracic and Lumbar Spine Precautions +

- ☐ Avoid thoracic/lumbar extension
- ☐ Avoid thoracic/lumber flexion
- ☐ Avoid thoracic/lumbar rotation

Post Operative Recommendations +

- ☐ No spinal or epidural anesthetic given until 8 hours postop and documented normal neurological exam
- ☐ Anesthetic plan allows for rapid emergence to allow neurological exam in recovery room within 1 hour
- ☐ Nursing orders in PACU to provide for awakening to level of consciousness that allows good neurological exam by surgical team before re-sedation

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Comparison of Imaging Methods and Radiation Exposure in Posterior Spinal Fusions for Scoliosis

Victoria Kuester, MD*; Hans Robert Tuten, MD; Chester Howard Sharps, MD; Jacob Riis, MD; John Ryan Quinn, MSIV*
Virginia Commonwealth University Health System, Richmond, VA

†**LOE-Diagnostic - Level III**

Background: Radiation exposure has been an emerging concern in the field of medicine. Deformity spine surgeons particularly depend on modalities that have higher exposure through scoliosis x-rays or computed tomography. As pedicle screw usage has increased so has the use of fluoroscopy to try and ensure anatomic placement of each screw. Recently other 3-D imaging devices with navigation have also been brought onto the market to help increase the accuracy of screw placement. Some have thought that because of the use of CT the radiation dose to the patient is increased, however there is no literature that compares the amount of radiation using the 3-D devices to traditional fluoroscopy. Although we know it decreases the amount of radiation to the surgeon and operating room staff, there is no comparison data for exposure to patients.

Purpose: Comparison of radiation exposure data for pediatric scoliosis patients receiving posterior spinal fusions using traditional fluoroscopy and the Medtronic O-arm in an effort to determine the method most likely to decrease radiation exposure in the pediatric population.

Methods: Retrospective review of data in patient charts from three pediatric surgeons practicing in both a University and private hospital setting. Data collected includes age, weight, height, diagnosis, Cobb angle, fusion levels, number of screws, number of hooks, O-arm spins, fluoro doses and O-arm doses. Outcome measures include overall radiation exposure and relative exposure levels per screw placed compared between the two methods.

Results: A total of 53 patients, 26 using the O-arm and 34 using traditional fluoroscopy, were analyzed. When radiation levels were compared on a per implant basis and total dose received, the absolute doses were found to be comparable between the two groups with average doses of 42.9mGy with the fluoro and 38.5mGy with the O-arm.

Conclusion: We found that regardless of the methods used there is still a significant radiation dose that is utilized in scoliosis procedures. The two methods analyzed did not display statistically significant differences in total absolute dose or per implant dose levels.

Significance: Safely managing radiation exposure for pediatric patients is of the utmost priority. Healthcare professionals, however, face repeated exposure to radiation on a daily basis. The O-Arm system does not increase overall exposure for patients and decreases radiation doses for providers and thereby provides a safe alternative to traditional fluoroscopy without compromising accuracy or patient care.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

What is the Anticipated U.S. Cost of Pedicle Screw vs. Luque Wire Instrumentation for Neuromuscular Scoliosis Surgery?

A. Noelle Larson, MD*; Suken A. Shah, MD; Scott J. Luhmann, MD; David W. Polly Jr, MD*
Multicenter Study (Mayo Clinic; A. I. DuPont; Washington University; U. of Minnesota)

†**LOE-Economic & Decision - Level III**

Purpose: Luque wire fixation is typically used for neuromuscular scoliosis surgery, but pedicle screws may have significant advantages. We developed an economic model to evaluate the cost of changing to a pedicle screw construct.

Methods: Descriptive analyses explored annual costs for inpatient stays associated with ICD-9-CM 737.39 (neuromuscular scoliosis) using discharge data from the 2009 KID-HCUP (AHRQ), a national all-payer pediatric database. Inpatient stays were assumed to represent T2-pelvis posterior fusion with no anterior procedures. We evaluated the relative cost of high and low density pedicle screw fixation (2.0 vs. 1.0 screws per level fused) and Luque wire instrumentation. An all-pedicle screw construct was assumed to shorten the length of stay (3 days/$3600), decrease transfusion rates (3 units/$3000), and eliminate revision for pseudoarthrosis (1.0-6.5% with Luque wires to 0% with pedicle screws). A sensitivity analysis was performed by varying cost per screw ($600-$1200) and rate of pseudoarthrosis in the Luque wire cohort (1.0-6.5%). Cost of revision surgery averted was calculated in order to determine under which parameters a pedicle screw construct would become cost neutral.

Results: Total annual costs for 1,079 hospital stays for neuromuscular scoliosis was $65.6M ($61,620 per patient). Substituting a low density screw pattern for Luque wires would result in an additional $8250 to $20,240 in implant cost. However, an anticipated 11-70 pseudoarthrosis revision surgeries would be avoided annually (Table). Assuming a low density screw construct, low screw cost, and high pseudoarthrosis rate, the model becomes cost neutral if revision surgery for pseudoarthrosis costs greater than $25,575 per patient. For a high density screw construct, high screw cost, and a high Luque wire pseudoarthrosis rate, the model only becomes cost neutral if revision surgery cost > $1.3M per patient.

Conclusion: Our economic model for neuromuscular scoliosis fusion estimates that switching from a Luque wire to pedicle screw construct would increase cost by $8,250-39,440 per patient (estimated $8.8M to $42.4M annual U.S. cost increase). Assuming decreased LOS, pseudoarthrosis, and transfusion rates, switching from Luque wires to a low density/low cost pedicle screw construct may prove cost effective.

Significance: High density pedicle screw constructs sold at market rates would need to have significant treatment advantages in order to offset such an increase in payer cost.

HCUP 2009, Neuromuscular Scoliosis (ICD-9-CM 737.39)

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

	Mean Cost Per Patient	Inpatient National Cost	Number of Revision Surgeries Prevented in U.S. from Switching to Screws	Cost of Revision Surgery to Achieve Cost Neutral Result
US Total 2009, 1,079 Hospitalizations	$61,620 Mean Cost per Patient	$65.6M Total Cost		
Change in Mean Implant Density (Screws/Level Fused)	**Mean Per Patient Cost Increase**	**Inpatient National Cost Increase**		
Luque Wire à High Density Construct (2 screw per level fused)	$17,850-$39,440	$15M - $27M	11-70 surgeries	$509,020 - $3,141,693
Luque Wire à Low Density Construct (1 screw per level fused)	$8,250 - $20,240	$34M - $60M	11-70 surgeries	$25,575 - $1,304,893

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Clinical Impact of Adopting a Novel Post Operative Pathway on Post Operative Stay Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

David E. Lazarus, MD; Benjamin L. Geddes, BS; Robert J. Owen, BS; Phillip M. Mitchell, MD; Michael L. Schmitz, MD; Dennis P. Devito, MD; ***Nicholas D. Fletcher, MD***
Emory University, Atlanta, GA

†**LOE-Therapeutic - Level III**

Introduction: Prior reports of accelerated discharge following posterior spinal fusion for adolescent idiopathic scoliosis focused on patients treated by different surgeons in separate hospital systems. The purpose of this study is to evaluate the impact of adopting a novel pathway on discharge following PSF for AIS using a single group of surgeons.

Methods: A retrospective review of patients undergoing PSF for AIS performed by four staff children's orthopaedists was performed evaluating demographics, curve characteristics, surgical intervention and complications. Patients were included if they completed 180 days of follow up, a time deemed sufficient to capture early complications related to discharge. Patients were divided based on their surgery occurring before or after the adoption of an accelerated discharge pathway (AD). Patients in the AD pathway were treated with early transition postoperatively to oral pain medications, regular mobilization beginning the day after surgery, rapid reinstitution of a regular diet, and discharge prior to return of bowel function. Patients treated prior to the AD pathway were managed using a more traditional (TD) pathway emphasizing a slower return to mobilization, more gradual transition off of intravenous narcotics, and discharge only after return of bowel function.

Results: Four surgeons performed 75 PSF for AIS using the TD pathway and 84 PSF after adoption of the AD pathway. There was no difference in age, sex, preoperative MT or T/L curve magnitudes between groups. There was no difference in groups with regards to the use of osteotomies, number of implants fused or total number of screws placed but more patients in the AD group underwent navigationally assisted screw placement (96.4% (AD) vs 76.0% (TD), p=<0.0001). Patients managed in the AD cohort had 1.2 hour shorter surgical times (p<0.0001). Length of stay was 0.98 days or 24.3% less in patients managed under the AD pathway (3.05 days (95%CI 2.99-3.16) vs 4.03 days (95%CI 3.04-4.20), p<0.0001). Regression analysis showed a weak correlation between length of surgery and hospital stay (r=0.39, p<0.001). There was no difference in wound complications requiring surgical intervention (4.0% TD vs 6.0%AD, p=0.72). There was no statistical difference between groups with regards to complications of any type.

Conclusion: The use of a coordinated discharge pathway helped to reduce length of stay in patients undergoing PSF for AIS without increase in complications.

Significance: This study demonstrates the utility and safety of rapid mobilization and discharge prior to return of bowel function for patients undergoing PSF.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Implementation of an Accelerated Discharge Pathway Reduced Hospital Stay Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis by Nearly 50%: A Multicenter Comparative Study

Nicholas D. Fletcher, MD*; Lindsay M. Andras, MD; David E. Lazarus, MD; Robert J. Owen, BS; Benjamin J. Geddes, BS; Jessica Cao, BS; David L. Skaggs, MD; Timothy S. Oswald, MD; Robert W. Bruce, MD*
Emory University, Atlanta, GA

†**LOE-Therapeutic - Level III**

Introduction: Hospital stay following posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) has decreased only modestly over time despite a healthy patient population. The purpose of this study was to evaluate the impact of a novel post operative pathway on length of stay (LOS) and complications.

Methods: A retrospective review of patients undergoing PSF for AIS in 2011-12 was performed at two institutions evaluating demographics, preoperative Cobb angles, surgical duration, blood loss, length of stay, and post operative complications. Patients at one center were managed using an accelerated discharge pathway emphasizing transition to oral pain medications on post operative day 1, mobilization with PT 2-3 times/day, and discharge prior to complete return of bowel function. Patients at the other center were managed without a standardized pathway.

Results: 105 patients underwent PSF and were treated by an accelerated discharge pathway (AD) while 45 patients were managed using a traditional discharge pathway (TD). There was no difference in proximal thoracic and main thoracic Cobb magnitudes and a small difference in thoracolumbar curve magnitudes (35±13° AD vs 42±13° TD, p=0.004) between groups. AD patients were treated using 16% fewer pedicle screws (mean pedicle screw density 1.34 vs 1.58, p<0.0001), with 9% fewer levels fused (mean 10.2±2 vs 11.2±2, p=0.02) and had a slightly shorter surgical time (median 3.1 hours vs 3.9 hours, p=0.0003) with a similar EBL (median 275cc (AD) vs 400cc (TD), p=0.06). Length of stay was 48% shorter in the AD group (2.2 days vs 4.2 days, p<0.0001). Length of surgery (Spearman rho (r)=0.22, p=0.007) and levels fused (r=0.22, p=0.009) showed weak correlation with length of stay and there was no correlation between length of stay and EBL.There was no difference in readmissions or wound complications between groups.

Conclusions: Hospital stay was nearly 50% shorter in patients managed by the AD pathway without any increase in readmissions or early complications.

Significance: Discharge following PSF for AIS may be expedited using a coordinated postoperative pathway. No increase in complications was seen using the AD pathway. Earlier discharge may reduce health care costs and allow an earlier return to normalcy for families.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Improving the Process of Care for Developmental Dysplasia of the Hip

Mackenzie M. Herzog, BA; ***Tim Schrader, MD***
Children's Healthcare of Atlanta

†**LOE-Therapeutic - Level II**

Purpose: In 2011, a multidisciplinary physician group implemented a new process of care for screening developmental dysplasia of the hip (DDH) in our community. A standardized screening document was created, pediatricians participated in the American Board of Pediatrics Maintenance of Certification program for DDH, and referral guidelines for further management, including referral criteria, ideal referral between 6-8 weeks of age, and immediate referral to an orthopaedist for clinically observed dislocation, were specified. The purpose of this study was to determine if implementation of the process of care led to changes in referral patterns for children with DDH.

Methods: March 2011 and October 2011, 143 physicians participated in implementation of the new process of care. We retrospectively reviewed all infants who presented for hip ultrasound at our regional children's hospital between June 2009 and September 2013. We compared June 2009-March 2011 to December 2011-September 2013 to evaluate the effect of the new process of care. Exclusion criteria were treatment for DDH prior to ultrasound. Age at the time of ultrasound and ultrasound findings were compared between groups.

Results: 726 patients met the inclusion criteria for this study. There were 321 ultrasounds prior to and 405 after the intervention. Mean age at ultrasound prior was 9.7 weeks (range: 1.0-32.8 weeks) compared to 9.6 weeks after (range: 1.6-26.5 weeks, p=0.641). There was a significant decrease in percentage of ultrasounds prior to 6 weeks of age following the intervention (8% vs 5%, p=0.037). There was a higher percentage of abnormal ultrasounds prior to the intervention(19% vs 15%, p=0.023), but there were fewer hip dislocations identified on ultrasound following intervention (16.4% vs 3.4%, p=0.007). There was no statistically significant difference between percent referred between 6-8 weeks of age (p=0.639), percent referred after 16 weeks of age(p=0.062), or percent of DDH diagnoses (p=0.456); however, there was a trend toward tighter time range for referral with 70% of patients referred between 6-12 weeks of age prior to the intervention versus 74% after(p=0.093). A records review revealed that physician knowledge of appropriate guidelines increased from 67% prior to implementation of the process of care to 95% following implementation.

Conclusion: Implementation of the process of care led to improvements in referral patterns for children with DDH. Fewer patients were referred for ultrasound prior to 6 weeks of age, leading to decreased likelihood of false-positive findings.

Significance: Standardization of the process of care for DDH improves patient care and can decrease healthcare cost associated with inappropriate testing.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Evaluation of Patient Satisfaction Scores in Pediatric Orthopaedics

Lee S. Segal, MD*; Carla Plantikow, M.Sc.; Randon Hall, MD, MBA; Kristina Wilson, MD, MPH; M. Wade Shrader, MD*
Phoenix Children's Hospital, Phoenix, AZ

†**LOE-Economic & Decision - Level II**

Objective: Patient satisfaction survey scores are increasingly being tied to incentive compensation, impact how we practice medicine, influence decisions on where to seek care, and in the future may be required for accreditation. The goal of this study is to compare the results of a random internal distribution of patient satisfaction surveys to responses received by mail in a hospital based, high volume pediatric orthopaedic practice.

Methods: The NRC Picker survey used at our institution is a pediatric outpatient 32 item instrument. Surveys are randomly mailed out to families seen in our clinic, and the results are determined on a quarterly basis. We randomly distributed the same survey in our clinic. The results of the surveys, Picker Mailed (PM) vs Internal (INT) over the same three month time period (2nd quarter 2013) were compared. The question of how one would rate your provider is converted from a continuous (0-10) to a binomial (0-1) scale, in which only ratings of 9-10 are a positive result in the Picker methodology.

Results: Response rate was 72/492 (14.6%) for PM, and 231/333 (69.4%) for INT ($p < 0.0001$). Rating your provider was 72.2% (PM) vs. 84.8% (INT) positive response ($p = 0.015$). Our analysis of the raw data (INT) has a mean rating of 9.42. When ratings of 8 were including as a positive response, our rating increased to 94.4% ($p = 0.001$). Waiting time response correlated with rating of provider ($p = 0.02$). For the majority of the items, the INT responses were consistently higher than the PM responses, including 6/7 responses that were statistically significant ($p < 0.05$).

Conclusion: Patient satisfaction surveys will continue to be part of healthcare, and properly designed and administered surveys provide robust measures of quality. Our study reinforces concerns about the survey; many of the survey items may not be appropriate for a high volume pediatric subspecialty practice, and may not reflect true quality of care. Other confounding issues include mode and timing of survey distribution and completion. One way to influence our scores is to educate our patients to help them understand how we as physicians are being evaluated. Further research is needed to evaluate the patients' health care experience and true quality of care.

Significance: Patient satisfaction surveys in pediatric orthopaedics should be designed and distributed in a manner that provides a true reflection of quality of health care in high volume subspecialty surgical ambulatory settings.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Use of 6-Axis External Fixation is Overall More Cost-effective than Ilizarov for Canadian Health Care Centers

Elisabeth Leblanc, MD*; Khalid Alkhelaifi, MD; Mohammad Alzahrani, MD; Marie Gdalevitch, MD*
Shriners Hospital for Children, Montreal, QB, CANADA

†**LOE- Economic & Decision - Level IV**

Purpose: Correction of limb deformities through use of an Ilizarov apparatus has been the gold standard for many years. In the past two decades, the use of computer assisted 6-axis external fixation has revolutionized deformity correction, particularly when the deformity has several components (angulation, translation, and rotation). These deformities previously required staged corrections or frame modifications in the operating room (OR). In Canada, the use of 6 axis external fixation has been limited by the elevated costs of the equipment. Our hypothesis is that the overall cost per patient for 6-axis external fixation is less expensive than Ilizarov. The objective of this study is to investigate the cost-effectiveness of using 6-axis external fixation in the Canadian health care system.

Methods: This retrospective study examines factors associated with cost per patient undergoing limb lengthening and deformity correction. Specifically costs associated with: OR time, OR staffing, instrumentation and equipment, duration of admission, return to OR, number of complications, frequency of follow-up and rehabilitation protocols were compared. Costs were calculated from the beginning of treatment until removal of external fixation and were averaged per patient. Inclusion criteria were patients who underwent Ilizarov or 6-axis circular fixation for deformity correction or lengthening between 2006 and 2013 at the Shriners Hospital. The primary outcome is the average total cost per patient for Ilizarov versus 6-axis external fixation.

Results: Taken separately, the equipment cost for 6-axis circular fixation was significantly higher than for Ilizarov. However, when all associated costs are taken into account, the use of 6-axis external fixation for lengthening and deformity correction was shown to be overall less expensive per patient. The most important factors that influenced the cost were the return to OR for frame adjustments (more frequent with Ilizarov, $p<0.05$) and the length of OR time (significantly longer with Ilizarov fixation $p<0.05$).

Conclusion: Return to the operating room was more frequent in the Ilizarov group and resulted in overall elevated costs. Therefore, even if the initial cost of the equipment for 6-axis external fixation is elevated, the overall cost for the treatment is lower than with Ilizarov. Furthermore, there was a trend for longer OR time in the Ilizarov group, which translates into decreased OR time for other procedures, decreasing the monetary productivity of the OR.

Significance: This study confirms that not only is 6-axis external fixation advantageous for the patient but also for the Canadian health care system.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Ponseti Corrected Clubfeet At Age Two Years: Is the Story Finished?

B. Stephens Richards III, MD*; Shawne Faulks, MSN, RN, CNS; Lori A. Karol, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE- Therapeutic - Level III**

Purpose: Most infants with idiopathic clubfeet treated by Ponseti's method reach the age of two years with corrected plantigrade feet without having required surgery (except percutaneous TAL). The purpose is to determine the percentage of these children whose corrected feet subsequently relapse beyond age two years and require operative treatment.

Methods: Patients ≥5 years old whose idiopathic clubfeet underwent successful treatment within the first 3 months of life and were in a plantigrade position at age two years were studied. If further treatment was required, the procedures and results were recorded.

Results: 243 feet that were plantigrade at age two years had an average followup of 7.5 years (range 5-11.5 years). 177 feet (72%) remained plantigrade and 66 feet (28%) relapsed requiring limited or extensive operative intervention. Of these 66 feet, 55 required limited procedures which included TALs, posterior releases, tibialis anterior tendon transfers, plantar fascia releases, lateral column shortenings, or metatarsal osteotomies. A single limited procedure was performed in 14 of these 55 feet and combinations of procedures were performed in 37 feet in order to maintain a plantigrade foot. Two separate operations consisting of limited procedures were required in 4 of the 55 feet. The remaining 11 feet required complete posteromedial releases to achieve a plantigrade position and were considered failures.

Conclusion: The majority of clubfoot patients (73%) with successful outcomes at 2 years of age using the Ponseti method will continue to do well without the need for surgery. However, nearly one quarter of these early successes (23%) will require a limited procedure, or a combination thereof, to maintain a plantigrade foot position. 4.5% (11/243) of the early apparent successes subsequently relapse to the point of needing a complete PMR.

Significance: Although most patients will maintain a plantigrade foot after reaching age two years, future limited procedures (all of which are extra-articular except for the posterior release) may be required in nearly one-fourth of these patients. These limited procedures should be considered an extended part of the Ponseti treatment program.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Surgical Treatment of Congenital Idiopathic Clubfoot After "French" Functional Treatment: Outcome in a 10-Year Pro Study

*Nicolas Bocahut; **Dr. Philippe Souchet**; Brice Ilharreborde, MD; Keyvan Mazda, MD*
Robert Debre Hospital, Paris, FRANCE

†LOE- Therapeutic - Level IV

Purpose: There have been few studies with sufficient follow-up and power to report results and incidence of surgery in management of clubfoot, or congenital talipes equinovarus after "French" functional treatment or Ponseti method. The purpose of this study was to report long-term results and incidence of surgical treatment in a prospective series of idiopathic clubfeet followed up from birth, managed functionally and if necessary secondarily operated.

Methods: All the children with idiopathic clubfeet born between the 1st of January 1995 and the 31st of December 2006 and seen for the first time before the age of 3 month were included. They received functional treatment, comprising physical therapy and orthoses, and were followed up prospectively regardless of compliance, up to the 1st of March 2013. Initial assessment of severity was based on the Dimeglio score, and functional assessment at follow-up on the Bensahel score. When necessary, the surgical procedure performed was always a one-stage medioposterior release "à la carte" with or without calcaneal osteotomy.

Results: At a mean 10.3 years' follow-up (range, 5.8-18.0 years), 155 clubfeet (48.3%) had required surgical management (excluding Achilles tenotomies) among 321 feet functionally treated with complete follow-up. Clubfeet requiring surgery were initially more severe: Dimeglio 11.4/20 vs 8.6/20. Mean age at surgery was 22,1 months. Initial Dimeglio score correlated with incidence of surgery: 15.4% (2/13) in group I, 30.7% (47/153) in group II, 70.5% (91/129) in group III and 100% (13/13) in group IV. At latest follow-up, distribution according to the Bensahel evaluation was as follows: 65.8% (102/155) in class I, 29.0% (45/155) in class II, 4.5% (7/155), 0.6% (1/155) in class IV and none in the upper classes (V, VI and VII). Mean post-operative follow-up was 9.1 years (range, 1.1-17,3 years), 94.9% of good results (147/155 operated feet in Bensahel class I or II at latest follow-up) and 8 bad results (class III or IV) were observed in the surgical group. Eleven feet (7,1%) needed more than one surgical procedure (average 1.4). Mean Bensahel score was poorer in the surgical than in the pure functional group: 4.0/50 vs. 1.4/50.

Conclusions: Many authors nowadays prefer the Ponseti method, because of a low rate of associated surgery. The present results confirm the high rate of surgery associated with the "French" functional method especially in feet initially classified Dimeglio III or IV but also the high rate of good results after surgery in all groups. This score at birth remains an essential predictive factor. Management of the most severe deformation always remains a difficult challenge.

Significance: Although surgery was frequent, long-term functional results after surgery were very satisfactory in all feet. Therefore, the objective of reducing surgical incidence should not let persist deformation at any cost.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Objective Measurement of Brace Compliance in Idiopathic Clubfoot Treatment

Donald D. Virostek, CPO; Kevin Felton, CPO; Megan Urrutia, MPO; Shawne Faulks, RN; ***Karl E. Rathjen, MD****; B. Stephens Richards III, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE- Therapeutic - Level II**

Purpose: Post-casting Foot Abduction Orthoses (FAO) use is critical to the success of the Ponseti method. The purpose of this study is to accurately and objectively determine the amount of time the brace is worn.

Methods: Since February 2010, all patients less than 12 months of age with idiopathic clubfeet who completed initial Ponseti cast correction were placed into a FAO with a temperature data logger imbedded in the sole of one of the shoes. To avoid influencing compliance with bracing, parents were informed of the temperature logger device but not that the compliance was being monitored. FAO was prescribed 22 hours per day for the first 3 months followed by 12 hours per night until 2 years of age.

Results: 155 patients have completed at least 3 months bracing. Brace use per day averaged 17.4 hours in these 155 patients (79% of the prescribed 22 hours/day use). 87 of the 155 patients completed the first year of bracing. The use per day for months 6-12 averaged 7.5 hours (63% of the prescribed time).

41/47 patients (87%) who were "highly compliant" (>90% prescribed wear) in the first 3 months continued to use the brace at least 50% of the prescribed time in months 6-12. 22/31 patients (70%) who were "compliant" (50-90% prescribed wear) in the first 3 months continued to use the brace at least 50% of the prescribed time in months 6-12. 8/9 patients who were "non-compliant" (< 50% prescribed wear) in the first 3 months remained non-compliant

Conclusion: Compliance with brace wear can be accurately measured. Adherence to the recommended wear schedules is consistently less than prescribed. Patients who are initially "highly compliant" tend to remain complaint.

Significance: Objective measurement of FAO wear will allow assessment of interventions aimed at increasing compliance. Future work should correlate amount of brace wear and outcome.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Recurrent Forefoot Adductus is a Predictor of Future Surgery in Clubfeet Treated by Ponseti Casting

Pooya Hosseinzadeh, MD; Erik D. Peterson, MD; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet L. Walker, MD; Vishwas R. Talwalkar, MD; ***Todd A. Milbrandt, MD, MS***
Lexington Shriners Hospital for Children, Lexington, KY

†**LOE-Prognostic - Level III**

Purpose: Tibialis Anterior Tendon Transfer (TATT) is performed for treatment of dynamic supination of clubfeet treated by Ponseti casting. The presence and severity of dynamic supination is difficult to quantify. Recurrent metatarsus adductus (MA) has also been observed following casting and is apparent on pedobarographs. Our purpose was to investigate whether the presence and magnitude of recurrent MA using pedobarographs predicted the future need for TATT. Our hypothesis was that the presence of MA as defined by measurement of the heel forefoot angle (HFA) (Figure 1) would correlate with the need for TATT.

Methods: A retrospective chart review of patients with diagnosis of idiopathic clubfoot treated at our center was performed after local IRB approval. The patients were divided into two groups, group +TATT with history of TATT and group -TATT with no TATT. Patients less than 5 years of age were excluded from –TATT. Heel forefoot angle (HFA) was measured on pedobarographs as an indicator of residual MA. HFA was compared between the two groups using t-test with significance established at $p<.05$ with a lower HFA signifying more MA. The predictive value of residual adductus was measured using regression analysis.

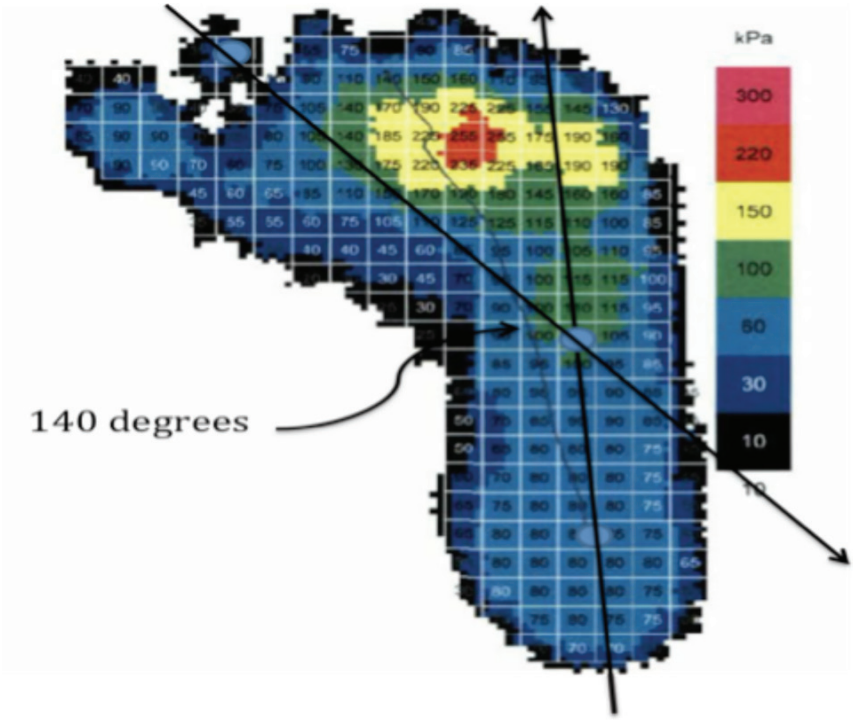
Results: A total of 143 patients (201 feet) met our criteria, 77 patients (56 male, 21 female) with 98 involved feet were in the +TATT group and 66 patients (51 male, 15 female) with 103 involved feet were included in the –TATT group. Average age at time of TATT was 3.7 years and average age of follow up was 7.6 years in group –TATT. Foot pressure analysis was performed at average age 3.1 years in +TATT and 3.4 years in the –TATT group. HFA was significantly different between +TATT (139) and –TATT (149) groups (P value<0.01). Further analysis of the HFA showed those with a HFA less than 140 had 86% chance for TATT. HFA greater than 150 resulted in TATT only in 11% of the cases.

Conclusion: Recurrent MA as measured by HFA on pedobarographs correlates with the need for future TATT surgery in children who have undergone Ponseti casting for clubfeet.

Significance: Recurrent MA in clubfeet treated by Ponseti casting is a deformity that can be easily measured on pedobarograph and serve as a warning sign of dynamic supination and lateral weight bearing. Clinicians can use this data to identify feet at risk for future surgery.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Figure 1- Heel Forefoot angle



♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Is the Anterior Tibialis Weaker After Transfer in Children with Clubfeet?

Hank White, PT, PhD; Juanita J. Wallace, MS; Samuel F. Augsburger, MS;
***Todd A. Milbrandt, MD, MS**; Vishwas R. Talwalkar, MD; Ryan D. Muchow, MD;*
Henry J. Iwinski, MD; Janet Walker, MD
Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington KY

†**LOE-Therapeutic - Level III**

Purpose: Despite the effectiveness Ponseti treatment, a certain percentage of children experience reoccurrence of the clubfoot deformity due over pull of the anterior tibialis. Transfer of the anterior tibialis (ATT) insertion to a more lateral location on the dorsum of the foot is designed to improve this muscle imbalance. Since loss of one muscle strength grade is expected in most tendon transfer surgery, we performed this prospective study to assess changes in ankle muscle strength in clubfeet with ATT.

Methods: Data from 21 subjects (14 male; 7 females) for a total of 30 involved limbs and 12 uninvolved limbs are presented. Mean age 3 years 11 months (range: 2yrs 7 months -7 years 4 months) at first visit. Mean time from first visit to surgery is one month (range 0-5 months). Anterior tibialis was inserted into the lateral cunneiform. Mean time to post-op assessment was 7 months (range 5-12 months). Patient's ankle musculature strength was assessed using a hand held dynamometer (PowerTrack II Commander from JTech Medical, Salt Lake City, Utah). 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 analysis.

Results: From preop to follow-up, involved limbs demonstrated 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. $p<.05$). A non-statistically significant increase in involved limb ankle inverter and everter strength was also noted. A positive correlation between change in dorsiflexors strength and time to follow up visit was noted ($r=0.6$). Uninvolved limbs in unilateral subjects also demonstrated a statistically significant increase in only inversion strength (11.1 to 15.6 lbs., $p<0.001$) while ankle plantar flexion, dorsiflexion and eversion remained unchanged during the assessment interval. Before surgery, the involved ankle dorsiflexors were statistically weaker than the uninvolved limbs (10.6 versus 14.0 lbs., $p<0.05$). Six months after surgery, the involved limbs the ankle dorsiflexors were not statistically weaker (13.2 versus 16.3 lbs.)

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

Significance: While muscle strength is diminished in limbs with clubfeet, there should be limited concern for loss of ankle dorsiflexion power after ATT.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Determination of Peak Growth Acceleration from Ossification of the Calcaneal Apophysis

Allen Nicholson, BS; Raymond W. Liu, MD; James O. Sanders, MD; ***Daniel Cooperman, MD***
Yale School of Medicine, New Haven, CT

†**LOE-Diagnostic - Level I**

Purpose: We examine the ossification sequence of the calcaneus of the foot to determine if it can be useful to predict peak growth acceleration (PGA).

Methods: We examined over 700 foot x-rays from 94 healthy children ages 10-15 who were studied from 1925 to 1945 in Cleveland, Ohio. This prospectively acquired data set was used by Greulich and Pyle to develop their classic system of skeletal maturity assessment. The PGA was calculated using the height of each child, which was measured at each x-ray. We examined the degree of ossification of the calcaneal apophysis as well as the stage of fusion. Degree of ossification was calculated by measuring the length of the ossified apophysis and dividing it by the maximal width of the calcaneal tuberosity.

Results: Ossification of the calcaneal apophysis occurs in a very orderly fashion with the ossification center first appearing 4.7 years (95% CI -5.38, -3.98) before the PGA. Ossification begins on the plantar surface and proceeds in a cephalic direction. The apophysis becomes fully ossified with no signs of fusion at 0.1 years (95% CI -0.1, 0.3) after the PGA. Fusion of the apophysis occurs over the next 1.5 years and is typically complete 2 years (95% CI 1.1, 1.6) after the PGA. Fusion begins in the middle of the apophysis and proceeds outward. Using the Pearson coefficient, interobserver and intraobserver reliability for assessing apophyseal ossification was calculated based on measurement of 20 randomly chosen x-rays by two observers and repeat measurement by the first, and were 0.976 and 0.998, respectively.

Conclusion: Ossification of the calcaneal apophysis provides a reliable and simple method of determining skeletal maturation and PGA.

Significance: Ossification of the calcaneal apophysis provides an osteologic marker of skeletal maturation in relation to PGA. The method is similar to the Risser sign in that it uses extension of the apophysis to assess maturity. However, it is more useful than the Risser sign for predicting PGA because at PGA the Risser sign is zero whereas the calcaneal apophysis fully covers the calcaneal bed but is not fused, allowing the surgeon to easily identify this important physiologic phase of growth. This information can aid the surgeon in determining optimal treatment of scoliosis.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Prospective Comparison of Subtalar Arthroereisis to Lateral Column Lengthening for Painful Flatfeet

David Chong, MD*; Bruce A. MacWilliams; Theresa A. Hennessey, MD; Noelle Teske, MSc; Peter M. Stevens, MD*
University of Utah, Salt Lake City, UT

†**LOE-Therapeutic - Level II**

Purpose: There is no consensus on the surgical treatment of unremitting, painful flatfeet in children. Subtalar arthroereisis has gained notoriety although there is a paucity of literature on its biomechanical effects. Our goal was to compare a group treated with subtalar arthroereisis with another group undergoing lateral column calcaneal lengthening. Our hypothesis was that the results of arthroereisis would be equivalent to the more established method of calcaneal lengthening.

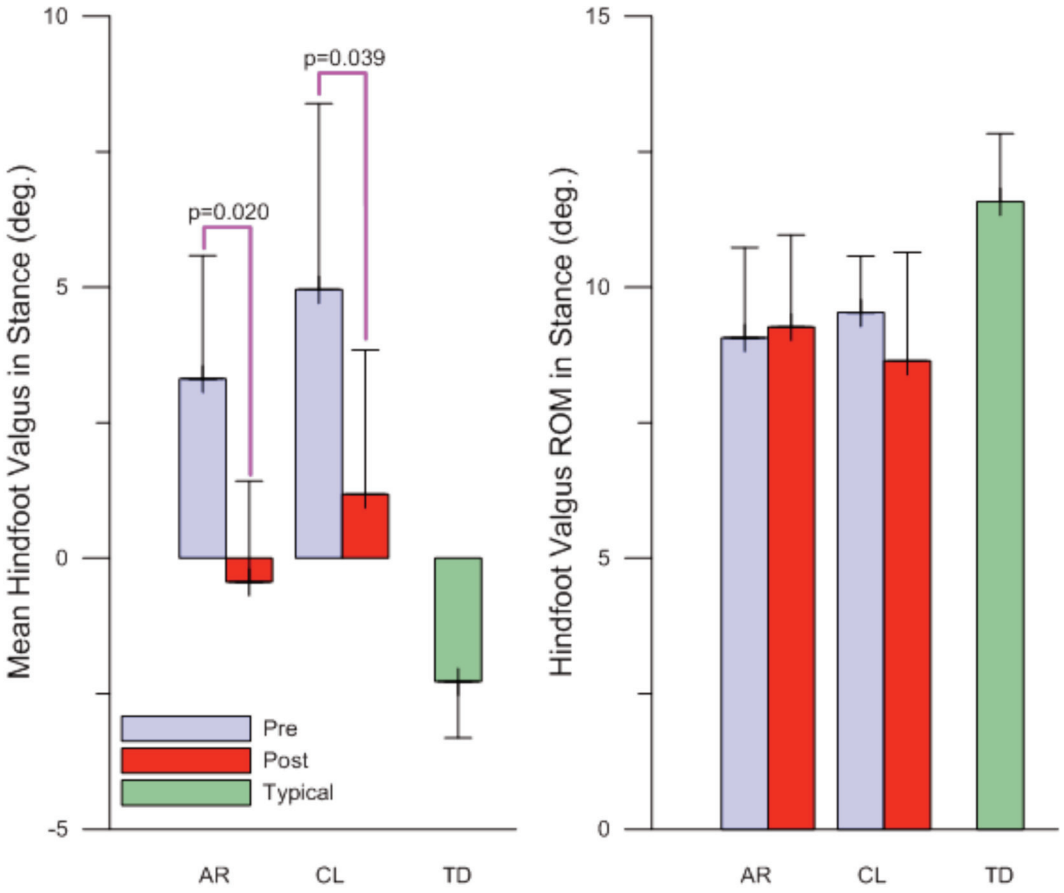
Methods: A prospective trial was conducted. We enrolled fifteen patients (mean age 12.8y) and 24 feet with painful, planovalgus feet refractory to conservative treatment. Seven patients and 13 feet were enrolled in the arthroereieis group, and eight patients and 11 feet were enrolled in the calcaneal lengthening group. Though not specifically excluded, none of the enrolled patients had an underlying neuromuscular diagnosis. Kinematic motion analysis was performed on each patient prior to surgery and at one year of follow-up. Pedobarometry studies, radiographs, and validated outcome questionnaires (Oxford Ankle-Foot Questionnaire for Children) were also performed to evaluate the outcomes of both groups.

Results: We were able to find statistically significant improvement in both groups, but we did not find a statistical difference between the outcomes to support one treatment over the other. Kinematic analysis in both groups showed significant decreased midfoot inversion and abduction. We also found the hindfoot did not stiffen with arthroereisis or calcaneal lengthening, and the range of motion was preserved with a more varus offset. Radiographs in both groups showed statistically significant improvements in the lateral talocalcaneal angle, AP and lateral talo-first metatarsal angle, and AP-talonavicular coverage. Pedobarometry of both groups showed significantly decreased time on the midfoot and medialization of the center of pressure. Oxford scores showed improvements in both groups.

Conclusion: Subtalar arthroereisis is less invasive and cost-effective, and is a feasible alternative to lateral column lengthening. While either procedure can achieve the desired outcome, the informed choice should be individualized, in accordance with parental expectations and desires. Further study, especially long-term, is warranted, and we plan to continue to follow these patients annually until maturity.

Significance: Subtalar arthroereisis should be considered in the treatment of painful, planovalgus feet.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.



♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Rate of Correction and Recurrence of Ankle Valgus in Children Using a Transphyseal Medial Malleolar Screw

Frank M. Chang, MD*; Julie Ma, BA; Zhaoxing Pan, MB, PhD; Liliana Hoversten, BA; Eduardo N. Novais, MD*
Children's Hospital Colorado, Aurora, CO

†**LOE-Therapeutic - Level III**

Purpose: Hemiepiphysiodesis or controlled growth using a transphyseal medial malleolar screw (TMMS) has been shown to be an effective surgical treatment for ankle valgus in growing children. The purpose of this study was to determine the rate of correction and recurrence of ankle valgus after a TMMS procedure.

Methods: Following IRB approval, we conducted a database search for children who underwent a TMMS procedure for treatment of ankle valgus. Sixteen males and 21 females (63 ankles) with a minimum one-year follow-up or screw removal after deformity correction were retrospectively reviewed. Patients were divided into clinical diagnosis groups, including multiple hereditary exostoses (n=14 ankles), cerebral palsy (n=4), spina bifida (n=7), idiopathic (n=24), and other (n=14). Valgus deformity was assessed on anteroposterior weight-bearing ankle radiographs by measurement of tibiotalar angle. Linear mixed effects models were used to determine rates of correction and valgus recurrence. Analysis of covariance was used to determine differences between age groups.

Results: Average age at surgery was 11.0 years (range 5.4-14.8 years) with a mean radiographic follow-up of 1.8 years (range 0.37-4.9 years). There was a significant ($P<0.001$) improvement in tibiotalar angle at the most recent follow-up: the mean pre-operative and most recent tibiotalar angles were 10.6±4.3° and 3.1±6.3°, respectively. The overall average rate of correction in tibiotalar angle was 0.28±0.05° per month ($P<0.001$). Patients with spina bifida had the slowest rate of correction (0.24±0.06°/month, $P<0.001$), while patients with cerebral palsy diagnoses had the fastest rate (0.90±0.17°/month, $P<0.001$). Patients younger than 11 years of age experienced faster correction than those older than 11 years of age ($P=0.02$). For subjects that received screw removal (43 ankles), the average time from insertion to removal of the screw was 1.41 years (range 0.44-5.16 years). The average recurrence rate in patients who underwent screw removal was 0.28±0.33° per month (18 ankles, $P=0.43$) until skeletal maturity.

Conclusion: Guided growth in children with ankle valgus can be an effective treatment, but the effects of additional skeletal growth should be considered as the ankle may rebound into valgus after correction and screw removal. Based on the patient's age, it may be beneficial to slightly overcorrect the ankle into varus. The mean rate of correction and recurrence described here can be used to determine when to insert and remove the screw.

Significance: Surgeons should consider overcorrecting patients with ankle valgus and remaining skeletal growth in order to prevent recurrence of the deformity.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Using the Oxford Ankle Foot Questionnaire to Evaluate Children with Flexible Flatfeet. A Comparison with Typically Developing Feet and Cerebral Palsy

Alpesh Kothari, MD; Julie Stebbins, PhD; Amy Beth Zavatsky, PhD;
Tim Theologis, MSc, PhD, FRCS
Nuffield Orthopaedic Centre, Oxford, UNITED KINGDOM

†**LOE-Diagnostic - Level III**

Purpose: To investigate the quality of life of children with pediatric flatfeet (PFF), and assess the inter-relationship of different domain scores, using the Oxford Ankle Foot Questionnaire for children (OXAFQ_C).

To assess how OXAFQ_C scores of children with PFF compare to children with typically developing feet (TDF) and those with symptomatic treated clubfoot, and the foot in cerebral palsy.

Methods: 27 children with PFF and 30 with TDF between the age of 8 and 15 were recruited into this ethically approved study. Classification of foot posture was based on objective anthropometric, pedobarographic and radiological measurements. No subject had coexisting musculoskeletal or neurological disease and had not had any previous lower limb operations. No subject was concurrently using orthotics. The OXAFQ_C was completed for each subject. OXAFQ_C data were also obtained from the gait laboratory database of 9 children with symptomatic treated clubfoot and 13 children with cerebral palsy. The different domain scores in the PFF group were compared using Spearman's rank correlation. Level of significance was adjusted, due to multiple comparisons, to 0.017. A Kruskall-Wallis test was used to compare OXAFQ_C scores between groups (Stata).

Results: The PFF group had a higher proportion of females than the TDF group (65% vs 30%). There was no difference in mean age between groups. The PFF group had a median OXAFQ_C score of 76% (100% is perfect function). Spearman's rank correlation demonstrated a significant relationship between the physical questionnaire domain and school & play ($\alpha<0.001$) and emotional ($\alpha=0.005$) domains. The TDF group had a median OXAFQ_C score of 95%. The difference between PFF and TDF questionnaire scores was statistically significant ($\alpha=0.001$). Qualitative analysis demonstrated that a proportion of children with PFF demonstrate similar OXAFQ_C scores to children with symptomatic treated clubfoot and cerebral palsy feet.

Conclusion: The use of the OXAFQ_C in this study has demonstrated that children with PFF have generally worse quality of life than children with TDF. Children with PFF who have physical impairment are also likely to have affected school and play and emotional function. A proportion of children with PFF demonstrate equivalent reduction in quality of life as children with better recognised foot and ankle pathologies.

Significance: PFF is not as benign as some clinicians believe and further investigation into why some children are so burdened by this condition is warranted.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Successful Pavlik Harness Treatment for Developmental Dysplasia of the Hip and Normal X-Ray At Age Two: Is a Longer Follow-Up Necessary ?

Nanni J. Allington, MD
CHR Citadelle, Liège, BELGIUM

†**LOE-Prognostic - Level III**

Purpose: A selected group of patients successfully treated for Developmental dysplasia of the hip (DDH) with a Pavlik harness (PH) might not require long-term follow-up with irradiating X-ray.

Methods: A retrospective review of a consecutive series of patients treated for DDH between January 1995 and July 2004 was undertaken. A very selected group was defined: the child had to be otherwise normal (neuromuscular diagnosis or syndromes were excluded), the treatment with the PH had to be successful, and the X-ray at age 2 had to be normal (normal acetabular index, no signs of avascular necrosis).

At last follow-up a clinical exam was performed and the following measurement were done on X-ray: center-edge angle, Seringe-Severin's score, teardrop, acetabular index (open growth plate), sharp's angle (mature), Mose's classification.

Results: Out of 170 consecutive children seen with DDH 130 fitted those criteria, 47 had insufficient data, 83 were studied, 22 had bilateral DDH and a total of 105 hips were reviewed. Of these 105 hips, 12 were Ortolani positive, 10 Barlow positive, 83 diagnosed at one month of age by dynamic ultrasound with subluxation/instability/dysplasia.

The mean follow-up was of 10 years and 4 months (8 to 16 years).

All 105 hips had a normal clinical exam as well as normal X-ray at the last follow-up : mean center-edge angle of 32° (25° – 40°), Seringe-Severin's score IA , normal teardrop, mean acetabular index 18 ° (9° to 24°), mean Sharp's angle of 35° (32° to 47°), Mose's cercle below 2.

Conclusion: Since the clinical exam and the X-ray done at long-term follow-up were normal, it might not be necessary to continue follow-up if X-ray at age two are normal after treatment with the PH.

Significance: Although the results of this study suggest that long-term follow-up might not be required in this selected group, an increase of the number of patients as well as a still longer follow-up (not all were skeletally mature) would be useful.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Radiographic Follow-Up for DDH After 6 Months of Age: Are X-Rays Necessary After a Normalized Ultrasound?

Eric J. Sarkissian, BS; John (Jack) M. Flynn, MD; ***Wudbhav N. Sankar, MD***
The Children's Hospital of Philadelphia, Philadelphia, PA

†**LOE-Prognostic - Level IV**

Purpose: Given concerns about cost and pediatric radiation exposure, we sought to evaluate the need of long-term radiographic follow-up of developmental dysplasia of the hip (DDH) in infants who have achieved normal clinical and sonographic exams. Our hypothesis was that infants with normalized hip instability, acetabular dysplasia, or both do not demonstrate residual acetabular dysplasia necessitating further radiographic monitoring.

Methods: We reviewed a consecutive series of infants with idiopathic DDH presenting to our institution between January 2008 and January 2012. We defined infants with "normalized" DDH as those who had achieved a stable clinical exam (negative Barlow/Ortolani) as well as an ultrasound revealing no signs of either hip instability or acetabular dysplasia (alpha angle ≥ 60°). We excluded infants demonstrating persistently abnormal sonographic indices, clinical exams, or both by 6 months of age, including those requiring surgical reduction. Anteroposterior pelvic radiographs at approximately 6 months and 1 year of age were then analyzed for evidence of residual radiographic acetabular dysplasia by a single observer who was blinded to the clinical outcome of the patients. An absolute acetabular index greater than 30° on the 6-month radiograph or greater than 28° on the 12-month radiograph was defined as acetabular dysplasia.

Results: Our study cohort consisted of 115 patients with DDH who had achieved normal sonographic and clinical exams at 3.1 ± 1.1 months of age. At the age of 6.6 ± 0.8 months, 17% of all patients showed radiographic signs of acetabular dysplasia. Of patients left untreated after 6 months (n=106), 33% had dysplasia on subsequent radiographs at 12.5 ± 1.2 months of age. We found no significant differences in either the 6- or 12-month rates of dysplasia between patients successfully treated with a Pavlik harness and patients normalizing without treatment but with a history of risk factors (female gender, breech presentation, and/or positive family history) ($p>0.05$).

Conclusion: We were wrong. Our overall incidences of radiographic dysplasia after previous DDH normalization were 17% and 33% at approximately 6 and 12 months of age, respectively, supporting the need for serial radiographic monitoring through at least walking age. Radiographic follow-up at 6 months and 1 year of age may be important to allow early identification and treatment of residual acetabular dysplasia.

Significance: Notable incidences of residual dysplasia in infants after previous normalization of DDH may warrant radiographic follow-up at 6 and 12 months of age to allow timely diagnosis and early intervention.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Complication Rate for Treatment of Developmental Dysplasia of the Hip with the Pavlik Harness

Valentin Noriega, Sr, MD; Carlos Alejandro Brambila, MD; ***Pablo Castañeda, MD***
Shriners Hospital for Children, Mexico City, MEXICO

†**LOE-Therapeutic - Level IV**

Purpose: To determine the complication rate for a single surgeon using the Pavlik harness for the treatment of developmental dysplasia of the hip (DDH), and identify risk factors for presenting a complication.

Methods: A retrospective review of 307 patients with DDH who had been treated with a Pavlik harness (mean age at start of treatment = 3.1 months) with a minimum follow-up of two years; 46 patients were found to have a "failure" of reduction and were no longer included as this was not considered a complication but rather a failure in treatment. The presence of femoral nerve palsy, brachial plexus palsy, dermatitis, posterior fixed subluxation of the hip (so-called Pavlik harness disease) and avascular necrosis (AVN) were determined. Risk analysis was carried out to identify the risk factors for presenting these complications.

Results: The overall complication rate was 13% (40 of the 307 patients). Three patients developed a femoral nerve palsy, all resolved within 6 days after removing the harness (rate = 0.98%). 19 cases of dermatitis were found (rate = 6.2%) and 18 cases of AVN were found (rate = 5.8%), of the 18 cases with AVN, 14 were classified as Salter & Thompson type I and 4 as type II; AVN was observed between 2 and 18 months after treatment had been started. The mean age for the 3 cases with femoral nerve palsy was 5.6 months, the mean age for the group that presented dermatitis was 4.3, the mean age for the group that presented AVN was 5.1 months, the mean age for all patients with a complication was 5. 1months compared with 3.1 months for the cohort without a complication. All of the cases with a femoral nerve palsy were dislocated at rest at the start of treatment, 15 of the cases that presented AVN were dislocated at rest and 3 were unstable. None of the hips considered as stable dysplasia presented any complication other than dermatitis.

Conclusion: The Pavlik harness is a safe treatment method with a very low rate of complications. Independent risk factors for presenting a complication were being over 4 months of age at the start of treatment and having a dislocated hip.

Significance: Parents of infants with DDH should be counseled that the probability of having a complication related to the use of the Pavlik harness is greater if the infant is over 4 months of age or has a dislocated hip.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

A Re-Evaluation of Commonly Accepted Risk Factors for Developmental Dysplasia of the Hip: Population-Based Cohort Study

Andreas Roposch, MD, MSc, FRCS*; Evangelia Protopapa, MSc; Saboura Mahdavi; Olivia Málaga-Shaw; Yael Gelfer, MD; Ajay Asokan; Paul Humphries, MBBS; Fatima Jichi; Rumana Omar*
Great Ormond Street Hospital for Children, UCL Institute of Child Health, London, UNITED KINGDOM

†**LOE-Prognostic - Level I**

Purpose: To determine risk factors for DDH using newly developed diagnostic criteria based on international consensus.

Methods: In this population-based cohort study, 13,278 babies born at a secondary care center (2010-2013) received a standardized examination within 24 hours postpartum, in which we prospectively ascertained the presence of the common risk factors for DDH (breech, family history, etc). Infants exhibiting ≥1 factor were eligible and underwent ultrasound done at 8 weeks. Alpha angles were measured by surgeon/radiologist in consensus and blinded to risk factors and age. We analyzed the association of the risk factors and ultrasonographic DDH using criteria based on international consensus, which define alpha <55° at 8 weeks as DDH.

Results: Of 2,276 (17%) eligible newborns, 2,191 (96%) were included in the study. 2,101 (92%) infants completed follow-up with DDH present in 76 hips (3.6%). Two strong independent risk factors were identified using multivariate analysis (odds ratio): foot deformity warranting physiotherapy or orthopaedic followup (4.52, $p=0.019$), family history of DDH (4.42, $p<0.001$). Of 139 infants who had one or both of these risk factors, 45 (32%) had DDH. An abnormal hip examination was indicative of DDH (56.24, $p<0.001$).

Conclusion: In this prospective study, a foot deformity was associated with a four-fold increased risk for DDH as was a family history of DDH.

Significance: Newborns with a foot deformity warranting physiotherapy or orthopedic followup had an increased risk for DDH.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Association Between Referral Pattern and Prevalence of Developmental Dysplasia of the Hip (DDH) – A Prospective Cohort Study

***Benjamin Escott, MBBS, MSc**; Augusta Lloyd, MS; Lauren Paraison, BA; Chan-Hee Jo, PhD; Adriana De La Rocha, MS; Daniel J. Sucato, MD, MS*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Prognostic - Level II**

Purpose: The purpose of this study was to explore the association between referral complaint and the prevalence of DDH in a prospective cohort of children referred for DDH assessment at a tertiary pediatric institution.

Methods: This is an IRB approved prospective study of infants <12 months of age without teratologic abnormalities referred to a tertiary center for DDH assessment from 2008-2013. Baseline demographics and clinical factors were collected upon enrollment and prospective diagnostic and treatment data was collected regularly. The primary outcome of this study was a diagnosis of DDH confirmed by clinical exam and/or imaging study. The primary predictor was referring complaint submitted by the referring physician. Multivariable logistic regression was performed to evaluate the association between referring complaint and prevalence of DDH including demographics, risk factors and other possible DDH determinants in the multivariable model to control for baseline differences.

Results: 1,294 patients were enrolled in this study. The most common referring complaints were hip clicks (n=404), breech presentation (n=235) and clinical instability (n=169). 319 patients (24.7%) were diagnosed with DDH. The highest and lowest prevalence of DDH was amongst children referred with clinical instability as detected by the referring physician (37.3%) and asymmetric thigh folds (3.0%), respectively. Differences in the odds of DDH by referring complaint remained significant ($p<0.0001$) after controlling for female gender (OR=2.8; $p<0.0001$), firstborn (OR=1.4; $p=0.03$), singleton birth (OR=3.3; $p=0.01$) and family history of DDH (OR=1.6; $p=0.02$). Clinical instability (OR=4.3), hip clicks (OR=2.0) and abnormal imaging (OR=1.8) were all associated with a greater odds of DDH when compared to breech presentation.

Conclusions: The prevalence of true DDH following referral to a tertiary center is 25% and correlates to specific referring complaints and has important implications on practice management and resource utilization.

Significance: 75% of children referred to our institution for DDH assessment were ultimately cleared of the diagnosis. Certain referral complaints are associated with significantly lower rates of DDH (e.g. asymmetric thigh folds or breech presentation). Better education of primary care practitioners about risk factors and optimal timing of sonographic evaluation may reduce unnecessary referrals, costly investigations and family stress for infants suspected of having DDH.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Referral for Breech Presentation Does Not Correlate with a Diagnosis of DDH in Children Less Than One Year of Age

Daniel J. Sucato, MD, MS*; Augusta Lloyd, MS; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Erica Flores, RN MSN; Lauren Paraison, BA*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Prognostic - Level II**

Purpose: Breech presentation has been a risk factor for developmental dysplasia of the hip (DDH). However, there are no studies specifically analyzing whether this risk factor is accurate as a single predictor.

Methods: This is an IRB approved prospective analysis of 1,324 patients less than one year of age who were referred to a tertiary pediatric orthopaedic institution to evaluate for DDH between 2008-2013. Patients were divided based on birth presentation as reported by the family at the time of initial enrollment and only those who were breech were included in this analysis.

Results: There were 555 (423 females, 132 males) who had breech presentation at birth and were evaluated at an average of 7.3 weeks of age (range 0.50 - 49.4 weeks). Of the 555, 228 (41.1%) patients were referred solely because of breech presentation without any other physical findings. Of the remaining, the referral included: asymmetric thigh folds (n=3, 0.5%), hip click (n=83, 15.0%), loose hip (n=35, 6.3%), unstable hip (n=17, 3.1%), and abnormal ultrasound (n=108, 19.4%). A total of 427 patients (76.9%) had normal hips (by exam and ultrasound) and only 128 patients (23.1%) had the diagnosis of DDH defined as a Barlow positive hip (n=13, 3.3%), Ortolani positive hip (n=19, 3.4%), unstable hip (n=3, 0.5 %), or sonographic hip dysplasia (n=85, 15.3%). Of the patients with DDH, 74 (57.8%) had a Pavlik harness and 3 (2.3%) had an abduction orthosis. Patients who were specifically referred for breech presentation had a lower incidence of DDH than those who had associated findings (11.4% vs. 88.6%, $p<0.001$). Logistic regression demonstrated that for all breech patients, the likelihood of having a confirmed diagnosis of DDH was higher in patients who were referred for either left-sided or bilateral pathology (OR 2.231, $p=0.009$) or a complaint other than breech presentation (OR 3.075, $p<0.001$), those with a positive family history (OR 2.755. $p=0.002$) and those who presented at a younger age (OR 0.878, $p<0.001$).

Conclusion: Breech presentation alone predicted DDH in 11.4% of patients, however, additive risk factors that improve predictability are younger age at evaluation, left side or bilateral hip concerns and a positive family history.

Significance: Breech presentation alone predicted DDH in 11.4% of patients. Risk factors in addition to breech presentation (younger age, family history, left hips or bilateral) should be used to help determine the need for referral.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Residual Dysplasia After Treatment with Pemberton vs. Salter Osteotomy for DDH: Mean 10 Yr Follow-Up

Daniel J. Sucato, MD, MS*; Adriana De La Rocha, MS; Chester J. Donnally, III, BS; Brigid N. Maloney, MS; David A. Podeszwa, MD; Lori A. Karol, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level IV**

Purpose: The Pemberton acetabuloplasty (PA) and the Salter osteotomy (SO) are commonly used to treat the young patient with residual acetabular dysplasia (RAD) following treatment for developmental dysplasia of the hip (DDH). The limitations of these procedures osteotomy have not been widely reported. The purpose of this study was to compare the rates of RAD after treatment with a PA vs a SO.

Methods: This is an IRB approved retrospective analysis of 294 patients who were treated with either a PA or a SO for idiopathic DDH between 1980 and 2007 with a minimum of 5 years follow-up. Clinical and radiographic data were collected and RAD was defined as an LCEA or VCEA <20° or AI >15°. Groups were compared and multivariate analysis was used to identify risk factors for RAD at final follow-up with $p<0.05$.

Results: A total of 85 hips in 78 patients at a mean follow-up of 10.5 yrs (range, 5.0-20.1yrs) were included. There were 19 (23%) hips in the PA group and 66 (77%) hips in the SO group. There were no differences between the groups with respect to any risk factor for DDH as well as for rates of prior treatment with a Pavlik harness (11% vs 33%, p=0.052), closed reduction (63% vs 74%, p=0.344), or open reduction (32% vs 24%, p=0.520). The preoperative dysplasia, measured by the AI, was worse in the SO group patients (32.3° vs 28.1°, p=0.037). At final follow-up there were no differences between the PA and SO group with respect to LCEA (24.2° vs 27.2°, p=0.277) or VCEA (23.1° vs 21°, p=0.782), however the SO group patients had lower AI (8.9° vs 12.7°, p=0.029). Overall 22 (28.2%) patients had evidence of RD without a difference seen between the PA and SO groups (32% vs 24%, p=0.520). All patients in the SO group required an additional anesthetic for pin removal without a difference in subsequent pelvic osteotomies between SO and PA groups (11% vs 11%, p=0.992). Multivariate analysis did not identify any significant predictors for RAD.

Conclusion: The Pemberton acetabuloplasty and Salter innominate osteotomy effectively treat residual hip dysplasia in the young patient. The Salter innominate osteotomy however requires pin removal as the additional procedure not necessary with a Pemberton.

Significance: At a mean 10 yr follow-up, there were no differences in the rates of residual dysplasia after treatment with a Pemberton or Salter osteotomy, however Salter patients require subsequent pin removal.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

The Medial Dye Pool Revisited: Correlation Between Arthrography and MRI in Closed Reductions for DDH

Itai Gans, BS; ***Wudbhav N. Sankar, MD***
Children's Hospital of Philadelphia, Philadelphia, PA

†**LOE-Diagnostic - Level II**

Purpose: Closed reduction and spica casting (CR) is the standard treatment for patients with DDH who are too old for or have failed Pavlik treatment. Arthrography is used to assess adequacy of reduction, based in part on the width of medial dye pool (MDP). Little data exists, however, about the amount of MDP that is acceptable or how fluoroscopic estimates correlate to the actual anatomic position of the "reduced" femoral head. Our purpose was to determine this correlation and to explore the potential limits of acceptable MDP measurements.

Methods: We retrospectively reviewed a consecutive series of DDH patients treated by CR, spica, and immediate post-operative MRI over a 4-year period. We measured the MDP and femoral head area (FHA) on the best-reduced arthrographic image (in pixels). We then measured MDP and FHA on the post-operative mid-coronal MRI section (in mm) and in 3 planes (neutral, 30° anterior, and 30° posterior) on the mid-axial MRI section . Using the FHA measurement ratio, we converted fluoroscopic MDP measurements from pixels to mm and compared MDP values from both imaging modalities using Pearson's correlation (R). To provide useful data for establishing intraoperative thresholds, MDP was also expressed as a percentage of femoral head width to control for fluoroscopic magnification.

Results: 20 patients (18 females, 2 males; 23 hips) met inclusion criteria. 22 of the 23 hips were reduced on post-operative MRI; the one hip which remained dislocated was treated with open reduction and excluded from our analysis. One additional hip was located, but had significant widening on axial MRI. Pearson's tests comparing arthrography and coronal MRI demonstrated excellent correlation (R=0.73). Correlation was even stronger between arthrography and axial MRI (neutral R=0.73; 30° anterior R=0.81; 30° posterior R=0.81). The mean fluoroscopic MDP in the successful, concentric, CRs was 4.2% ± 5.8% of the femoral head width (range 0.6%-15.8%).

Conclusion: There is very strong correlation between MDP measurements on arthrography and immediate post-operative MRI in both coronal and axial planes. Based on our data, an arthrographic MDP between 0.6% and 15.8% of femoral head width always resulted in an excellent reduction, suggesting that a MDP of ≤16% of femoral head width may be a useful intraoperative criterion for determining the adequacy of closed reduction.

Significance: Medial dye pool (MDP) measurements on arthrography and immediate post-operative MRI strongly correlate, indicating MDP is a good measure of femoral head anatomic position within the acetabulum.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Age at Presentation Does Not Influence Failure Rate of Open Reduction of an Idiopathic Dislocated Hip

Chukwudi K. Chukwunyerenwa, MD; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Yavuz Saglam, MD; Megan Lynn Young, MD; David A. Podeszwa, MD; ***Karl E. Rathjen, MD***
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Prognostic - Level III**

Purpose: Patients who present at an older age with developmental dysplasia of the hip (DDH) are generally considered to be at a higher risk for poor outcomes. The purpose of our study was to compare the radiographic parameters of dysplasia and rates of failure, AVN, and degenerative changes following open reduction (OR) for DDH in 3 different age groups.

Methods: IRB-approved retrospective analysis of patients treated with an OR for idiopathic DDH, minimum of 5 year follow-up. Clinical risk factors and standard radiographic measurements of acetabular dysplasia were collected, including acetabular index (AI), lateral center edge angle (LCEA) and Tönnis grade. Evidence of avascular necrosis (AVN) was also recorded using the Bucholz method. Patients were classified into three groups based on the age at initial OR: Group 1, <2 years old treated with a Pavlik or closed reduction; Group 2, 2-4 years without prior treatment; Group 3, >4 years without prior treatment. Statistical analysis used chi-square and student t-tests, p-value of <0.05 considered significant.

Results: 216 hips in 177 patients (156 females/21 males) with average follow-up of 11.8 years (range, 5.0-22.5) were included (Group 1 - 115 hips, Group 2 - 68 hips, Group 3 - 33). Average age at OR was 2.4 years (range, 0.2-8.9). Pre-operatively, the AI was significantly lower in Group 1 (37.8°) compared to Group 2 (41.7°) and Group 3 (41.8°) (p=0.006). 18 patients (8.3%) had re-dislocation after their initial OR. The rate of re-dislocation after initial OR was similar between groups (7.8% vs 7.4% vs 12.1%, p=0.689). 58 hips (26.9%) required subsequent pelvic osteotomies for residual dysplasia. There were no differences between groups undergoing subsequent pelvic osteotomy (33% vs 22.1 vs 15.2%, p=0.0693). At final follow-up, there were also no significant differences between the groups with respect to LCEA (21.6° vs 23.0° vs 22.5°, p=0.589) or AI (18.3° vs 15.8° vs 14.6°, p=0.456). 63 patients (29.2%) had radiographic evidence of AVN. Multivariate analysis did not identify any significant risk factors for re-dislocation or AVN.

Conclusion: A delay in presentation of an idiopathic dislocated hip does not increase the risk of re-dislocation, AVN of the femoral head or residual acetabular dysplasia at a minimum of 5 year follow-up.

Significance: Patients who have failed closed methods may be as difficult to treat as patients who present at an older age. This could be related to "disease severity" and should be considered when treating these patients.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Patient Factors Associated with Delayed Diagnosis of Developmental Dysplasia of the Hip

Antoinette W. Lindberg, MD*; Klane K. White, MD; Viviana Bompadre, PhD; Amanda Celest Roof, MD; Emma K. Satchell, BA*
Seattle Children's Hospital, Seattle, WA

†**LOE-Prognostic - Level III**

Purpose: Left untreated, developmental dysplasia of the hip (DDH) can result in early degenerative disease in the hip and lumbar spine. Early detection and treatment of DDH is important for preventing such long-term disabilities. Previous studies have determined that disparities exist in pediatric specialty care among different racial, ethnic, and socioeconomic backgrounds. This study aims to identify factors that may affect timely medical attention for DDH.

Methods: Charts of patients seen for DDH between July 2006 and June 2011 were reviewed. Patients who were initially treated elsewhere, who normalized within the first 12 weeks of life without intervention, or who had teratologic dislocations were excluded. Variables collected included race, ethnic group, home language, insurance type, median income for zip code, family history, birth presentation, age, and laterality. The patients were divided into two groups: early (first seen before reaching six months of age) and late presenting patients (seen after six months of age).

Results: 457 patients (82.9% female, 17.1% male) were identified. There were 378 early presentations and 79 late presentations. Bivariate analysis determined the average income for early presentations was significantly higher than for late presentations ($70,769 vs. $61,591, p<.001). Non-whites were more likely to present late than whites (65% vs. 45%, respectively, p=.004). Non-English speakers were significantly more likely to present late than early (20% vs. 8%, p=.003). Late presentations were significantly more likely to be vertex than early presenters (85% vs.41%, p<.001). Patients with bilateral DDH (57%) are less likely to present late than those with unilateral DDH (p<.001). Patients with public insurance (25%) were significantly more likely to present late (p=.001). In the multivariate regression analysis, only lack of family history (p=.005) and vertex birth presentation (p<.001) were significant predictors of late presentation. The multivariate analysis may miss significant relationships due to lost data points. Similarly, bivariate analysis does not control for confounds.

Conclusion: Patients who do not speak English, who are non-white, who have public insurance, or who have a lower median income may have significant barriers that prevent them from accessing treatment in a timely manner. Our findings also suggest that current screening practices may be effectively capturing patients with known risk factors but more rigorous screening may be needed for patients without family history or breech presentation to prevent a missed diagnosis.

Significance: The factors identified with an association with late presentation can be targeted for improvements in outreach and screening measures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Efficacy and Satisfaction Comparing Two Braces in the Treatment of DDH: A Randomized Clinical Pilot

Virginia F. Casey, MD*; J. Michael Wattenbarger, MD; Christian Clark, MD*
OrthoCarolina, Charlotte, NC

†**LOE-Therapeutic - Level II**

Purpose: Pavlik harness has been used successfully in our institution for the intial treatment of developmental dysplasia of the hip for many years. We have begun using the plastazote abduction brace (brace) for cases in which the Pavlik (harness) failed with success. Anecdotally the parents reported satisfaction with the ease of use and comfort of the Plastazote brace. The purpose of this study was to pilot the use of the plastazote brace for the initial treatment of DDH and to study the efficacy of the brace and parent satisfaction compared with Pavlik treatment in a randomized trial.

Methods: 29 infants were enrolled in this IRB approved pilot randomized clinical trial all with clinical instability. They were randomized in a 1:1 fashion to either a harness or a brace. There were two infants with Ortolani positive hips in each group. Success was defined as resolution of instability and normalization of ultrasound and radiographs. Patient/parent satisfaction was measured by a questionnaire at the 3-4 week visit and the six month visit.

Results: Eleven of 14 (79%) patients were successfully treated with the brace and 14 of 15 (93%) patients were successfully treated with the harness. Of the three brace failures, one was then subsequently successfully treated with the harness. The one harness failure also failed brace treatment. Both the brace and the harness were well tolerated by the parents and infants. One infant had a femoral nerve palsy with the harness which resolved. There were no complications in the brace group. The caregivers report that the brace was easier to clean than the harness and there were less concerns about skin irritation with the brace.

Conclusions: Surprisingly, we found more failures in the initial treatment of DDH with the Plastazote abduction brace compared to the Pavlik harness. This difference in efficacy in treatment could certainly be due to the small sample size (a type 2 error), however, given the results of this randomized pilot we have decided not to pursue a larger trial.
There was a trend for the parents to prefer the abduction brace for ease of cleaning and less skin irritation..

Significance: This randomized pilot study shows a trend toward increased effectiveness by the Pavlik harness compared to the Plastazote brace though parents prefer the Plastazote brace in the treatment of DDH.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Long-Term Outcomes of Operative and Nonoperative Treatment of Congenital Coxa Vara

David W. Roberts, MD; *Yavuz Saglam, MD; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Harry Kwang-Woo Kim, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level III**

Purpose: Little has been reported on long-term outcomes of treatment in congenital coxa vara (CCV). This study sought to validate commonly used radiographic parameters, and assess outcomes after operative and non-operative treatment in CCV with mean follow-up of 10 years.

Methods: Retrospective review was performed of all patients with CCV at our institution from 1980-2012. Those able to return for additional follow-up were assessed with modified Harris Hip Score (mHHS) and gait analysis. Neck-shaft angle (NSA), head-shaft angle (HSA), and Hilgenreiner-epiphyseal angle (HEA) were assessed for interobserver reliability with intraclass correlation coefficients (ICC). Multivariate analysis was performed to identify risk factors for recurrence after surgery ($p<0.05$).

Results: There were 47 hips in 33 patients. Age was 5.4±4.8 years at presentation. Follow-up was 10.0±5.4 years (range 2-28 years). Valgus proximal femoral osteotomy was performed 27 patients, most commonly fixed with a blade plate (41%) or hip screw (41%). Interobserver reliability was excellent for HEA (ICC 0.984) and NSA (ICC 0.897), but only very good for HSA (ICC 0.791). Operative patients had more severe deformity initially than non-operative patients (NSA 90° vs. 121°, $P<0.0001$; HEA 68° vs. 35°, $P<0.0001$), but similar radiographic outcomes at follow-up (NSA 121° vs. 120°, $p=0.20$; HEA 31° vs. 45°, $p=0.36$). Many operative cases had abnormal growth in femoral neck length (56%) and most showed some progressive decline of NSA over time (81%, average -1.4° per year). Repeat osteotomy for recurrence was required in 6 cases (22%), but multivariate analysis did not identify any significant predictors. Complications included 2 cases of AVN (7%) and 2 cases of fixation failure (7%). All patients returning for gait analysis (n=8) had abnormal gait patterns, with varying degrees of impairment in hip function (mHHS mean 81.7, range 63.8-90.2).

Conclusion: HEA and NSA are the most reliable measurements of proximal femoral deformity in CCV. Abnormal proximal femoral growth is common in CCV, especially in severe cases requiring operative treatment. Many patients with CCV have persistent gait abnormalities at long term follow-up despite "satisfactory" radiographic outcomes.

Significance: This series of 47 hips with CCV showed satisfactory radiographic outcomes, but persistent abnormal gait and functional impairments at mean 10 year follow-up.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Severity of Dysplasia and Patient Activity Predict Age of Presentation for Periacetabular Osteotomy for Symptomatic Hip Dysplasia

Travis Matheney, MD*; Young Jo Kim, MD, PhD; Ira Zaltz, MD; John C. Clohisy, MD; David Zurakowski PhD; Michael B. Millis, MD; The ANCHOR Study Group*
Boston Children's Hospital, Boston, MA

†**LOE-Prognostic - Level III**

Purpose: The age when patients present for treatment of symptomatic hip dysplasia (DDH) with periacetabular osteotomy (PAO) varies widely. Factors influencing age at surgery have been suggested to include: 1) severity of dysplasia and 2) pre-existing activity level; however, this has yet to be confirmed. The purpose of this study was to determine whether severity of dysplasia and activity level are independent predictors of age of presentation for PAO.

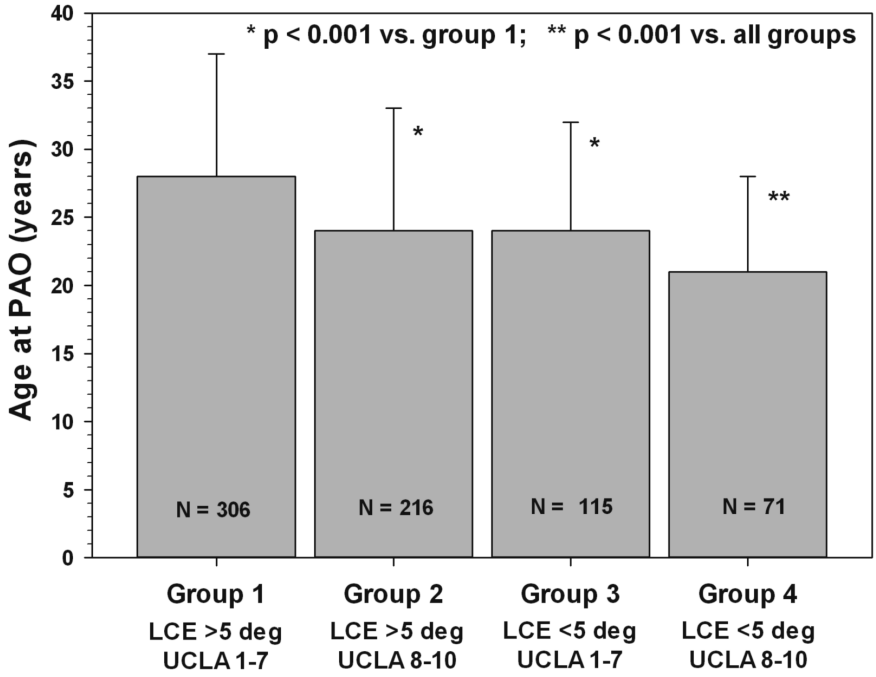
Methods: A retrospective, IRB approved review of prospectively collected data from a multi-center study group identified 756 PAOs performed for DDH. Demographics considered included age at surgery, BMI, and duration of symptoms (average 1-3 years). Severity of DDH was assessed by x-ray measurement of lateral and anterior center edge angles (LCE and ACE) and acetabular inclination (AI). Activity level was assessed with the UCLA score categorized into minimally (1-4), moderately (5-7) and highly active (8-10). 708 patients (94%) had information on all measures. Spearman correlations and t-tests were used for univariate analysis. Multivariate analysis of variance (ANOVA) was applied to determine independent predictors of age at PAO.

Results: Univariate analysis indicated that age at presentation for PAO correlated with LCE angle and ACE angle ($p<0.001$), UCLA score ($p<0.001$), and BMI ($p=0.04$). Since LCE and ACE angles were highly correlated (rho = 0.61, $p<0.001$), LCE angle was used to define severity of DDH with three groups: mild (25-16 deg), moderate (5-15 deg), or severe (<5 deg). Multivariate linear regression confirmed that high UCLA score and severe hip dysplasia were independent predictors of age at PAO ($p<0.001$**, see figure**). More active patients and/or those with severe dysplasia presented for PAO at a younger age.

Conclusion: Patients with severe DDH and higher activity level develop symptoms and present for periacetabular osteotomy at younger ages. On average, patients experience hip pain between 1-3 years prior to treatment. To the best of our knowledge this has not been previously reported.

Significance: Results from this multi-center study confirm clinical suspicion that more severe dysplasia and higher activity level are associated with earlier presentation for symptomatic DDH.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.



♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Total Hip Arthroplasty in Patients 21 and Younger Using Highly Cross Linked Polyethylene: Excellent Survivorship At 5 Years

Frank C. Bohnenkamp, MD; Gail Pashos; Adam Sassoon, MD; Geneva Baca, BA;
John C. Clohisy, MD
Washington University, St. Louis, MO

†**LOE-Therapeutic - Level III**

Purpose: In an effort to increase mental and physical health of adolescents the World Health Organization published recommendations of physical activities that are moderate to vigorously intense for a minimum of 1 hour daily. Many adolescents afflicted with endstage hip disease are unable to meet the minimum recommendations. The optimal treatment modality restoring function and eliminating pain has yet to be defined. One option utilized is THA yet remains controversial due to paucity of known survivorship in this population. This study evaluates mid-term survivorship of THA using HCLPE in young/adolescents with end stage hip disease.

Methods: We queried our institution's joint repository of 7,456 hips to identify patients 21 years of age and younger who underwent THA using HCLPE from 2000-2009. Patients reported outcomes collected pre and post-operatively were analyzed at midterm followup using student's t-test. Data collection included modified Harris Hip Score (mHHS), Western Ontario McMaster Universities Osteoarthritis Index (WOMAC), and UCLA activity score. Complications and revisions were recorded.

Results: Fifty-five THA's were performed in 25 females and 17 males with a mean age of 17.5 (11-21) using a HCLPE bearing surface. Mean follow-up was 60 months (26-95). The most common indication for THA was osteonecrosis. All acetabular components were uncemented, 53 femoral components were uncemented, and 2 femoral components were cemented. One patient had revision at 71 months for aseptic loosening. The mean HHS increased from 41 to 78, the mean UCLA score increased from 2.8 to 5.9. All WOMAC subscores increased, pain 43-77, stiffness 40-68, and function 42-76, $p<0.001$.

Conclusion: In this cohort only 1 patient required revision for aseptic loosening at midterm follow up. This patient cohort demonstrated significant functional impairment preoperatively and showed improvement in pain and function following surgical intervention. Despite these gains, their average postoperative activity level remained moderate, which may partly contribute to increased prosthetic survival. Continued concern for decreased longevity in this patient population is warranted; however, these results are encouraging. Further longitudinal data is needed to determine the long-term survivorship of THA in this cohort.

Significance: This study is one of the larger clinical series to date, reporting midterm follow-up of uncemented THA in the extremely young, using HCLPE as a bearing surface.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Periacetabular Osteotomy for the Treatment of Acetabular Dysplasia Secondary to Charcot-Marie-Tooth Disease is Associated with Similar Clinical Improvement But Higher Complication Rate When Compared to Developmental Dysplasia of the Hip

Eduardo N. Novais, MD*; Young Jo Kim, MD, PhD; Patrick M. Carry; Michael B. Millis, MD*
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level III**

Purpose: Hip dysplasia affects 10% of patients with Charcot-Marie Tooth disease. **A**cetabular dysplasia and hip subluxation are more severe in Charcot-Marie-Tooth hip dysplasia (CMTHD) when compared to developmental dysplasia of the hip (DDH). The Bernese periacetabular osteotomy (PAO) is commonly performed for the treatment of symptomatic acetabular dysplasia secondary to DDH. However there is limited evidence to support PAO in the treatment of CMTHD. The purposes of this study were to compare clinical, functional and radiographic outcomes of PAO among patients affected by hip dysplasia secondary to Charcot-Marie-Tooth versus patients affected by DDH.

Methods: After IRB approval, a retrospective matched cohort study based on age and gender was used to compare the outcomes of PAO in patients with symptomatic hip dysplasia secondary to Charcot-Marie-Tooth disease versus classic DDH. Clinical and functional outcomes were assessed by the Harris Hip Scores (HHS). Occurrence of post-operative complications and radiographic correction were compared in the two groups.

Results: A total of 89 hips (31 CMTHD; 58 DDH) were included in the analysis There was no difference in gender (p=0.3551), age at surgery (p=0.4187), BMI (p=0.0873), history of a previous hip surgery (p=0.0738) or duration of follow-up (p=0.1365) between the groups. The average follow-up was 5.3 years (range 2-16 years). Preoperatively the HHS was significantly [p=0.0338] lower in the CMTHD-group compared to the DDH-group. Following surgery, the HHS improved in both groups and there was no significant difference [p=0.5383] in HHS scores between the two groups. The odds of a complication requiring modification to postoperative clinical care were significantly higher in the CMTHD group compared to the DDH group [OR: 3.22, 95% CI: 1.09 to 9.53; p =0.0342]. Significant [P<0.05] improvements in the radiographic measures of hip dysplasia (ACEA, Tönnis angle and LCEA) were achieved in both groups after surgery. Tönnis arthritis grade was significantly worse in the CMTHD group both pre (p=0.0046) and post-surgery (p<0.0001).

Conclusion: At a mean of 5 years, the results of PAO for correction of CMTHD are encouraging and comparable to DDH. Radiographic improvement, improved function and decreased pain after PAO may be expected in CMT patients with symptomatic hip dysplasia undergoing PAO. However, patients with CMTHD are at a significantly higher risk for complications.

Significance: Overall, based on evidence of improved radiographic correction and improvements in self-reported hip function and pain, the current study supports benefits of the Bernese periacetabular osteotomy in subjects with Charcot Marie Tooth Hip Dysplasia.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

♦ Final Fusion After Growing Rod Treatment for Early Onset Scoliosis: Is It Really Final?

Connie Poe-Kochert, CNP; Claire Shannon, MD; Jeff B. Pawelek, BS; George H. Thompson, MD; ***Christina K. Hardesty, MD****; David S. Marks, FRCS; Behrooz A. Akbarnia, MD; Richard E. McCarthy, MD; John B. Emans, MD*
Rainbow Babies and Children's Hospital, Cleveland, OH

†**LOE-Therapeutic - Level IV**

Purpose: "Final fusion" is commonly felt to be the end point for early onset scoliosis (EOS) patients with growing rod (GR) treatment. But is it? The purpose of this study was to determine the incidence and cause of reoperation after final fusion for GR patients with EOS.

Methods: An IRB approved, multicenter, EOS database was queried to identify GR patients with a minimum of 2 years of follow-up after final fusion. All reoperations were recorded as well their causes. Reoperation was defined as a return to the operating room for any reason related to the EOS.

Results: There were 119 potential patients in which 95 (80%) met the inclusion criteria (34 neuromuscular, 30 syndromic, 23 idiopathic, and 8 congenital patients). The mean age at final fusion was 12 years (range 8 to 18 years) and the average follow-up after final fusion was 4 years (range, 2 to 10 years). Nineteen patients (20%) had reoperations: 8 syndromic, 6 neuromuscular, 5 idiopathic and no congenital patients. The mean time to first reoperation after final fusion was 2 years (range, 11 days to 7.4 yrs). Thirty-eight procedures were performed on theses patients: 15 for infection (7 debridement, 4 skin breakdown, 4 instrumentation removal), 8 for failure of instrumentation (5 rod fractures, 3 distal hook or screw pullout), 7 for painful or prominent implants, 2 procedure each for progressive coronal deformity, pseudoarthrosis, sagittal decompensation and one procedure each for neurological condition (chiari decompression) and thoracoplasty. The mean number of reoperation for the 19 patients was 2 (range, 1 to 7 reoperations). We did not attempt to determine the current results of these additional procedures.

Conclusions: A higher than anticipated percentage of EOS patients with GR treatment required reoperation after final fusion. Long term follow-up after final fusion is therefore necessary to determine final results. Further investigation must be done to determine methods for preventing the need for reoperation after final fusion.

Significance: Reoperation after final fusion has not been studied before. Parents and patients need to be advised about the possibility of further surgery after final fusion and the importance of long term follow-up.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Pulmonary Outcomes of VEPTR Expansion Thoracoplasty in Early Onset Scoliosis

***Vincent F. Deeney**; Ozgur Dede, MD; Etsuro K. Motoyama; Charles I. Yang, BS, MD, MS; Rebecca Mutich, BS; Austin Bowles, MS*
Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA

†**LOE-Therapeutic - Level IV**

Purpose: VEPTR expansion thoracoplasty is a common method used to manage thoracic insufficiency syndrome (TIS). Literature is scarce on the effects of this technique on pulmonary function. The aim of this study is to report the mid-term results of VEPTR expansion thoracoplasty (ETP).

Methods: Between 2002 and 2008, 21 children with TIS underwent ETP with VEPTR application and had complete chart data, pre-operative and follow-up radiographs and PFTs acquired at index implantation, first expansion and last expansion. Pulmonary function tests (PFTs) with forced and passive deflation techniques developed for children under general anesthesia were performed prior to index and each expansion surgery, under the same anesthesia. Pulmonary and radiographic parameters were analyzed longitudinally.

Results: Average follow up was 6 years and average age at implantation was 4.8 years. The mean N of expansion surgeries per patient was 11, mean interval was 6.4 months. There were no major complications.

The mean pre-treatment Cobb angle was 80 and mean local kyphosis angle was 57 degrees (7-107 degrees). The initial coronal correction of was maintained at the final follow up (67 degrees), however local kyphosis angle deteriorated insignificantly (66 degrees)($p>0.05$). The average gain in T1-12 was 20.5 mm (3.1 mm/year) and in T1-S1 was 29 mm (4.6mm/year) during the treatment period.

The SAL ratio improved from 0.77 to 0.87 ($p<0.0001$) and FVC increased from a mean of 0.65L to 0.96L ($p<0.0001$). However, % predicted for height (and arm span) decreased from 86% (77%) to 64% (58%), respectively, as the children gained an average of 23 cm height. Respiratory system compliance (Crs/kg) decreased from 1.4 to 0.86 (by 38.6%)($p<0.0001$). A comparison of the largest two groups (congenital versus syndromic) showed no differences in radiographic or pulmonary parameters.

Conclusion: VEPTR thoracoplasty resulted in modest correction of Cobb angle with no significant change in sagittal alignment. FVC increased with a moderate increase in radiographic SAL. However, these increases did not keep up with the child's overall growth. Respiratory compliance decreased over time.

Significance: This study provides an intermediate term follow up of VEPTR expansion thoracoplasty in early onset scoliosis and effects on the pulmonary function.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Delayed VEPTR Implantation Results in Similar Radiographic Outcomes with Fewer Complications

Vidyadhar S. V. Upasani, MD*; John B. Emans, MD; John T. Smith, MD; Randal R. Betz, MD; John (Jack) M. Flynn, MD; Michael P. Glotzbecker, MD*
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level III**

Purpose: Our purpose was to analyze the risks and benefits of early VEPTR implantation (less than 3 years of age) compared to delayed intervention (3-6 years of age). We hypothesized that early intervention may facilitate thoracic spine growth and symmetric chest growth. However, later intervention has the possible advantages of fewer surgical lengthenings, better implant anchors and fewer complications.

Methods: A multi-center prospective database of patients treated with the VEPTR device was retrospectively reviewed. 71 patients with minimum 5-year follow-up were included in the study. 37 patients were in the under 3 group and had an average follow-up of 7.6±1.7 years (Group 1). 34 patients were in the 3-6 age group and had an average follow-up of 8.0±2.2 years (Group 2). Patients in both groups had similar diagnoses. Radiographs from the pre-operative, immediate post-operative and most recent follow-up visits were reviewed to determine coronal plane deformity, hemithorax height and width dimensions and change in T1-T12 height over time. Change in T1-T12 height over time and across age groups was assessed using a piecewise linear mixed model. The number of complications per lengthening was analyzed across age groups using poisson regression analysis for rate data.

Results: Pre-operative and most recent major Cobb angles were not significantly different between the two groups (66±22° and 60±20° vs. 63±19° and 57±23°, respectively) (p=0.38). Thoracic spine height increased from 11.6±2.4cm to 15.7±3.6cm in Group 1 versus 13.8±2.5cm to 17.7±4.0cm in Group 2. The change in T1-T12 was significantly correlated to the number of lengthenings (P<0.001). However, there was no difference between age groups (P=0.55). Right and left hemithorax height and width measurements as well as thoracic depth measurements also increased over time, however no differences were found between age groups (p=0.11, p=0.79 and p=0.11, respectively). 115 complications occurred in Group 1 compared to 68 complications in Group 2. The number of complications per lengthening was significantly different between the two age groups. Subjects who were 3-6 years of age had 41% fewer complications per lengthening compared to subjects who were less than 3 years old (IRR=0.59, 95% CI=(0.44-0.80), P<0.001).

Conclusion: VEPTR treatment resulted in similar radiographic outcomes in terms of deformity control and thoracic growth in both age groups. Complications such as implant failure, device migration, deep infections and wound dehiscence were significantly more prevalent in patients who were younger at initiation of surgical treatment.

Significance: Non-surgical modalities to control deformity may be considered to delay VEPTR implantation as radiographic outcomes are similar and complications rates were lower in the older patient population.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

♦ Traditional Growing Rods Versus Magnetically Controlled Growing Rods in Early Onset Scoliosis: A Case-Matched Two-Year Study

Behrooz A. Akbarnia, MD*; Kenneth M.C. Cheung, MD; Gokhan H. Demirkiran, MD; Hazem B. Elsebaie, MD; John B. Emans, MD; Charles E. Johnston II, MD; Gregory M. Mundis, MD; Hilali H. Noordeen, FRCS; Jeff B. Pawelek, BS; David L. Skaggs, MD; Paul D. Sponseller, MD; George H. Thompson, MD; Muharrem Yazici, MD; Growing Spine Study Group*
San Diego Center for Spinal Disorders, La Jolla, CA

†LOE-Therapeutic - Level III

Purpose: The purpose of this study was to compare two-year outcomes of magnetically controlled growing rods (MCGR) and traditional growing rods (TGR) for the treatment of early onset scoliosis using a case-matched series.

Methods: MCGR patients were selected based on the following criteria: ≤10 years old, major curve ≥30°, T1-T12 <22 cm, no previous spine surgery and minimum 2-year follow-up. 12 of the 17 qualified MCGR patients had complete data available for analysis. Each MCGR patient was matched to a TGR patient by etiology, gender, single vs. dual rods, pre-op age (+/-10 months) and pre-op major curve (+/-20°). One male MCGR patient was matched to a female TGR patient since a male-male match could not be found. Annual T1-S1 growth was the change in spinal height from post-index surgery to the latest follow-up divided by the time interval.

Results: There were 4 neuromuscular, 4 syndromic, 3 idiopathic and 1 congenital patient in each group. MCGR patients had a mean pre-op age of 6.8 years, which was similar to TGR patients. Mean post-op follow-up was greater for the TGR patients (4.1 vs. 2.5 years; p=0.01). Major curve correction was not significantly different between the groups at any time point (Table 1). TGR patients had significantly greater overall gain in T1-S1 compared to MCGR patients (p=0.01). Annual T1-S1 growth was greater for TGR patients (11 vs. 7 mm/year) but this difference did not reach statistical significance. MCGR patients had 16 open surgeries and 137 non-invasive lengthenings while the TGR cohort had 78 open surgeries including 49 surgical lengthenings. 2/12 MCGR patients had 4 revisions, and 8/12 TGR patients had 17 revisions (p=0.05).

Table 1. Mean major curve and T1-S1 spinal height measurements at each study time point.

		Pre-op (mean)	Initial Post-op (mean)	Latest Follow-up (mean)	Pre to Post Δ (mean)	Post to Latest Follow-up Δ (mean)	Pre to Latest Follow-up Δ (mean)
Major Curve	**MCGR**	59°	32°	38°	43%	-25%	35%
	TGR	60°	31°	41°	47%	-27%	32%
	p	0.5	0.8	0.7	0.8	0.7	0.6
T1-S1 Spinal Height	**MCGR**	270 mm	295 mm	307 mm	18 mm	15 mm	38 mm
	TGR	264 mm	311 mm	347 mm	41 mm	36 mm	77 mm
	p	0.6	0.06*	0.04*	0.04*	0.2	0.01*

*The significance level was set at 0.1 for all analyses.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Conclusions: There was no significant difference in major curve correction between groups. TGR patients had a greater overall increase in spinal height; however, annual T1-S1 growth was not significantly different between the two groups. MCGR patients had 62 fewer open surgical procedures than TGR patients, and TGR patients experienced a significantly higher rate of revision surgery.

Significance: Major curve correction was similar between MCGR and TGR groups. Spinal length gain was greater in TGR patients, yet MCGR patients had 62 fewer surgeries and less follow-up.

Growing Spine Study Group received support from Growing Spine Foundation for this study.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

♦ Case-Matched Comparison of Spinal Fusion versus Growing Rods for the Surgical Treatment of Progressive Idiopathic Scoliosis in Skeletally Immature Patients

*Jeff B. Pawelek, BS; **Burt Yaszay, MD**; Stacie Nguyen, MPH; Peter O. Newton, MD; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD; Harms Study Group; Growing Spine Study Group*
Rady Children's Hospital, San Diego, CA

†LOE-Therapeutic - Level III

Purpose: Scoliosis surgeons face two distinct treatment options for progressive idiopathic scoliosis in skeletally immature patients: spinal fusion (SF) or growth-friendly surgery such as growing rods (GR). Our objective was to compare treatment outcomes of these two surgical techniques using a case-matched series.

Methods: A multicenter EOS database query identified 11 GR patients who met the following criteria: 1) idiopathic etiology; 2) 9-11 years old at initial surgery; 3) major thoracic curve; and 4) underwent "final" spinal fusion. A second multicenter AIS database was used to identify SF patient matches. All SF patients had major thoracic curves, pre-op open triradiate cartilage and minimum 2-year post-op follow-up. A one-to-one patient match was performed based on pre-op age, major curve size and location of major curve apex. All x-rays were visually compared to confirm similar curve patterns. Latest follow-up was analyzed after final fusion for GR patients.

Results: Mean pre-op age was 10.8 years (range, 10.0-11.6 years) for SF patients and 10.1 years (range, 9.2-11.4 years) for GR patients. GR patients had an average of 2.4 lengthenings prior to final fusion and longer total follow-up compared to SF patients (5.6 years vs. 2.5 years). Initial curve correction was significantly greater for SF patients after fusion compared to GR patients after initial GR surgery (71% vs. 38%; p=0.004). However, overall curve correction at latest follow-up was not statistically different (58% vs. 45%; p=0.110). While pre-op T1-S1 spinal height was similar between SF and GR patients (p=0.145), GR patients had a significantly greater percent gain in spinal height compared to SF patients from pre-op to latest follow-up (24% vs. 13%; p=0.01). GR patients also had a greater percent gain in T1-T12 thoracic height from pre-op to latest follow-up, but this difference was not significant (18% vs. 13%; p=0.74). GR patients had more levels instrumented compared to SF patients at initial surgery and at latest follow-up (12.0 vs. 10.5 levels and 13.1 vs. 11.1 levels, respectively). 5 of 11 (45%) GR patients required a total 10 revision surgeries, and 2 of 11 (18%) SF patients each required one revision surgery.

Conclusion: In this case-matched series, SF patients had slightly greater curve correction yet significantly less percent gain in spinal height compared to GR patients. The surgical revision rate for GR patients was more than double the revision rate of SF patients (45% vs. 18%).

Significance: Late juvenile patients with progressive idiopathic scoliosis who underwent growing rod surgery had similar curve correction, additional gain in spinal height, and more than double the rate of revision surgery compared to case-matched patients who had a definitive spinal fusion procedure.

Harms Study Group received support from DePuy Synthes Spine for this study.
Growing Spine Study Group received support from Growing Spine Foundation for this study.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

A Prospective Multicenter Study of Neuromonitoring for Cerebral Palsy Scoliosis: The Nature and Rate of Alerts and Recovery of Changes

Suken A. Shah, MD*; Paul D. Sponseller, MD; Peter O. Newton, MD; Burt Yaszay, MD; Firoz Miyanji, MD; Amer F. Samdani, MD; Mark F. Abel, MD; The Harms Study Group*
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

†**LOE-Prognostic - Level I**

Introduction/Purpose: The usefulness of intraoperative neurophysiologic monitoring in scoliosis surgery for patients with CP is questioned by some. The rate, severity and outcome of neurological injuries during surgery in these patients are not well reported. The purposes of this study were to 1.) study the feasibility and reliability of intraoperative neurophysiologic monitoring (IONM) in patients with scoliosis due to CP and 2.) determine the rate, nature and outcome of neurological monitoring alerts in spinal deformity surgery in these patients.

Methods: A prospectively collected, multicenter database of 197 children with CP and scoliosis who underwent surgery was reviewed; 172 had IONM attempted, and of those with complete records, 86% had good or fair potentials that were useful during surgery, and 14% had IONM attempted and abandoned due to poor baseline signals.

Results: Seventeen patients (10%) had a TcMEP alert during surgery; the most common triggering events were: traction (5), intraoperative hypotension (3), positioning of the patient (3), curve correction/placement of rods (3), placement of screw, hook or wire (2), tightening of wire (1). All intraoperative events were detected by IONM with a decrease from baseline MEP and 11/17 had a decrease in SSEP. The treatment was typically a surgical pause, elevation of BP, release of traction, reduction of correction, removal of screw/wire, change in positioning or administration of methylprednisolone. All changes were reversible with interventions from immediate to 90 minutes later. No correlation to curve size, apex or EBL could be identified with the numbers available. The patients who had IONM attempted and abandoned due to poor baseline signals were typically severely involved spastic quadriplegic patients with MR. Traction was implicated in 5 IONM alerts and 7 instrumentation-related alerts and corrective maneuvers resulted in recovery to baseline signals in all patients.

Conclusions: IONM was feasible in 86% and TcMEP provided reliable information regarding an impending neurologic deficit. The rate of neurologic monitoring alerts in this population of patients with CP undergoing spinal deformity surgery for scoliosis was 10%. When corrective action was taken for alerts, recovery of potentials was noted in all patients.

Significance: Monitoring of MEP and SSEP in these patients undergoing spinal deformity is feasible and useful to detect impending neurologic deficits. IONM should be utilized when possible in scoliosis surgery even in patients with CP to detect neurological adverse events. In view of the increased incidence of neurologic monitoring alerts, the difficulty of monitoring, patient variability, and potential for recovery similar to preoperative status, the surgeon and family should come to explicit agreement preoperatively for a course of action if changes were to occur.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Genetic Test for Progression of Adolescent Idiopathic Scoliosis: Clinical Experience versus Historical Controls

Keith P. Mankin MD
Raleigh Orthopaedic Clinic, Raleigh, NC

†**LOE-Prognostic - Level III**

Purpose – Most mild scoliotic curves are stable, but uncertainty in their behavior necessitates frequent follow-up and radiographs. A salivary genetic test (ScoliScore™) provides prognostic information as to the progressive nature of a curve within certain ages and magnitudes. In this study, patients who had ScoliScore testing were compared with historical controls for rate of progression, advancement to treatment, number of office visits and radiographs in order to determine the clinical impact of ScoliScore.

Methods – 152 patients aged 9 – 13 with scoliosis ≤ 25° were tested with ScoliScore. Records for 75 patients with similar age and curvature but no ScoliScore were also reviewed. Initial Cobb angles and those at most recent visit were recorded for each patient, as well as number of clinic visits, x-rays and the progression to treatment. All families gave consent and assent for use of the data.

Results – Of the 152 ScoliScore patients, 83 were low risk (55%), 51 were intermediate (12%) and 18 high risk (33%). The low risk group had significantly lower average curve progression (1.8°) vs. high (12.2°) and intermediate (5.8°) and vs. controls (5.4°). In the high risk group, 94.4% progressed more than 10° vs. 1.2% in the low risk. None of the low risk group required bracing, vs. 21.6% of the intermediate and 72.2% of the high risk. 24 of 152 (15.8%) ScoliScore patients were ultimately braced, vs. 15 of 75 controls (20%). At time of data collection, no ScoliScore patient needed surgery vs. 2.7% of the controls.

The ScoliScore group had fewer average clinic visits (3.6) and x-rays (2.7) than controls (4.0 and 3.9 respectively). The low risk group had significantly fewer of x-rays (1.6) than controls and either of the other ScoliScore cohorts.

Conclusion – The study confirms the prognostic effectiveness and the clinical impact of ScoliScore. High risk patients had greater progression and required treatment more frequently than low risk or controls.

Low risk patients had significantly less curve progression and treatment. They also required significantly fewer x-rays and clinic visits than high risk or controls.
No ScoliScore patient required surgical intervention in this study. It is possible that the early prognostic knowledge allowed more effective early brace intervention, but this remains to be shown definitively.

Significances – The study demonstrates that prognostic screening reduces the number of x-rays in adolescent scoliosis. It also confirms the utility of the test in determining the behavior of a curve.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Effectiveness of Spinecor Brace versus Rigid Brace for Treatment of Adolescent Idiopathic Scoliosis: A Prospective Randomized Controlled Trial Using the Scoliosis Research Society Standardized Criteria

Jing Guo; Tsz Ping Lam, MBBS, FRCSE; Man Sang Wong, CPO, PhD;
***Bobby Kin Wah Ng, MD**; Kwong Man Lee; King Lok Liu; Alec Lik Hang Hung;*
Fiona Wai Ping Yu; Yong Qiu; Jack C-Y Cheng, MD
Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Shatin, HONG KONG

†**LOE-Therapeutic - Level II**

Purpose: SpineCor is a relatively innovative flexible bracing system for non-operative treatment of adolescent idiopathic scoliosis (AIS). However, the effectiveness of SpineCor remains controversial. The purpose of the randomized controlled trial was to compare the treatment outcomes of SpineCor brace with that of rigid brace following the standardized Scoliosis Research Society (SRS) criteria with a minimum follow-up of 2 years beyond skeletal maturity.

Methods: Female AIS subjects (Cobb 20°-30°) aged 10 to 14 were randomly allocated into 2 groups undergoing treatment with SpineCor (S Group, n=20) or rigid braces (R Group, n=18). During SpineCor treatment, patients who had curve progression of > 5° were switched to rigid brace treatment. The effectiveness of the 2 brace treatments was assessed using the SRS standardized criteria.

Results: Before skeletal maturity, 7 (35.0%) patients in the S Group and 1 (5.6%) patient in the R Group had curve progression > 5° (P=0.026). At skeletal maturity, 5 of the 7 (71.4%) patients who failed with SpineCor bracing showed control from further progression by changing to rigid bracing. At the latest follow-up with a mean duration of 45.1 months after skeletal maturity, 29.4% of patients who were successfully treated by rigid brace showed further curve progression beyond skeletal maturity, versus 38.5% of patients in the SpineCor group (P>0.05).

Conclusion: Curve progression rate was found to be significantly higher in the SpineCor group when compared with the rigid brace group during treatment. Changing to rigid bracing could control further curve progression for majority of patients who progressed with SpineCor bracing. For both SpineCor and rigid brace treatments, 30% to 40% of patients who were originally successfully treated by bracing would exhibit curve progression of > 5° after skeletal maturity.

Significance: Rigid brace is superior to SpineCor brace in controlling curve progression during treatment. SpineCor may be prescribed for selected patients, but needs to be closely monitored and switched to rigid brace once progression is detected.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

The Use of Chewing Gum Postoperatively in Pediatric Scoliosis Patients Facilitates an Earlier Return to Normal Bowel Function

Jonathan K. Jennings, MD; J. Scott Doyle, MD; Shawn R. Gilbert, MD; Michael J. Conklin, MD; ***Joseph G. Khoury, MD***
Children's of Alabama, Birmingham, AL

†**LOE-Therapeutic - Level II**

Purpose: In surgical correction of scoliosis in pediatric patients, gastrointestinal complications, including postoperative ileus, can result in extended hospital stays, poorer pain management, slower progression with physical therapy, and overall decreased patient satisfaction. In patients undergoing colorectal, gynecological, and urological surgery, gum chewing has been shown to reduce time to flatus and passage of feces. We hypothesized that chewing gum could also speed return to normal bowel function in pediatric patients undergoing surgical correction of scoliosis.

Methods: IRB approval was obtained for a prospective randomized controlled trial. Eligible patients included all adolescent idiopathic scoliosis patients undergoing posterior spinal fusion. Exclusion criteria included previous gastrointestinal surgery or pre-existing gastrointestinal disease. Patients were randomized by coin flip. The treatment group chewed sugar-free bubble gum five times a day for twenty to thirty minutes beginning on post-operative day one, and the control group did not chew gum. Patients were asked a series of questions regarding subjective gastrointestinal symptoms each day. Time to flatus and first passage of feces were recorded as indicators of return to normal bowel function. Normality of data was assessed using normal probability plots.

Results: 83 patients completed the study (69 females, 14 males, mean age 14.4 years). Of the 42 patients in the chewing gum group, eight patients elected to stop chewing gum regularly prior to discharge due to a variety of reasons. Patients who chewed gum experienced first bowel movement on average 145.5 hours after surgery, 30.9 hours before those who did not chew gum ($p=0.04$). Gum-chewing patients first experienced flatus at an average of 54.7 hours after surgery compared with 61.8 hours for controls. This trend did not reach statistical significance ($p=0.11$). No difference was noted in duration of hospital stay or subjective complaints.

Conclusion: Chewing gum following posterior spinal fusion for scoliosis is safe and efficacious for speeding return of normal bowel function.

Significance: Chewing gum after surgical correction of scoliosis facilitates an earlier return to normal bowel function, which may improve patient satisfaction in the early postoperative period.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Effect of Time and Fusion Length on Motion of the Un-Fused Lumbar Segments in Adolescent Idiopathic Scoliosis

Michelle Marks, PT, MA*; Tracey Bastrom, MA; Maty Petcharaporn, BS; Suken A. Shah, MD; Amer Samdani, MD; Randal R. Betz, MD; Baron Lonner, MD; Firoz Miyanji, MD; Peter O. Newton, MD*
Setting Scoliosis Straight Foundation, San Diego, CA

†**LOE-Therapeutic - Level II**

Purpose: Two questions confront the surgeon and patient with regards to motion in the un-fused lumbar segments prior to fusion for AIS: what will happen in the long term and what effect will the fusion length have? The purpose of this study was to assess L4-S1 coronal motion of the spine in AIS following instrumented fusion with regards to post-operative time and fusion length, independently.

Methods: Patients were offered inclusion into this IRB approved prospective study at their routine 2-16 year post-operative visits at one of 5 centers. Coronal motion was assessed by standardized radiographs acquired in maximum right and left bending positions. The intervertebral angles were measured via digital radiographic measuring software and the motion from the levels of L4 to S1 was summed. The entire cohort was included to evaluate the effect of follow-up time on residual motion. Patients were grouped into early (<5 years), midterm (5-10 years) and long (>10 years) follow-up groups. A subset of patients (n=35) with a primary thoracic curve and a non-structural modifier type 'C' lumbar curve were grouped as either selective fusion (LIV of L1 & above) or longer fusion (LIV of L2 & below) and effect on motion was evaluated.

Results: The data for 259 patients revealed the distal residual un-fused motion (from L4 to S1) remained unchanged across early, midterm, to long term follow-up. In the subset of patients, a significant increase in motion from L4-S1 was seen in patients who are fused long (18 degrees) versus selectively fused patients (9 degrees), irrespective of length of follow-up time.

Conclusion: Motion in the un-fused distal lumbar segments did not change within the >10-year follow-up period. However, in patients with a primary thoracic curve and a nonstructural lumbar curve, the choice to fuse longer versus shorter is met with significant consequences.

Significance: The summed motion from L4-S1 is 50% greater in patients fused longer compared to those patients with a selective fusion, in which post-operative motion is shared by more un-fused segments. The implications of this focal increased motion are unknown but can be surmised.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

A Prospectively Collected Multicenter Cohort Analysis of Anterior versus Posterior Spinal Fusion for Lenke 5 (Thoracolumbar/Lumbar) Adolescent Idiopathic Scoliosis

Mark A. Erickson, MD; Brendan Caprio, BS; ***Sumeet Garg, MD****; Cameron R. Niswander, BA; Zhaoxing Pan, MB, PhD; John B. Emans, MD; Spinal Deformity Study Group*
Children's Hospital Colorado, Aurora, CO

†**LOE-Therapeutic - Level III**

Purpose: Both anterior spinal fusion (ASF) and posterior spinal fusion (PSF) are utilized for treatment of Lenke 5 curves in patients with adolescent idiopathic scoliosis (AIS). A comparative analysis was done to determine if any differences in outcomes or complications are present between techniques.

Methods: A prospectively collected multicenter database of patients treated surgically for AIS was retrospectively reviewed. 152 patients had Lenke 5 AIS and minimum two year follow-up (98 ASF, 51 PSF, 3 combined ASF/PSF). The combined ASF/PSF patients were excluded. Data was collected to compare ASF and PSF groups with regard to demographics, surgical characteristics, and SRS 22 scores. Radiographic measures included sagittal balance, coronal balance, main Cobb angle, LIV tilt angle, shoulder height, and trunk shift.

Results: There was no difference in demographics between groups. PSF patients had significantly less operative time (223 minutes vs 297 minutes, $p<0.0001$). On average, the PSF group was fused one level greater than the ASF group (5.9 vs 4.6 levels, $p<0.0001$). There was no difference between groups in estimated blood loss, intra-operative blood transfusions, or length of stay. The PSF group had more frequent post-operative blood transfusions (45% vs 5%, $p<0.0001$). Table 1 describes radiographic characteristics of the two groups. The minimal significant differences in shoulder height and LIV tilt are likely within clinical measurement error. Percent surgical correction was not different between groups (66% PSF, 62% ASF, $p=0.2591$). The lowest end vertebra (LEV) was selected as lowest instrumented vertebra (LIV) in 73% of PSF and 61% of ASF subjects. The LIV was cephalad to the LEV in 16% of PSF and 35% of ASF subjects. The LIV was caudal to the LEV in 11% of PSF and 4% of ASF subjects. There was a significant difference ($p=0.028$) between treatment groups' preoperative self-image scores on the SRS-22r, but it was less than the reported minimum clinically important difference. There were no other differences in the SRS-22r scores between groups pre or post-operatively at two years.

Conclusion: There is no difference in radiographic or clinical outcomes between patients having ASF or PSF for Lenke 5 AIS. The average number of levels fused is greater with PSF.

Significance: ASF and PSF provide equivalent outcomes for patients with Lenke 5 AIS. ASF may save a fusion level, but has longer operative time than PSF.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Table 1: 2 Year Post-Operative Radiographic Measurements by Surgical Group					
Variable	**Approach**	**N**	**Mean**	**Std Dev**	**P-value**
Sagittal Balance (mm)	PSF	48	-23.77	25.76	0.1144
	ASF	95	-27.58	25.78	
Coronal Balance (mm)	PSF	51	-4.8	11.07	0.5952
	ASF	98	-3.64	17.72	
TL/L Cobb Angle (mm)	PSF	51	16.82	9.26	0.2591
	ASF	98	16.4	10.52	
Thoracic Trunk Shift (mm)	PSF	38	-2.13	9.12	0.198
	ASF	76	0.43	14.02	
LIV Tilt Angle (degrees)	PSF	51	-3.33	8.4	0.01
	ASF	98	-1.2	8.05	

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

♦ **Safety of Topical Vancomycin for Pediatric Spinal Deformity: Non-Toxic Serum Levels with Supratherapeutic Drain Levels**

Sheyan J. Armaghani, MD; Travis J. Menge, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD, MS***
Vanderbilt Children's Hospital, Nashville, TN

†**LOE-Therapeutic - Level IV**

Purpose: Evaluate the safety and efficacy of topical vancomycin in pediatric patients undergoing spinal deformity surgery to determine if 1) postoperative serum levels approach toxicity (25 mcg/ml), and 2) establish if drain levels exceed the minimum inhibitory concentrations (MIC) for common pathogens (MRSA, MSSA, P. acnes – 2 mcg/ml; S. epidermidis, E. faecalis – 4 mcg/ml).

Methods: Topical vancomycin powder (1 gram) was applied during wound closure following instrumented posterior spinal fusion. All patients received intravenous perioperative antibiotics (cefazolin, clindamycin, and/or gentamicin) and a subfascial drain was utilized. Postoperative serum and drain vancomycin levels were collected immediately postoperative and over the first two postoperative days. Complications were recorded.

Results: The study population consisted of twenty-five patients with a mean age of 13.5 years (9.5 – 17.1) and body weight of 44.5 kg (18.1 – 86.2). Underlying diagnoses included: adolescent idiopathic scoliosis (12), neuromuscular scoliosis (10), and kyphosis (3). The mean number of fusion levels was 12.7 (9 -17). Mean serum vancomycin levels trended downward from 2.5 mcg/mL (POD #0) to 1.9 mcg/mL (POD #1) to 1.1 mcg/mL (POD #2). The highest serum level was observed in an 18 kg child with a level of 10 mcg/mL on POD #1. Mean drain levels also trended downward from 403 mcg/mL (POD #0) to 251 mcg/mL (POD #1) to 115 mcg/mL (POD #2). No vancomycin toxicity or deep wound infections were observed. One patient with neuromuscular scoliosis developed a1cm superficial wound dehiscence that was managed with dressing changes.

Conclusion: Topical application of 1 gram of vancomycin in pediatric patients undergoing instrumented posterior spinal fusion produced vancomycin drain levels well above the minimal inhibitory concentration (MIC) for common pathogens, and serum levels below the toxicity threshold (25 mcg/ml). There were no deep wound or antibiotic related complications.

Significance: Application of 1 gram of topical vancomycin produced non-toxic serum levels even in small patients (18 kg). High levels of vancomycin in the wound were documented by drain outputs through POD #2, providing effective local prophylaxis during early wound healing.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

	Serum Vancomycin Level (mcg/mL)	Drain Vancomycin Level (mcg/mL)	Time from Wound Closure (hours)
POD #0	2.5 (1 – 6)	403 (25 – 800)	2.5 (0.7 – 6)
POD #1	1.9 (0 – 10)	251 (34 – 422)	15.5 (9 – 24)
POD #2	1.1 (0 – 2)	115 (11 – 334)	39.3 (35 – 49)

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Does Leveling the Upper Thoracic Spine Have Any Impact on Post-Operative Clinical Shoulder Balance in Lenke 1 and 2 Patients?

*Dzulkarnain Amir, MD; **Burt Yaszay, MD**; Carrie E. Bartley, MA; Tracey P. Bastrom, MA; Peter O. Newton, MD*
Rady Children's Hospital, San Diego, CA

†**LOE-Therapeutic - Level IV**

Purpose: To determine if surgically leveling the upper thoracic spine results in level shoulders postoperatively.

Methods: Prospectively collected Lenke 1 and 2 cases from a single center were reviewed. Clinical shoulder imbalance was measured from 2-year postop clinical photos utilizing Pixelsticks (v2.3, Plum Amazing Software LLC) and Trigonometric software (v1, David Caddy). Lateral shoulder imbalance was assessed utilizing clavicle angle. Medial imbalance was assessed with trapezial angle and trapezial area ratio (TAR). First rib angle, T1 tilt, and upper thoracic curve were measured from 2-year radiographs. Angular measurements were considered level if ≤3° of zero. TAR was considered level if ≤1 standard deviation of the natural log of the ratio. Upper thoracic Cobb at 2-years was categorized as at or below the mean value (≤14°) versus above the mean.

Results: 84 patients were identified. There was a significant change in all three measures of shoulder balance from preoperative to postoperative (clavicle angle: -3±3° to 0.3±2°; trapezial angle: -4±5° to 1±4°; TAR (ln): -0.2±0.4 to 0.1±0.4; $p<0.001$). The percentage of patients with a level clavicle angle (≤3°) was not significantly different between 1st rib angle within 0-3° or >3° ($p=0.8$), T1 tilt within 0-3° vs >3° ($p=0.6$), or postoperative upper thoracic Cobb at/below the mean of 14° vs above the mean ($p=0.6$). There was a significant difference in the proportion of patients with level trapezial angle based on 1st rib angle ($p=0.006$), T1 tilt ($p\leq0.001$), and postop upper thoracic Cobb ($p=0.04$). The percentage of patients with balanced TAR was not significantly different between 1st rib angle groups ($p=0.5$), T1 tilt ($p=0.3$), or postop upper thoracic Cobb ($p=0.9$). The odds ratio of having a level trapezial angle if 1st rib is level, OR=3.9 (1.4-10.6); if T1 tilt is level, OR=5 (1.9-12.9); and if postop upper thoracic Cobb is within the 14°, OR=2.6 (1.0-6.3).

Conclusion: Leveling the upper thoracic spine does not appear to guarantee clinically balanced shoulders or clavicles. Instead, the trapezial prominence seemed impacted by leveling T1 and the 1st rib and minimizing the upper thoracic curve. The solution to achieving laterally balanced shoulders postoperatively remains unanswered.

Significance: Previous research has shown that preoperatively tilted proximal ribs and T1 tilt are more correlated with trapezial prominence than with clavicle angle. When evaluated postoperatively, the results suggest that leveling the upper thoracic spine (1st rib, T1 tilt, upper thoracic Cobb) is associated with a more level trapezial prominence than with balanced clavicles.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Complications Associated with Temporary Internal Distraction in Severe Scoliosis

Graham T. Fedorak, MD, FRCSC; ***Robert H. Cho, MD***
Shriner's Hospital for Children, Los Angeles, CA

†LOE-Therapeutic - Level IV

Purpose: Temporary internal distraction has recently been described as an alternative to pre-operative halo traction, intra-operative halo-femoral distraction and anterior release in patients with severe scoliosis. Previous reports have referred to loss of motor-evoked potentials for neuromonitoring as an uncommon, brief, phenomenon and other complications as similarly uncommon.

Methods: A retrospective chart review was performed identifying twelve scoliosis patients for whom temporary internal distraction was utilized. Curve characteristics, degree of correction, underlying etiology, past medical history, neuromonitoring data and intra- and post-operative complications were evaluated.

Results: The mean pre-operative curve was 105 degrees (83-130). Eight patients had a single posterior surgery while three patients had two operative procedures, initial distraction followed by definitive fusion. One patient had an anterior release followed by a posterior fusion involving temporary internal distraction. At final fusion, curve correction averaged 69% (44-81). When two procedures were performed, the mean interval was seven days. Four patients developed pneumothoraces requiring chest tube placement. Three pneumothoraces were noted intra-operatively with internal distraction and one post-operatively. Three patients experienced significant, temporary, loss of transcranial motor evoked potentials, which took up to sixty-one minutes to fully recover following reversal of distraction. One patient with pneumothorax required prolonged post-operative ventilation and management in the intensive care unit for one month after developing ventilator acquired pneumonia.

Conclusion: While temporary internal distraction is a powerful corrective technique, it is not without complications. Pneumothorax occurred in one-third of patients and significant, reversible, loss of neuromonitoring signals in one-quarter of patients. Transcranial motor-evoked potentials can take a prolonged period of time to return to normal following reversal of distraction.

Significance: Temporary internal distraction provides excellent one or two stage posterior-only correction, but should be undertaken with caution. Pneumothorax is common and chest tubes should be available for all such cases. Cognizance of the sometimes slow return of neuromonitoring signals when this technique is utilized is important for surgeons who encounter loss of motor evoked potentials intra-operatively with distraction.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Do Crosslinks Improve Clinical or Radiographic Outcomes of Posterior Spinal Fusion with Pedicle Screws in Adolescent Idiopathic Scoliosis? A Multicenter Cohort Study

***Sumeet Garg, MD**; Cameron R. Niswander, BA; Zhaoxing Pan, MB, PhD; Mark A. Erickson, MD; Spinal Deformity Group*
Children's Hospital Colorado, Aurora, CO

†**LOE-Therapeutic - Level III**

Purpose: Crosslinks are frequently utilized during posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS). It is unclear if they provide any advantages with all pedicle screw constructs. List price for crosslinks at our institution is from $1000-$2000 per crosslink based on specific type.

Methods: A prospectively collected multicenter database of patients with AIS undergoing spinal fusion was retrospectively queried. Study inclusion criteria were: PSF with all pedicle screw fixation (>90% fixation points) and minimum two years follow up. Revision surgeries, combined anterior/posterior procedures, or patients with sacral-pelvic fixation were excluded. Collected data included demographics, radiographic measures, complications, SRS-22r scores, and SAQ scores.

Results: 500 patients were included in the cohort (377 crosslinks, 123 no crosslinks). Age, BMI and gender were not different between the two groups. There were no differences in radiographic measures between the two groups pre-operatively. With the exception of slightly decreased lumbar Cobb angle (2.7 degrees) in the crosslink group at two year follow-up, no other radiographic measures were different at two year follow-up. Complications occurred in 30 patients; 21 (6%) crosslink, and 9 (7%) no crosslink, p=0.478. Infection occurred in one patient in crosslink group and none in the no crosslink group. Reoperation occurred in 4 patients, all of whom had crosslinks. Three of these were implant removals at patient request. The fourth reoperation was revision for adding on of deformity distally.

The total SRS-22r scores were significantly lower in the group with crosslinks at both the preoperative (0.1, p=0.0003) and 2 year follow up visit (0.2, p=0.0032). However, the total score improved before and after surgery by a similar amount for each group, p=0.4634. The individual SRS-22r domain scores followed a similar trend. Preoperatively, the patient SAQ appearance score was higher in the crosslink group (0.18, p=0.0113) as was the parent SAQ appearance score (0.17, p=0.0185).At two year follow-up, the parent and patient SAQ appearance scores were not different between groups (p=0.3139 and p=0.2087, respectively). The SAQ expectations domain scores were similar for all visits and improvement on both the patient and parent questionnaires.

Conclusions: There do not appear to be any significant clinical or radiographic outcome differences in patients with AIS undergoing PSF based on use of crosslinks at 2 years follow-up.

Significance: Surgeons should consider eliminating use of crosslinks in patients with AIS having PSF with all pedicle screw constructs. This may have substantial cost savings without affecting patient outcome.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Epidural Anesthesia versus Continuous Peripheral Nerve Blocks for Pain Management After Following Extremity Long Bone Osteotomies in Pediatric Patients

***Jeremy D. Onnen, MD**; Jonathan R. Knott, BS, MS; Stephanie M. Holmes, MD; Stephen P. Spanos, MD; Jay Harnden, MD; Peter M. Stevens, MD*
University of Utah School of Medicine, Primary Children's Hospital, Salt Lake City, UT

†**LOE-Therapeutic - Level III**

Purpose: This was a retrospective chart review designed to determine if there is a difference in total length of hospital stay, postoperative pain medication administration, and total hospital charges between groups of pediatric patients undergoing long bone osteotomies who were managed postoperatively with an epidural catheter versus a continuous peripheral nerve block (CPNB). We hypothesized that patients managed with epidural catheters would have a significantly longer hospital stay, but would require significantly fewer morphine equivalents (MEq) of pain medication compared to patients managed with CPNB.

Methods: A pre hoc power analysis demonstrated at least thirty patients would be required in each group to achieve adequate power. Data were gathered by a retrospective chart review of 120 pediatric patients who underwent femoral or tibial osteotomies between 2010 and 2012 as performed by four surgeons at our institution. The 60 most recent patients managed by epidural catheters were compared to the 60 most recent patients managed by CPNB. Exclusion criteria included inadequate documentation or concurrent confounding procedures. Length of postoperative hospital stay for each patient was calculated to the hour. Postoperative pain medication for each patient was converted to morphine equivalents (MEq). Total morphine equivalents were then divided by patient's weight (kg) and hours of hospital stay. Postoperative hospital charges were also totaled for each patient. Statistical analysis was carried out using separate independent 2-sample t-tests to compare each outcome between the two groups (total MEq/kg, total MEq/kg/hr, total length of stay, and total hospital charge).

Results: Of the 120 charts reviewed, 39 patients in the epidural catheter group and 42 patients in the CPNB group remained after exclusion. The CPNB group used significantly more morphine equivalents per kilogram (23.21 MEq/kg v. 1.97 MEq/kg, p=0.02). The CPNB group also used significantly more morphine equivalents per kilogram per hour (0.55 MEq/kg/hr v. 0.02 MEq/kg/hr, p = 0.035). The average total length of hospital stay was significantly longer for the epidural group (84.10 hrs v. 44.12 hrs, $p < 0.001$). The average total hospital charge for the epidural group was also significantly more (14,244.38 dollars v. 11,140.26, p = 0.00005).

Conclusions: Patients managed by epidural catheters stayed in the hospital significantly longer postoperatively but required significantly fewer morphine equivalents then did those who were managed by CPNB. Additionally, total hospital charges for patients managed by epidural anesthesia were significantly greater than those managed by CPNB.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Significance: These findings indicate a significant financial and social advantage to using continuous peripheral nerve blocks for managing postoperative pain in pediatric patients who undergo long bone osteotomies. Their hospital stays may be noticeably shorter and their charges considerably less than if an epidural catheter were used.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Results of Tibial Epiphysiodesis Using Eight-Plate in Leg Length Discrepancy

Elodie Gaumétou; Brice Ilharreborde; G.F. Penneçot; ***Keyvan Mazda***
Robert Debre Hospital, Paris, FRANCE

†**LOE-Therapeutic - Level IV**

Introduction: Among the numerous epiphysiodesis procedures described in the literature, the guided growth principle of the 8-plate technique, initially described for angular deformities correction, has progressively gained popularity among paediatric orthopaedic surgeons to treat lower limb discrepancy (LLD). The goal of this study was to assess the efficacy of the 8-plate procedure for tibial epiphysiodesis in LLD.

Materials and Method: All children treated for LLD using tibial 8-plate were prospectively included. A minimum 2-year follow-up was required. Efficacy of the tibial epiphysiodesis was calculated at 6 months postoperative and at latest follow-up, according to a validated method, previously published for percutaneous epiphysiodesis using transphyseal screws (PETS). Radiological measurements were performed on low-dose stereoradiography (EOS) using 3D segmental lengths measurements. Intraoperative and postoperative complications were reported.

Results: 26 patients (mean age 12.6 years at surgery) were included. The efficacy was only 17% at 6 months and 31% at follow-up. The epiphysiodesis effect appeared to be greater at follow-up when the screws were initially introduced in parallel position, compared to the angled position (40% and 30%, respectively), within the plate. In 7 cases (26.9%), the epiphysiodesis was completely inefficient during follow-up (0% growth reduction). The angle between the 2 screws significantly increased during follow-up, but the progression of the angle was not correlated to the epiphysiodesis efficacy. No intraoperative complication occurred, and no valgus deformity was reported during follow-up. Six patients (23%) presented pain on the plate and 4 revisions for material removal were performed. In addition, 4 (15%) underwent revisions, 1 for infection, 1 for plate repositioning, and 2 for insufficient growth arrest.

Conclusion: Results of the current series show that the eight-plate technique is inappropriate for tibial epiphysiodesis in LLD. The procedure is simple and was associated with few perioperative complications, but the growth arrest observed at follow-up only reached 31% of the expected gain, twice inferior to the one previously reported with PETS using the same calculation method. The influence of patient age, screws direction and operative planification need to be further studied.

Significance: The eight-plate technique is inappropriate for tibial epiphysiodesis in LLD.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Circular External Fixation for Correction of Deformity in Blount Disease

Stephanie W. Mayer, MD*; Dan Sun, BS; Robert K. Lark, MD; Robert D. Fitch, MD*
Duke University Medical Center, Durham, NC

†LOE-Therapeutic - Level III

Purpose: To evaluate the results of correction of Blount disease in young patients using circular external fixators, and to determine factors in successful treatment.

Methods: 53 patients who underwent correction of Blount disease with an Ilizarov external fixator or a Taylor Spatial Frame (TSF) by a single surgeon were analyzed. Preoperative demographic data was recorded. The medial proximal tibial angle(MPTA), mean axis deviation (MAD), posterior proximal tibial angle (PPTA), and knee joint angle (KJA) were measured on radiographs pre-operatively, pre-frame removal, and at last follow up. A t-test was used for statistical analysis to determine radiographic changes from baseline as well as any recurrence between frame removal and last follow up. The population was further analyzed for differences between those who had an Ilizarov or TSF, those who had a diagnosis of infantile or late onset disease, and those who had or had not undergone previous surgery. Complications were recorded.

Results: The average age was 11.15 years old. Mean follow up time was 29.88 months. Mean pre-operative MPTA (71°), MAD (3.41), and KJA (5°) were significantly improved at the time of frame removal (MPTA (87°), MAD (0.46), KJA (3°)) as well as at the last follow up visit (MPTA (86°), MAD (0.33), PPTA (72°), and KJA (2°)). There was no significant difference between the pre-frame removal measurements and those at the last follow up. There was no difference in any measurement or degree of improvement between the Ilizarov or TSF groups except for the KJA which was significantly improved in the TSF group (2° vs 5°). There was no significant difference in measurements between those who had prior surgery or not or between patients with infantile or late onset disease. Average time in the frame was 14.02 weeks. There were 23 frames with pin site infections, 2 of which became deep infections. Two patients had a transient nerve palsy.

Conclusions: The MPTA, MAD and KJA were significantly improved using circular external fixators. This improvement was durable following frame removal. Frame type, prior surgery and diagnosis did not affect the outcome. Pin site infection was the most common complication.

Significance: Both Ilizarov and TSF circular fixators are good options for correction of deformities involved in infantile and late onset Blount disease. TSF may provide better correction of the posterior proximal tibial angle.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

EOS as a New Means of Accessing Femoral Version: A Comparision Study of EOS versus Computed Tomography

M. Lucius Pomerantz, MD; Diana A. Glaser, PhD; Amy Fredrick; Josh Doan, MEng; Sita Kumar; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

†**LOE-Diagnostic - Level III**

Purpose: Routine clinical analysis of femoral version is based on clinical exam and multiplanar imaging such as computed tomography (CT). The purpose of this study was to validate EOS biplanar radiography's ability to measure femoral version via 3-dimensional (3D) reconstructions, in order to provide the needed clinical information but with limited radiation exposure.

Methods: Two different cadaveric femurs (phantoms) were placed in a stabilizing platform and scanned with CT in supine positions in native version (0 degrees) and with version modified by rotating (-10°, -5°, +5° or +10°) through a mid-diaphyseal osteotomy. Each femur, at each version, was scanned in an upright position within the EOS unit. For each EOS scan, the platform was also rotated -10°, -5°, 0°, +5° and +10°. Two independent observers measured femoral version from each axial CT image (5 per phantom) and from each EOS scan (25 per phantom). Each observer performed the measurements twice. Inter and intra-reliability was determined and the error to the true version was determined for both scanning techniques. The average error was evaluated as well as the upper bound of the 95% CI.

Results: For CT measurements, the interobserver intraclass correlation (ICC) ranged from 0.981-0.991 and the intraobserver ICC ranged from 0.994 to 0.996. For EOS reconstructions, the interobserver ICC ranged from 0.983 to 0.998 and the intraobserver ICC ranged from 0.982 to 0.999. For axial CT measurements, the upper bound of error from the true value was 5.4° - 7.5°, and it was 3.98° -8.7° for EOS (see table). There was no statistical difference in any measures between CT and EOS.

	MIN Error	MAX Error	Diff
-10°	4.7°	6.1°	1.4°
-5°	3.98°	6.4°	2.4°
neutral	5.4°	6.8°	1.4°
5°	4.3°	8.7°	4.4°
10°	4.5°	5.6°	1.1°

Conclusion: Our findings show that the accuracy of EOS femoral version measurements is comparable to the accuracy of axial CT measurements, with both demonstrating high inter- and intra-observer reliability. Moreover, version measurements are not biased by the position of the patient within the EOS machine.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Significance: Biplanar radiography reconstructions such as from EOS Imaging have the potential to accurately and reliably provide clinical data on femoral version with significantly less radiation exposure.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Core Decompression and Bone Marrow Aspirate Concentrate for Treatment of Perthes Disease

***Karen Bovid, MD**; Tim Schrader, MD*
Children's Orthopaedics of Atlanta, Atlanta, GA

†**LOE-Therapeutic - Level IV**

Purpose: The ideal treatment of Legg-Calvé-Perthes disease remains controversial. Core decompression with or without bone grafting has been used to treat osteonecrosis of the femoral head prior to collapse related to other etiologies. The primary aim of this study is to determine radiographic and clinical outcomes in patients with Perthes disease who underwent core decompression and autologous bone grafting using bone marrow aspirate concentrate (BMAC).

Methods: This IRB-approved retrospective review included patients with Perthes disease treated with core decompression, BMAC, and Petrie casting by a single surgeon between January 2011 and January 2012. Outcomes measured included hip range of motion(ROM), strength assessed with hand held dynamometer(HHD), radiographs, and subjective patient outcome questionnaires. Outcomes were compared prior to and following intervention. Patients were matched to controls treated with hip arthrogram, exam under anesthesia, and Petrie casting prior to 2010 on age at time of surgery and pre-surgical Lateral Pillar and Modified Elizabethtown classifications.

Results: Seven patients, average age at surgery 7.8 years, met the inclusion criteria for the treatment group. Average number of nucleated cells delivered with BMAC injection was 1313.3±479.4 million. ROM, strength and subjective questionnaire follow-up was obtained from 6 patients (86%) at a mean of 1.7 years following surgery. Radiographic follow-up was obtained on all patients. Abduction ROM increased from 23±9 to 31±7 degrees($p=0.088$) and internal rotation ROM improved from 24±3 to 36±9 degrees($p=0.006$) following core decompression and BMAC. HHD for hip abduction improved from 2.5±2.9 to 22.3±10.3 lbs($p<0.001$). All patient outcomes scores improved postoperatively: HOOS symptoms 48±11 to 88±15($p<0.001$), pain 52±40 to 91±10($p=0.031$), ADLs 72±21 to 97±4($p=0.009$), sports 53±30 to 92±12($p=0.008$), quality of life 25±18 to 86±16($p<0.001$), LEFS 55±5 to 72±12($p=0.005$), and SF-36 physical 34±0.6 to 51±8($p<0.001$), mental 50±17 to 62±1($p=0.087$). Comparison of the treatment group and the matched controls indicated that there was a trend toward faster progression through radiographic stages to reossification for the core decompression and BMAC group 364±87 days versus 475±154 days for controls($p=0.123$).

Conclusion: Treatment of patients with early stage Perthes by core decompression and BMAC resulted in a trend toward quicker progression through radiographic stages to reossification in the BMAC group compared to controls. Excellent patient reported outcomes, improvements in hip ROM and strength, and good radiographic results were also reported.

Significance: This pilot study indicates core decompression and BMAC may allow for faster progression to radiographic healing and lifting of activity restrictions.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Efficacy of the Modified Bröstrom Repair for Adolescent Patients with Chronic Lateral Ankle Instability

Jared T. Lee, MD; Adam Y. Nasreddine, MA; Nicole J. Stenquist, BA;
Mininder S. Kocher, MD, MPH
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level IV**

Purpose: The purpose of this study was to report on the outcomes of the modified Bröstrom technique in the pediatric and adolescent population for chronic lateral ankle instability.

Methods: A retrospective review of patients presenting to our institution over an 8-year period yielded 57 cases of chronic lateral ankle instability refractory to non-operative treatment in 47 children or adolescents. All patients were treated with a modified Bröstrom technique in which the anterior talofibular ligament was repaired in an anatomic orientation. Demographic and clinical data were collected and outcome scores were obtained including the MARX activity scale, UCLA activity score, and modified AOFAS score.

Results: Thirty-one (66%) of 47 patients returned the outcomes questionnaires, had >6 months follow up and met all inclusion criteria. Mean clinical follow up was 36 months (median: 37 months; range 9 – 73 months). The mean age of patients was 14.8 years (range, 9 – 18 years old). There were no major complications. One patient had persistent pain laterally and subtalar laxity with the ankle dorsiflexion. The mean score for the MARX scale, UCLA score, and modified AOFAS score were 12 (range, 0-16), 10 (range, 3 – 10), and 84 (range, 35 – 100) respectively. Based on the modified AOFAS outcome score, 71% of patients had a good to excellent outcome.

Conclusion: Lateral ankle sprains are common injuries that may result in chronic lateral ankle instability despite appropriate therapy. Surgical treatment with anatomic repair of the ATFL using the modified Brostrom technique should be considered as it provides improved stability, low complication rate, and good functional outcomes.

Significance: Lateral ankle sprains are very common representing up to 30% of sports related injuries. The anterior talofibular ligament (ATFL) and less commonly the calcaneofibular ligament are injured. The majority of these injuries can be adequately treated non-operatively with functional therapy. Surgical treatment is reserved for injuries that fail non-operative treatment. Anatomic repair using the modified Bröstrom technique has been shown to have good clinical outcomes in the adult population. This study shows that the modified Bröstrom technique is safe and effective for the pediatric population.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Fate of the Neuromuscular Hip After Spinal Fusion

Lindsay M. Crawford, MD*; Jose A. Herrera Soto, MD; Jonathan H. Phillips, MD; Dennis R. Knapp, Jr, MD*
Arnold Palmer Children's Hospital, Orlando, FL

†**LOE-Therapeutic - Level IV**

Purpose: Patients with neuromuscular conditions have a high incidence of spinal deformities. The goals of treatment of neuromuscular scoliosis are to achieve a balanced spine and level pelvis. Most constructs include pelvic fixation. However, the pelvis can become a stiff "end vertebra" that prevents compensatory mechanisms to adjust to hip deformities in this patient population. This may in fact lead to surgical intervention of the hip. The purpose of this study is to determine the frequency and factors associated with hip pathology and surgery following spinal fusion in this patient population.

Methods: We performed a retrospective chart and radiographic review of neuromuscular patients that underwent posterior spinal fusion at our institution from 2005 to 2011. We collected radiographic data of pre and post operative pelvic obliquity and hip reduction status and position (up, level, or down). We further evaluated patients requiring hip surgery. Hip surgeries were considered containment or salvage.

Results: 58 patients with an average follow up of 3.5 years after spinal fusion. 48 hips in 39 subjects (67%) demonstrated or developed hip subluxation/dislocation. 23 of the total 58 patients (40%) underwent a hip procedure. 21 (45%) cerebral palsy and 2 (18%) myelodysplasia patients required a hip procedure in addition to spinal fusion. 12 new hip subluxation/dislocations occurred after spine surgery; 25% in the down hip, 67% in the up hip and 8% with a leveled pelvis. 4 (33%) of the new post-operative subluxation/dislocations required hip surgery; all had pelvic obliquity $<6^{o}$. 12 hips in 11 patients underwent hip surgery prior to PSF, 7 were varus femoral osteotomies for subluxation. In follow-up after PSF, none of these had a new dislocation after spine surgery. 5 hips required salvage prior to PSF. 15 hips in 12 patients required hip surgery after PSF at a mean of 1.7 years after PSF. 13 were salvage procedures for painful hip and 2 varus femoral osteotomies for subluxations.

Conclusion: In the neuromuscular patients that underwent PSF, 40% of these patients required a hip procedure. In the patients that had a varus osteotomy prior to PSF, the hips maintained reduction after spinal fixation. After correction of pelvic obliquity, 21% of patients had new onset hip subluxation/dislocation after PSF. Post-operative subluxation/dislocation was not dependent on whether the hip was up or down pre-operatively.

Significance: Hip vigilance is recommended for patients with neuromuscular scoliosis that require PSF. The parents should be alerted of the possible need for hip surgery after spinal fixation.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Effect of Continuous Intrathecal Baclofen Therapy on Walking Children with Cerebral Palsy

*Blazej A. Pruszczynski, MD; **Julieanne P. Sees, DO**; John D. Henley, PhD; Chris Church, PT; Kenneth J. Rogers, PhD; Freeman Miller, MD*
Department of Orthopedics, Nemours Alfred I. DuPont Hospital for Children, Wilmington, Delaware, USA

†**LOE-Prognostic - Level IV**

Purpose: Continuous intrathecal infusion of baclofen (CITB) is effective in management of severely involved children with cerebral palsy (CP). However little is known regarding the effect of CITB in ambulatory patients. This study assessed the effects of CITB on the function and gait in ambulatory children with CP.

Methods: Data were collected retrospectively before and after pump implantation. We compared scores of GMFCS, GMFM, step length, velocity and gait deviation index (GDI). In addition, from medical chart, the subjective patient opinion regarding the outcome with CITB was summarized. Data were analyzed and summarized using descriptive statistic as well as two tail t-test (TT) and paired sample Wilcoxon test (WT).

Results: Twenty seven ambulatory children with cerebral palsy were included. The mean clinical follow-up for all patients was 5y3m (SD: 2y3m, range 1y-9y7m). The mean follow-up for gait parameters was 2y5m (SD: 1y9m, range 8m-7y6m) and were available for 19 children. Five patients were quadriplegic, 16 were diplegic, two were hemiplegic and four were dystonic. On the pre-op examination the GMFCS level was as follows: I–2, II–7, III–8, IV–8. For overall population: the GMFM score significantly improved by 4 points from a mean of 14.8±11.2 to 18.8±12.1 ($p=0.046$, WT). However, there was no significant change in the group as a whole in gait velocity or GDI. On individual patient assessment, based on medical notes, improvement in gait was noted in 3 of 4 patients with movement disorders. Five of 8 children with pumps implanted before the age of 10 improved in velocity by greater than 10 cm/sec, but only 1 of 10 children with pumps implanted after the age of ten improved in gait velocity. Three teenage patients discontinued CITB therapy due to weakness and decreased walking endurance (diplegic pattern, GMFCS II and III).

Conclusion: CITB treatment did not significantly change the gait parameters in the group considered as a whole set. However younger patients and those with movement disorders demonstrated subjective benefits reported in medical charts. CITB creates weakness which was not tolerated by teenagers with pure spasticity and was reported by parents. Proper patient selection remains complex and unpredictable.

Significance: CITB continues to have potential for positive effects in ambulatory patients if careful patient selection is considered. The flexibility of dose control and the reversibility of treatment make this treatment very adaptive to patient needs.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Body Composition in Ambulatory Children with Cerebral Palsy is Related to Health and Environmental Factors

Donna J. Oeffinger, PhD; Neeley Buhr, MS; Janet Walker, MD;
Todd A. Milbrandt, MD, MS; Vishwas R. Talwalkar, MD; ***Henry J. Iwinski, MD***
Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington, KY

†**LOE-Prognostic - Level III**

Purpose: Obesity rates for ambulatory individuals with cerebral palsy (CP) are comparable to their typical peers. Studies investigating risk factors and health consequences of obesity in CP are limited. This study investigated the associations among body composition and environmental, health and socioeconomic factors in ambulatory children with CP.

Methods: A convenience sample of 63 children (male=38, diplegia=48, hemiplegia=15) with CP (GMFCS I-III), mean age 12.3±3.4 years, was prospectively studied. Assessment of height, weight, blood pressure and non-fasting blood samples were obtained. Body fat percentages (BF%) were estimated using bioelectrical impedance analysis. Environmental factors were measured using the *Active Where?* Survey and socioeconomic factors assessed using questionnaires. Statistical analyses included Spearman's correlation coefficient, one-sided T-test, and regression.

Results: Mean age and gender matched BMI percentile (BMI%) was 66.3%±32.7% [Underweight=4, Healthy weight=35, Overweight=11 and Obese=15]. BF% was adequate in 22 and excessive (female>30%, male>25%) in 43 children. BMI% is significantly positively correlated with systolic BP%, glucose (GLU), triglycerides (TRG), and screen time and negatively correlated with HDL and 25OH-vitamin D (VitD) levels (Table 1). BF% is significantly correlated with lower HDL and higher TRG. Comparisons by CDC categories showed that the overweight/ obese groups had significantly ($p<0.05$) higher systolic BP% and LDL and lower HDL and VitD levels. Family income was significantly ($p<0.05$) associated with BMI%. 25% of overweight/ obese individuals were in low income category vs. 4% of underweight/healthy individuals.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Table 1: Spearman Correlations R	BMI%	p-value	BF%	p-value
Systolic BP%	**0.33**	**0.008**	0.23	0.0706
Diastolic BP%	0.17	0.1895	0.24	0.0541
GLU (mg/dL)	**0.28**	**0.027**	0.08	0.547
Total Cholesterol (mg/dL)	0.03	0.8056	0.08	0.5488
HDL (mg/dL)	**-0.51**	**<0.0001**	**-0.38**	**0.0023**
LDL (mg/dL)	0.18	0.165	0.15	0.2406
TRG (mg/dL)	**0.36**	**0.0038**	**0.29**	**0.0223**
25OH-VitD (ng/mL)	**-0.26**	**0.038**	-0.22	0.0845
PreAlbumin (mg/dL)	0.16	0.1973	0.04	0.7433
Screen time (wkdays)	**0.31**	**0.0137**	0.14	0.2723

Conclusions: As with their typical peers, obesity in ambulatory children with CP is associated with negative cardiovascular risk factors, increased screen time and lower family income.

Significance: This study highlights that the obesity epidemic influences all types of children in a negative way, including those with CP. Best clinical practices to obtain obesity control should be encouraged to improve the overall health of this patient population.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Comparison of Hamstring Lengthening with Hamstring Lengthening Plus Transfer for Treatment of Flexed Knee Gait in Ambulatory Patients with Cerebral Palsy

Camila B. R. De Mattos, MD; K. Patrick Do; Rosemary Pierce, PT; Jing Feng, PhD; Michael D. Aiona, MD; ***Michael D. Sussman, MD***
Shriners Hospitals for Children, Portland, OR

†**LOE-Therapeutic - Level III**

Purpose: To evaluate the medium term difference of hamstring lengthening alone (HSL group) with hamstring lengthening plus transfer (HST group) in the treatment of flexed knee gait in ambulatory patients with cerebral palsy. We hypothesize that: 1. Hamstring surgery improves knee flexion towards normal during gait, 2. HST can maintain the extension hip power during walking, 3. Recurrence of increased stance phase knee flexion is less in the HST group

Methods: We retrospectively reviewed the gait analysis and physical examinations of 50 patients with ambulatory cerebral palsy that underwent surgery for flexed knee gait. All patients underwent pre-operative, 1 year and medium term gait analysis and physical exam.

Results: The mean age at surgery was 9.9 years. Thirty-two patients on the HST group. Eighteen patients on the HSL group. The follow-up time ranged from 3.5 to 5 years. All patients had a significant ($p<0.05$) improvement of the Straight Leg Raise, Knee Flexion and Popliteal Angle in both HST and HSL groups in the 1 year post-op. All patients had a significant ($p<0.05$) improvement on Average Pelvic Tilt and Minimum Knee Flexion in stance in both HST and HSL groups in the 1 year post-op. There was significant ($p<0.05$) improvement in the Peak Hip Power in Stance only in the HST group in the 1 year post-op. All patients had a significant ($p<0.05$) improvement of the Knee Flexion and Popliteal Angle in both HST and HSL groups in the longer term. There was a significant ($p<0.05$) improvement on Minimum Knee Flexion in stance in both HST and HSL groups in the long term. There was significant ($p<0.05$) improvement of the Average Pelvic Tilt only in the HST group in the longer term. There was significant ($p<0.05$) improvement in the Peak Hip Power in Stance only in the HST group in the longer term. We had 2 patients that had recurvatum in the post-operative period.

Conclusions: There is no clear benefit in regards to recurrence comparing HST and HSL. In both procedures there was maintenance of stance phase knee flexion. There seems to be a continuing improvement of hip extension power in the HST group. Longer follow-up is needed for additional recurrence information.

Significance: This study helps pediatric orthopaedic surgeons to choose the between 2 different techniques to treat flex knee gait in patients with cerebral palsy by showing the medium term assessment of gait analysis and physical exam of both procedures.

1. IRB Statement - approved
2. FDA Status - not applicable
3. Non Exclusive License Agreements - not applicable
4. Level of Evidence – 3

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Table 1. Preoperative and postoperative measurements for the HSL and the HST groups.

	HSL				HST			
	Pre	Post	Change	p	Pre	Post	Change	p
Physical Exam	n = 18				n = 32			
Straight Leg Raise (deg)	57.8 ± 7.7	63.3 ± 8.2	5.6±10.8	<0.05	55.8 ± 9.3	65.9 ± 6.8	10.2± 11.4	<0.05
Knee Extension (deg)	-8.3 ± 8.6	0.3 ± 5.6	8.6±7.8	<0.05	-5.6 ± 8.5	1.3 ± 5.6	6.9±8.7	<0.05
Popliteal Angle (deg)	58.9 ± 14.4	45.6 ± 9.7	-13.3±14.5	<0.05	57.7 ± 10.7	45.6 ± 9.7	-14.9±13.9	<0.05
Kinematics	n = 18				n = 32			
Average Pelvic Tilt (deg)	16.7 ± 7.1	21.6 ± 7.6	4.9±9.2	<0.05	14.1 ± 7.0	20.1 ± 5.8	5.9± 8.2	<0.05
Minimum Knee Flexion in stance (deg)	22.4 ± 13.3	10.7 ± 12.1	-11.8±8.3	<0.05	24.9 ± 11.9	12.5 ± 14.3	-13.6±8.3	<0.05
Minimum Hip Flexion in Stance (deg)	10.1 ± 11.0	7.5 ± 8.8	-2.6±8.6	0.21	6.9 ± 9.4	4.3 ± 10.2	-2.6±9.1	0.11
Kinetics	n = 8				n = 16			
Peak Hip Power in Stance (W/Kg)	1.0 ± 0.4	0.9 ± 0.5	-0.1±0.7	0.66	1.0 ± 0.5	1.2 ± 0.5	0.2±0.3	<0.05

Table 2. Preoperative and Long Term measurements for the HSL and the HST groups.

	HSL				HST			
	Pre	Long Term	Change	p	Pre	Long Term	Change	p
Physical Exam	n = 18				n = 32			
Straight Leg Raise (deg)	57.8 ± 7.7	58.3 ± 9.4	0.3±10.1	0.90	55.8 ± 9.3	57.9 ± 6.2	2.2±11.8	0.30
Knee Extension (deg)	-8.3 ± 8.6	0.0 ± 8.4	8.3±10.7	<0.05	-5.6 ± 8.5	0.8 ± 8.6	6.3±10.9	<0.05
Popliteal Angle (deg)	58.9 ± 14.4	51.1 ± 12.3	7.8±14.9	<0.05	57.7 ± 10.7	49.4 ± 10.1	8.3±15.1	<0.05
Kinematics	n = 18				n = 32			
Average Pelvic Tilt (deg)	16.7 ± 7.1	19.6 ± 7.3	2.6± 10.3	0.30	14.1 ± 7.0	19.3 ± 7.9	5.4± 8.6	<0.05
Minimum Knee Flexion in stance (deg)	22.4 ± 13.3	10.8± 12.1	-11.7±12.5	<0.05	24.9 ± 11.9	12.5 ± 14.3	-12.4±17.6	<0.05
Minimum Hip Flexion in Stance (deg)	10.1 ± 11.0	8.4 ± 7.9	-1.7±9.7	0.45	6.9 ± 9.4	8.3 ± 12.2	1.5±11.6	0.49
Kinetics	n = 8				n = 16			
Peak Hip Power in Stance (W/Kg)	1.0 ± 0.4	1.2 ± 0.4	0.2±0.6	0.51	1.0 ± 0.5	1.4 ± 0.7	0.4±0.7	<0.05

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Role of Rectus Femoris Transfer in the Development of Crouch Knee Gait in Cerebral Palsy

***Mauro C. De Morais Filho, MD**; Francesco C. Blumetti, MD; Cátia M. Kawamura, PT; Michelle De Oliveira Cardoso, MD; Daniella L. Neves, MD; Marcelo H. Fujino; José Augusto F. Lopes, MSc*
AACD, São Paulo, BRAZIL

†**LOE-Therapeutic - Level III**

Purpose: The aim of this study was to analyze knee flexion during stance phase after rectus femoris transfer (RFT), in order to evaluate the influence of RFT in the development of crouch knee gait in cerebral palsy (CP).

Methods: A total of 3283 patients with spastic diplegic cerebral palsy seen at our gait lab from 1996 to 2013 were identified from our database. Inclusion criteria were: (1) Gross Motor Function Classification System (GMFCS) levels I-III; (2) kinematic criteria for stiff-knee gait at baseline; (3) individuals who underwent orthopedic surgery in the lower limbs and had done gait analyses before and after the intervention. Patients who fulfilled the inclusion criteria were divided in 2 groups: Group A (185 knees), including patients who underwent orthopedic surgery without a RFT between exams; Group B (123 knees), represented by patients who underwent orthopedic surgery including a RFT. Clinical and kinematic parameters were evaluated at baseline and at follow-up for all groups. The primary outcome was minimum knee flexion in stance (MKFSt) and the secondary outcomes included total knee range of motion (KROM).

Results: The two groups matched at gender distribution, GMFCS profile, pre-operative GDI, knee flexion in stance phase before surgery and follow-up time (3 years). In Group A, the mean MKFSt increased from 13.19° to 16.74° (p=0.003) and in Group B from 10.60° to 14.80° (p=0.001). The post-operative MKFSt was similar among Groups A and B (p=0.534). In Group B, the MKFSt after surgery was higher in patients with GMFCS III (22.51° - p<0.001). A significant increase in MKFSt in the second exam (from 13.01° to 22.51°) was observed only in the GMFCS III patients in the RFT group (p<0.001). An improvement in KROM (from 32.79° to 36.63°) after surgery was noted only in Group B (p<0.001), and this effect was more remarkable for patients GMFCS II.

Conclusion: In this study, RFT was not related to the development of crouch knee gait after a mean follow-up time of 3 years. The increase in MKFSt was similar between Groups A and B. Patients with GMFCS III who underwent multilevel surgery including RFT, exhibited higher increase in MKFSt after treatment than GMFCS levels I and II. The improvement of KROM was observed only in the RFT group, and it was more significant for the GMFCS II patients.

Significance: GMFCS level III patients presented highest MKFSt after RFT.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Lower Extremity Malrotation Recurrence in Ambulatory Children with Cerebral Palsy

Alexander M. Broom, BA; Susan A. Rethlefsen, DPT; Tishya Wren, PhD; ***Robert M. Kay, MD***
Children's Hospital Los Angeles, Los Angeles, CA

†**LOE-Therapeutic - Level III**

Purpose: To examine factors predictive of recurrence of femoral and/or tibial torsion following derotation osteotomy in ambulatory children with cerebral palsy (CP).

Methods: We identified children with CP who had undergone derotation osteotomy of the femur (FDRO) and/or tibia (TDRO) and who had both pre- and post-operative (1-11 years after surgery) gait analysis. A retrospective review was conducted of their surgical history, physical exam measures, and dynamic gait characteristics. Recurrence of rotational problems was defined as positive if a subsequent derotation was either done or recommended following a postoperative gait analysis. Possible predictors of recurrence were evaluated using logistic regression.

Results: 160 limbs in 98 patients underwent derotation osteotomies during the study period. Of these, 25 (15.6%) developed recurrent torsion of the femur and/or tibia which required or was recommended for a second derotation operation. Predictors of overall recurrence included GMFCS level and preoperative thigh-foot angle (TFA). For patients who underwent an FDRO without concomitant TDRO, recurrence (6/69) was predicted by preoperative TFA. When an isolated external TDRO was done without concomitant FDRO, recurrence was seen in 3/32, and overcorrection was seen in 4/32 limbs. When isolated internal TDROs were performed, recurrence was seen in 2/11 limbs, and no overcorrections were seen. There were no preoperative predictors of recurrence of internal or external tibial torsion. For patients in whom concomitant FDRO and TDRO were performed, results varied according to the direction of tibial derotation. When both the femur and tibia underwent external DRO, all recurrences were in the femur (5/39) and no recurrence or overcorrection was seen in the tibia. When external FDRO was combined with internal TDRO, much higher rates of recurrence were seen in both bones (femur 2/7, tibia recurrence 3/7, tibia overcorrection 2/7). Higher GMFCS level (greater disability) and more internal preoperative TFA were predictors of recurrence in this group of patients.

Conclusion: Higher GMFCS level and more internal preoperative TFA were the main predictors of the likelihood of later rotational problems after a derotation osteotomy had been performed. Rotational problems in the tibia appear less predictable than in the femur, as both recurrence and overcorrection were seen at that level. The highest need for re-operation was seen after external FDRO combined with internal TDRO.

Significance: These findings may help to refine indications for derotational osteotomy, particularly for higher GMFCS levels where there is an increased risk of later recurrence or overcorrection of rotational problems.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Assessment of the Predictors of Post-Operative Length of Stay in Neuromuscular Patients Undergoing Reconstructive Hip Surgery

***Matthew E. Oetgen, MD**; Lily Adler; Catherine W. Gillespie, MPH, PhD; Allison Matthews, MSCR; Karen M. Thomson, MD*
Children's National Medical Center, Washington, DC

†**LOE-Prognostic - Level III**

Purpose: Patients with neuromuscular diseases often develop hip subluxation requiring surgical intervention. There is a high incidence of post-op complications associated with these surgeries leading to prolonged hospital stay. We attempt to identify the patient and procedural risks factors associated with prolonged post-op length of stay (LOS) after neuromuscular hip reconstruction.

Methods: We performed a retrospective chart review of all patients undergoing reconstructive hip surgery for neuromuscular hip subluxation or dislocation at a single academic pediatric institution from 2010 to 2011. Patient, procedural, and post-op variables were abstracted from patient records. Variables were assessed using univariate analysis to determine those associated with "prolonged" post-op stay (≥7 days, representing the upper quartile of our sample). All variables found to be at least marginally associated ($p<0.1$) with prolonged post-op stay were entered into a multivariable regression to identify independent predictors of this outcome.

Results: A total of 76 patients (97 hip procedures) were included in the study. Most (80%) of the population had a diagnosis of cerebral palsy; 9% chromosomal abnormality, and 6% spina bifida. The distribution of post-op LOS ranged from 2 days to 5.6 months, with a median of 5 days. Significant predictors of LOS ≥7 days in the univariate analysis were: presence of a G tube (p=0.02), history of reactive airway disease (0.02), increased # of pre-op comorbidities (0.03), # of surgical procedures performed (0.05), undergoing an open hip reduction (0.002), duration of surgery (0.03), estimated blood loss (0.03), being followed by hospitalist service post-op (0.02), and post-op need for ICU (0.002). Factors independently associated with prolonged LOS from the multivariate analysis are summarized in the following table.

Characteristic	Adjusted RR	95% CI	p-value
Age (years)	1.08	1.03-1.14	0.002
Pre-operative G tube	2.04	1.00-4.15	0.050
Open hip reduction performed	2.00	1.08-3.70	0.027
Followed by hospitalists	2.24	1.08-4.69	0.031

Conclusion: We have defined patient and procedural variables which appear to be associated with risk of prolonged LOS (≥7 days) following neuromuscular hip reconstruction. Medical

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

optimization of patients with these risk factors in the pre-op period may lead to safe reductions in post-op LOS in this population.

Significance: Safely decreasing LOS following neuromuscular hip reconstruction may be possible by targeting this group of high risk patients potentially leading to significant cost savings and improved patient safety.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Solid versus Floor Reaction Ankle-Foot-Orthoses for Children with Cerebral Palsy

Hank White, PT, PhD; Juanita J. Wallace, MS; Samuel F. Augsburger, MS; Todd A. Milbrandt, MD, MS; Vishwas R. Talwalkar, MD; ***Ryan D. Muchow, MD****; Henry J. Iwinski, MD; Janet Walker, MD*
Shriners Hospital for Children and University of Kentucky Department of Orthopaedic Surgery, Lexington KY

†**LOE-Therapeutic - Level III**

Purpose: Children diagnosed with cerebral palsy (CP) have gait problems that are frequently treated with ankle-foot-orthoses. A solid ankle-foot-orthosis (SAFO) is designed to rigidly fix the ankle in neutral dorsiflexion throughout the gait cycle and may control knee hyper-extension during stance. The floor reaction AFO (FrAFO) is designed to rigidly fix the ankle in neutral, to prevent excessive ankle dorsiflexion and excessive knee flexion during stance. This is the first study to compare the effects of SAFOs and FrAFOs for children diagnosed with CP.

Methods: We retrospectively studied children with CP spastic diplegia who underwent a 3D motion analysis study while walking barefoot and wearing their clinically prescribed AFOs on the same day. 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.

Results: Limbs that wore FrAFOs had statistically 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, $p<.01$). Because of these starting differences, we compared the change in each group's gait pattern from barefoot to braced walking trial to determine the magnitude of change between brace types. There was a significant difference in the control of knee flexion at initial contact (SAFO -0.3 degrees versus FrAFO -4.6 degrees, $p<.05$); 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 significant 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 $p<.05$).

Conclusions: Despite significantly less ankle dorsiflexion in mid stance, the FrAFO failed to significantly improve mid stance knee flexion compared to SAFO for children diagnosed with CP.

Significance: These results should make clinicians ask if it is worth spending the additional resources to make the more expensive FrAFO.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Relationship of Strength, Weight, Age, and Function in Ambulatory Children with Cerebral Palsy

***Jon R. Davids, MD**; Donna J. Oeffinger, PhD; Anita M. Bagley, PhD; Mitell Sison-Williamson, AB; George E. Gorton III, MS*
Shriners Hospital for Children, Sacramento, CA

†**LOE-Prognostic - Level II**

Purpose: The natural history of ambulatory function in individuals with cerebral palsy (CP) consists of deterioration over time. The etiology of this deterioration is unclear. The goal of this study was to establish the relationship between strength, weight, age, and function in children with diplegic CP.

Methods: The study design was prospective, case series of 255 subjects, ages 8 to 19 years, with diplegic CP. Linear regression was used to determine change in lower extremity muscle strength (STR), measured by a validated dynamometer protocol; body weight; and strength normalized to weight. The cohort was analyzed as a whole, by age, and in groups based on functional impairment as reflected by Gross Motor Function Classification Scale (GMFCS) levels I to III.

Results: STR increased for the entire cohort at a rate of 20.83 N/Yr, and this rate of increase was significant ($p=0.01$). Weight increased for the entire cohort at a rate of 3.5 Kg/Yr, and this rate of increase was significant ($p<0.0001$). Lower extremity strength normalized to weight (STR-N) decreased for the entire cohort at a rate of 0.84 N/Kg/Yr, and this rate of decrease was significant ($p<0.0001$). The rate of decline in STR-N (N/Kg/Yr) was comparable among age groups of the children in the study group. There were no significant differences in in the rate of decline of STR-N (N/Kg/Yr) among GMFCS levels. Independent ambulation (GMFCS I or II) was likely (75% probability) when STR-N was 14 N/Kg (33 % predicted), and unlikely (25% probability) when STR-N was 0.5 N/Kg (1% predicted).

Conclusion: The results of this study support the longstanding clinical observation that STR-N decreases with age in children with CP. This decrease occurs throughout all of the growing years, and across GMFCS levels. Independent ambulation becomes less likely as STR-N decreases. This information can be used to provide guidelines for a range of interventions designed to promote ambulation in children with CP.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

To Brace Or Not? The Answer is "It Depends." Preliminary Results from BrAIST

Lori A. Dolan, PhD*; Stuart L. Weinstein, MD; BrAIST Study Group*
University of Iowa, Iowa City, IA

†LOE-Therapeutic - Level II

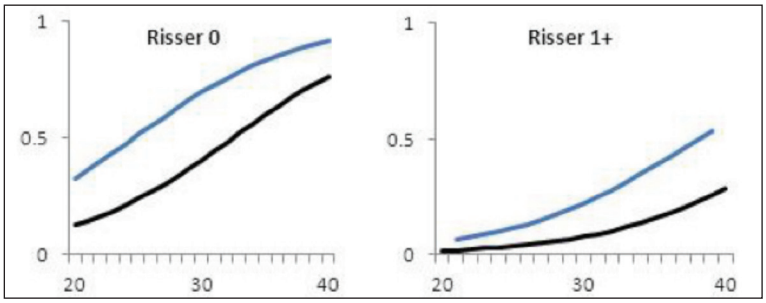
Purpose: The purpose of this analysis was to develop a simple, yet accurate, model of the risk of significant curve progression in AIS and the risk reduction associated with bracing.

Methods: Data from the first 240 subjects who completed BrAIST were used. 94 were observed and 146 were braced. All were followed until the Cobb exceeded 50° ("failure"), or until skeletal maturity. The relationship between age, SRS classification, Cobb angle of the largest curve, treatment and the outcome were evaluated. Logistic regression models were tested, and the most predictive 3 variable model was chosen.

Results: 52% of the observed group failed, compared to 28% of the braced group. Risser grade, age and Cobb angle were all associated with failure. The best-fitting model included the variables Risser (0 or 1+), Cobb angle and treatment (chi-square, $p<0.0001$, c statistic=0.807). Increasing Cobb angle was associated with higher probability of failure. In Risser 0 patients, the calculated probability of failure ranged from 32% (Cobb angle 20°) to 91% (Cobb angle 40°). Bracing reduced these probabilities to 13% and 76%, respectively. Probability of failure was much lower in Risser 1+ patients, ranging from 7% (Cobb angle 21°) to 53% (Cobb angle 40°), which reduced to 2% to 28% with bracing.

Conclusion: Risser 1+ patients present with a much lower risk of progression than those who are less mature. Larger Cobb angles are associated with increasing risk of failure. Bracing decreased the risk of failure for all patients, but the degree of benefit varied across presentations.

Significance: This model provides a simple, yet predictive model of the risk of curve progression and the decrease in risk due to bracing. Current indications brace many patients who are actually at low risk for significant progression, or whom benefit little from bracing. These results can be used by clinicians and families to make evidence-based decisions concerning bracing for AIS, with the family choosing observation or bracing based on their own risk-benefit considerations.



Risk of failure associated with Observation (grey line) and Bracing (black line) by Cobb angle

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Higher Implant Density Does Not Result in Increased Curve Correction or Improved Clinical Outcomes in Adolescent Idiopathic Scoliosis (AIS)

Tristan Nishnianidze, MD; Kenneth J. Rogers, PhD; Blazej A. Pruszczynski, MD; Petya Yorgova, MS; Baron S. Lonner, MD; ***Suken A. Shah, MD***
Nemours - Alfred I duPont Hospital for Children, Wilmington, DE

†**LOE-Therapeutic - Level III**

Purpose: Increasing attention is being focused on quality, safety and value, especially in spinal deformity surgery. The role of implant density, or the number of spinal anchors per level fused, is controversial; improved correction in the coronal plane may be obtained at significant expense and/or risk. The purpose of this study was to assess outcome after PSF for AIS and compare low vs. high-density constructs in a prospective cohort of AIS patients.

Methods: Seventy patients were identified from a multicenter prospective database of adolescents with AIS and minimum 2-year follow up. All patients had Lenke type 1 and 2 curves with predominantly (>80%) screw constructs. Screw density was calculated by dividing the number of screws by number of fused levels (s/l). In our data set 35 pts had ≤1.54 s/l, which was defined as the low-density construct group (LD) and all were included in the study. Thirty-five patients from the database with ≥1.8 s/l were selected to create a high-density construct (HD) group. Patients in HD group were matched by preop thoracic Cobb angle and age. Two-tailed independent sample t-tests with equal variances were conducted to variables including SRS outcomes scores, fusion length, thoracic, upper thoracic and lumbar Cobb angles, sagittal contour T2-T12, T5-T12, T2-T5, and global sagittal balance, preoperatively, immediately postoperatively and at 2 years follow-up.

Results: The groups were well matched preoperatively. No significant differences were found between the high and low-density groups for each variable postoperatively. The largest differences (non-significant) between groups were at 2-year postoperative proximal junctional kyphosis (4.3˚, p =0.07), pre operative sagittal T10-L2 angle (4.4˚, p=0.97), and preoperative sagittal T5-T12 angle (4.5˚, p = 0.18). Preoperative SRS total scores were similar (4.06 LD vs. 3.96 HD) and improved postoperatively in a similar fashion (4.50 LD vs. 4.49 HD), p=0.51.

Conclusion: These results suggest that for a large array of measures, there is no clinical or radiographic difference between high-density and low-density screw constructs in AIS. Should these results be further validated across many patients, curve patterns and long term outcomes, they would suggest that the use of low anchor density is equivalent in clinical practice. Additionally, lower density instrumentation techniques require less surgical time, may have fewer complications (malposition and bleeding), and certainly lower cost.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

An Evaluation of the Validity of a DNA-Based Prognostic Test for Adolescent Idiopathic Scoliosis

Benjamin D. Roye, MD, MPH*; Margaret L. Wright, BS; Hiroko Matsumoto, MA; Petya Yorgova, MS; Geraldine Neiss, PhD; Joshua E. Hyman, MD; David P. Roye, Jr, MD; Suken A. Shah, MD; Michael G. Vitale, MD, MPH*
Morgan Stanley Children's Hospital of New York Presbyterian, New York, NY

†**LOE-Diagnostic - Level III**

Purpose: Scoliscore was designed to estimate the risk of curve progression to >40° in patients with Adolescent Idiopathic Scoliosis (AIS). The role of this test in clinical practice remains unclear as a third party has not validated the test results. The purpose of this study was to determine if Scoliscore effectively stratifies risk of progression in our AIS patients.

Methods: 85 patients at two centers were administered the Scoliscore after meeting inclusion criteria (Caucasians with AIS, aged 9-13 with an initial Cobb angle 10°-25). Two groups were created: a progression group (Cobb>40° or fusion) and a non-progression group (skeletal maturity without curve progression). Scoliscore values and risk levels were compared between the two groups.

Results: The average Scoliscore for all 85 patients was 111 ± 58 (2-193). 23 patients (27%) had curve progression >40° or fusion. Scoliscore risk distribution in our population was 18.8% low (0-50), 65.9% intermediate (51-179), and 15.3% high (180-200). There was no significant difference in Scoliscore between patients with curve progression (108 ± 51) and those without (107 ± 63) (p=.279). The Positive Predictive Value (PPV) of the test was 0.23 (95% CI: 0.06-0.54) and the Negative Predictive Value (NPV) was 0.88 (95% CI: 0.60-0.98). Among patients with high risk scores, 23.1% had curve progression, compared to 12.5% of with low risk scores. Scoliscores and rates of progression were not affected by brace wear.

Conclusion: Scoliscores did not differ between patients with and without curve progression. The trend line in our study was not consistent with the risk of progression chart previously published. This deviation may be due to differences in our test population, such as higher acuity of practice in tertiary pediatric hospitals, (in)accuracy in race information, failure of non-progressors to follow-up, or limited sample size. As more of our patients reach skeletal maturity we will be better able to determine the clinical utility of this test. This preliminary work is the first attempt to externally validate and better understand the prognostic ability of the Scoliscore test.

Significance: This is the first study to independently evaluate the ability of the Scoliscore, a DNA-based prognostic test, to stratify risk of curve progression in patients with Adolescent Idiopathic Scoliosis.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Treatment of Femur Fractures in Children Ages 2-6: A Multi-Center Prospective Trial

Charles L. Lehmann, MD; John T. Anderson, MD; Daniel G. Hoernschemeyer, MD; Kathryn A. Keeler, MD; Matthew B. Dobbs, MD; Scott J. Luhmann, MD; June C. O'Donnell, MPH; Perry L. Schoenecker, MD; ***J. Eric Gordon, MD***
Washington University School of Medicine, St. Louis, MO

†LOE-Therapeutic - Level II

Purpose: Current AAOS guidelines for femur fractures in children age 2-6 years recommend early spica casting although some individuals have recommended intramedullary stabilization in this age group. The purpose of this study was to compare the treatment and socioeconomic impact of spica casting and flexible intramedullary nailing in this age group.

Methods: Patients ages two to six years old with acute, non pathologic femur fractures were prospectively enrolled at one of three children's hospitals. The treatment method was selected after discussion of the options by the surgeon with the family. Either early closed reduction with spica cast application or intramedullary stabilization using flexible intramedullary nails was accomplished under general anesthesia. Data was prospectively collected on patient demographics, fracture characteristics, complications, and pain medication. The Revised Impact on Family Scale (a validated instrument focusing on caregiver return to work, transportation difficulties, and mobility) was obtained at either the two or six week follow-up visit. Radiographs and clinical exams were also performed at the two week, six week, three month, and six month follow-up visits.

Results: Seventy-four patients were included in the study: 38 in the spica group and 36 in the nailing group. The mean age of the spica group was 2.7 years and the mean age of the nailing group was 3.2 years. All fractures healed with no evidence of malunion or more than 1.5cm of shortening. The Revised Impact on Family score was 43.5 for the spica group and 48.3 for the nailing group, a statistically significant difference ($p=.03$) in a multivariate analysis suggesting a lower impact on the family in the intramedullary nailing group. There was no significant difference between pain medication requirements in the first 24 hours postoperatively. One patient in the spica group returned to the operating room 2 weeks postoperatively with a soiled cast and was converted to intramedullary fixation at 2 weeks post fracture.

Conclusions: Both early spica casting and intramedullary nailing were effective methods of treating femur fractures in children 2-6 years of age. Intramedullary stabilization had a significantly lower impact on the family.

Significance: Therapeutic Level II – Prospective Observational Study. The treatment of femur fractures in younger children can impact families differently. Intramedullary stabilization provides an option in this age group that may be advantageous in some social situations that depend on the child's caregiver return to work or child mobility. Fracture treatment should be individualized based on factors that extend beyond anatomic and biologic factors.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Supracondylar Fractures with Isolated Anterior Interosseous Nerve Injuries: Are they Urgent Cases?

*Kody K. Barrett, BA; **David L. Skaggs, MD**; Jeffrey R. Sawyer, MD; Lindsay Andras, MD; Alice Moisan, BSN, RN, CCRP; Christine Goodbody, BS; John (Jack) M. Flynn, MD*
Children's Hospital Los Angeles, Los Angeles, CA

†**LOE-Prognostic - Level II**

Purpose: To determine if patients with supracondylar humerus (SCH) fractures with isolated anterior interossous nerve (AIN) injuries should be treated urgently.

Methods: A retrospective multi-center study of 4409 patients with operative SCH fractures was conducted. Exclusion criteria were nerve injuries other than the AIN, pulselessness, associated forearm fracture, open fractures, < 2 months follow-up, or pathological fractures.

Results: Thirty-five patients met inclusion criteria. The average time to surgery in these cases was 14.6 hours (range 2-36). There was no statistically significant difference in time to total return of AIN function when stratified by time to surgery (0-6 hours [4 pts]=55 days, 6-12 hours [9 pts]=53 days, 12-24 hours [21 pts]=74 days, >24 hours [1 pt]=28 days; P=0.668). Complete return of AIN function occurred in all patients with an average time to complete return of 49 days (range 2-224). 90% of patients recovered AIN function by 149 days. Five patients had reduced flexion or extension at time of final follow up, and one patient had a cubitus varus deformity that did not require surgical correction. No patients developed compartment syndrome.

Conclusion: This is the largest series of AIN injuries with SCH fractures in the literature. There is no evidence in this series that an isolated AIN injury in the setting of a SCH fracture requires the fracture to be treated urgently. Delay in treatment up to 24 hours did not lengthen the time of nerve recovery or lead to other complications.

It is critically important to stress that this series excluded cases with pulselessness, other nerve injuries, and associated forearm fractures which all may require urgent surgery, and that surgeons may have treated other cases urgently based on swelling, antecubital ecchymosis or other factors suggesting urgent care was needed.

Significance: Barring other clinical indications for urgent treatment of a SCH fracture, an isolated AIN may not by itself be an indication for urgent surgery. All AIN injuries in this series showed complete recovery at a mean of 49 days.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Screening Inflammation and Coagulation Activity Allows for Rapid Risk Stratification in Children Presenting with Symptoms of Musculoskeletal Infection

Megan Mignemi, MD; Kathleen Byington, NP; Jeffrey E. Martus, MD, MS; Christopher M. Stutz, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jonathan G. Schoenecker, MD***
Vanderbilt University Medical Center, Nashville, TN

†**LOE-Diagnostic - Level II**

Purpose: Children with dissemination of musculoskeletal (MSK) infection to multiple anatomic locations are more likely to suffer significant morbidity and mortality than those with isolated infection. Ideally, physicians would have the capacity to identify these patients early, thus allowing for more aggressive diagnostics and treatment. Despite recent progress in the discovery of inherent biomarkers induced by infection, such biomarkers and their use in rapid risk stratification of infection severity remain elusive. Importantly, it has been observed that bacteria directly or indirectly cause exuberant activity of the coagulation and inflammatory cascades. We therefore tested the hypothesis that simultaneous screening of coagulation and inflammatory markers (D-dimer and CRP respectively) upon presentation would prove a sufficiently sensitive and specific means of risk stratifying patients with MSK infection.

Methods: An IRB-approved prospective study of children evaluated for MSK infection was conducted over 2 years. Infections were categorized as 1) Aseptic (negative blood cultures) 2) "Local" (culture positive from one anatomic location with negative blood cultures) and 3) "Disseminated" (multifocal infection, positive blood cultures and/or thrombo-embolic disease - DVT or septic-PE). Standard laboratory values, relevant clinical information, CRP and quantitative D-Dimer were collected on each patient at time of presentation.

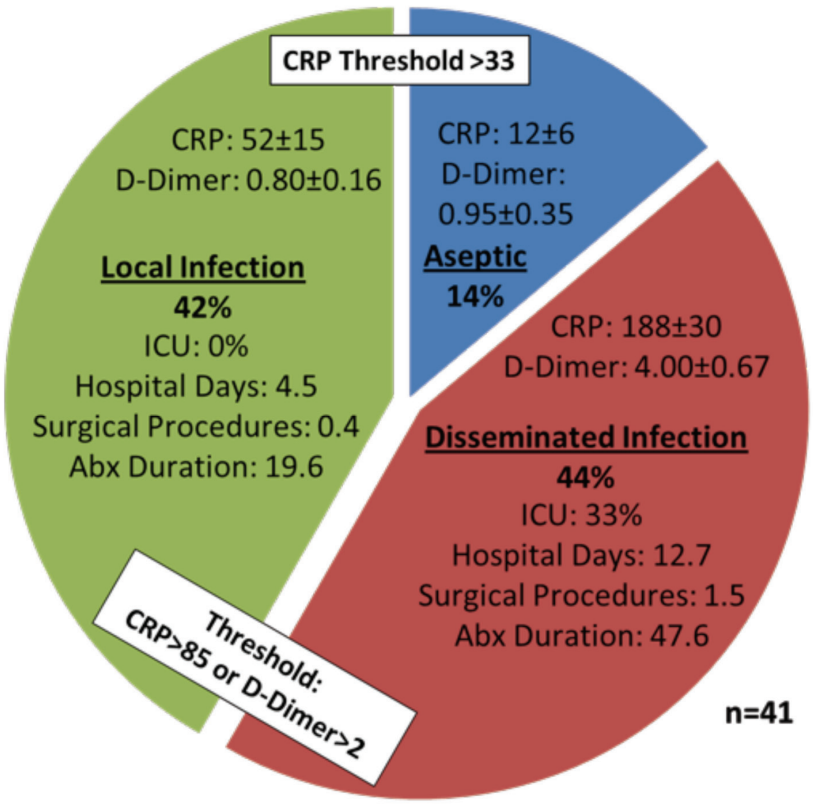
Results: A summary of the results are presented in the figure. Children with disseminated disease were significantly ($p<0.01$) more likely to: require ICU admission, have longer hospital stays, require more surgical procedures and need a longer duration of antibiotic treatment. CRP performed well at delineating aseptic, local and disseminated infection. CRP>33mg/L at presentation was predictive ($p<0.01$) of infection versus aseptic processes. CRP>85mg/L was predictive of disseminated versus local infection. D-dimer>2.00mcg/mL accurately identified disseminated versus local infection and patients with thromboembolic disease ($p<0.01$). Notably, temperature, WBC and ESR were not found to be predictive of a patient's infection category.

Conclusions: These defining parameters of infection accurately risk stratify children with MSK infection. CRP and D-dimer together are sufficiently sensitive and specific at providing information needed to rapidly risk stratify patients for greater severity MSK infection.

Significance: Monitoring laboratory values indicative of inflammatory and coagulation activity provides physicians with quantitative data required to risk stratify patients rapidly

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

at presentation with symptoms of MSK infection. The utility of this information is early identification of patients with disseminated disease thus indicating the need of more aggressive work-up, antibiotic and surgical treatment with the intent of reducing the risk of complications, hospital stay and cost associated with MSK infection.



†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Pavlik Harness Treatment May Not Be Necessary for All Newborns with Ultrasonic Hip Dysplasia

Harry K.W. Kim, MD*; Augusta Lloyd, MS; Adriana De La Rocha, MS; Brigid N. Maloney, MS; Erica Flores, RN MSN; Chan-Hee Jo, PhD; Lauren Paraison, BA*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level IV**

Purpose: Currently, there is no clear treatment guideline for management of newborns with ultrasonic hip dysplasia (UHD), defined as having a normal hip exam and α angle <55°. As a result, some physicians routinely treat with Pavlik harness (PH) while others observe. Purpose of this study was to assess the treatment patterns of 7 pediatric orthopedic surgeons for UHD at a tertiary referral center and to determine the outcomes of patients managed with PH or observation (OB).

Methods: This is an IRB approved prospective study of 1,324 babies referred to a tertiary center for DDH from 2008-13. Babies ≤ 6 wks of age with UHD were included. Diagnostic criteria for UHD were normal hip exam, α angle <55°, and head coverage >10%. Statistical analyses included t-test, chi-square test, Fisher's Exact and logistic regression.

Results: 128 hips in 89 consecutive patients met the inclusion criteria. 67 hips (52%) were treated with PH. 61 hips (48%) were observed (OB). Of the 7 physicians, 1 treated all patients with PH while 6 used OB or PH. Mean α angle was lower in the PH vs. OB group (48±4^{o} vs. 50±3^{o}, p<0.001). Mean head coverage was also lower in the PH vs. OB group (30 ±9% vs. 38±8%, p<0.001). Logistic regression analysis revealed that a lower head coverage had a more significant impact on treatment decision for PH vs. OB than the α angle (OR 0.91, p<0.001). In terms of outcome, no difference in rates of good outcome was observed between the groups (PH 94% vs. OB 89%, p=0.21) at follow-up ultrasound defined as α angle ≥ 60° and head coverage ≥50%, or acetabular index ≤25° on 1 year x-ray. Two OB hips were initially observed and later treated with PH, and noted as failed outcome for OB. PH group had a significantly higher number of hip ultrasounds (4.7 ±2.6 vs. 2.8 ±1.2, p<0.001).

Conclusion: Even in one center, treatment patterns for UHD varied considerably. Interestingly, the amount of head coverage had a greater influence on treatment decision for PH than the α angle. While the PH group had lower head coverage and α angle, 89% of the OB group had good outcomes at follow-up, suggesting that not all patients with UHD need PH treatment.

Significance: Results suggest that not all patients with UHD need to be treated. Longer follow-up and further studies are needed to develop specific treatment guideline and criteria for UHD.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Natural History of Scoliosis in Osteogenesis Imperfecta

Peter A. Smith, MD*; Alireza Anissipour, DO; Joseph Krzak, PhD; Angela Caudill, MPT; Sahar Hassani, MS; Kim W. Hammerberg, MD*
Shriners Hospitals for Children, Chicago, IL

†**LOE-Therapeutic - Level III**

Purpose: Spinal deformities are frequent in Osteogenesis Imperfecta (OI). We sought to describe the behavior of spinal curvature during growth in patients with OI and establish the relationship to disease severity, mobility status, and medical treatment with bisphosphonates.

Methods: The medical records and radiographs of children and young adults with OI were reviewed in this IRB approved retrospective study. Severity was classified by the modified Sillence classification and also by the Functional Mobility Score (FMS). For each participant with scoliosis, serial curve measurements were recorded throughout follow up.

Results: A total of 316 patients diagnosed with OI were found and 157 patients with scoliosis were identified, a prevalence rate of 50%. Scoliosis prevalence (68%) and progression rate (6 degrees per year) were the highest in the most severely affected group of patients, those with modified Sillence type III. An intermediate group, modified Sillence type IV, demonstrated intermediate values (54%, 4 degrees per year). The mildest group of OI patients, modified Sillence type I, had the lowest prevalence (39%) and rate of progression (1 degree per year). The FMS 50 meter score was also predictive, with those using a wheelchair (FMS=1) showing increased curve prevalence and progression than the independent ambulators without an assistive device (FMS= 5 or 6). Individuals who walked with an assistive device (FMS=2,3 or 4) had intermediate severity of scoliosis degree and progression (Figure 1). Early treatment, before age 6, with bisphosphonate therapy in type III OI decreased the progression rate by 3.8 degrees per year, which was statistically significant. We were unable to show a benefit of bisphosphonate treatment on curve behavior in other types of OI or at an older age.

Conclusion: The prevalence of scoliosis is much higher in OI than the general population. Functional mobility was predictive by the level of scoliosis severity and cobb angle. The Progression rates of scoliosis with OI are variable depending on severity of OI. High rates of progression in types III and IV OI contrast with type I OI, which follows a more benign course. Bisphosphonates initiated before age six can modulate curve progression in type III OI.

Significance: These findings showed a high rate of significant spinal deformity in children and young adults with severe OI, as defined by Sillence type and the functional mobility score. Our data indicate significant benefits of treating children with severe OI with bisphosphonates at an early stage.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

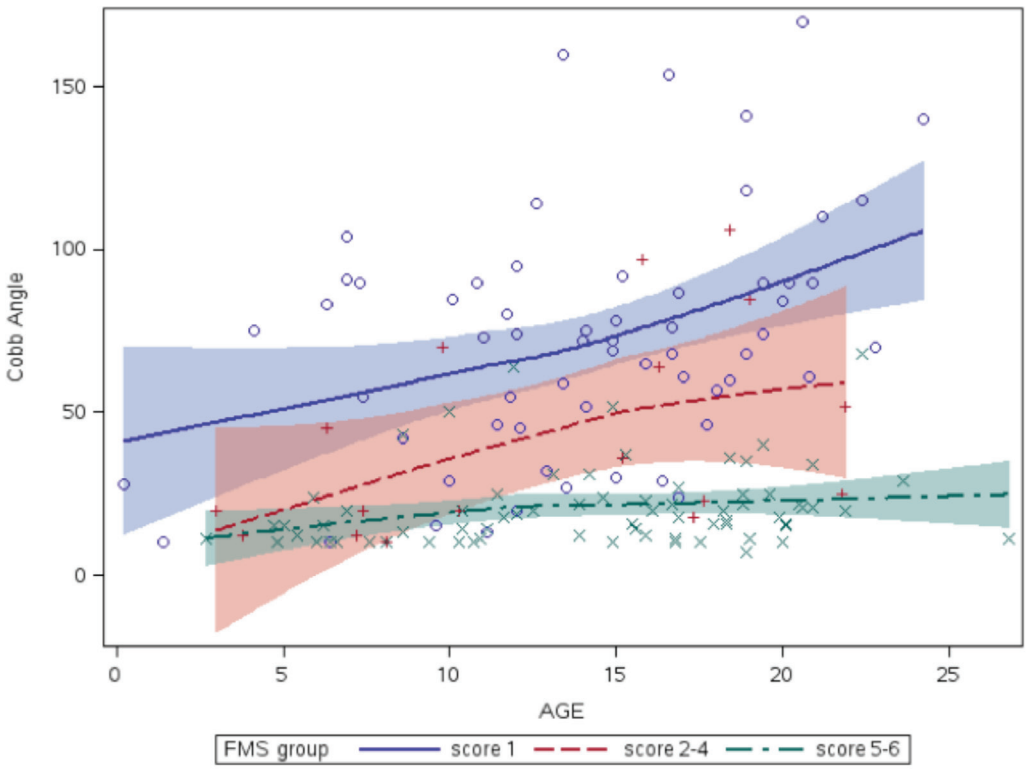


Figure 1.A scatterplot shows cobb angle measurements at different ages for all individuals with OI and scoliosis. Patients are divided in to three groups based on severity of OI as measured by the Functional Mobility Scale (FMS).Patients who were independent ambulators on even and uneven surfaces(FMS Scores 5 and 6) had lower cobb angles than those who use a cane, crutches or walker (FMS scores 4,3,2) and those who require a wheelchair for mobility (FMS score 1) .

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Diagnostic Value of Intra-Operative Monitoring and Early Post-Operative Spect-Bonescan in the Assessment of Femoral Head Vascularity After Surgical Dislocation for Slipped Capital Femoral Epiphysis

***Oliver Birke, MD**; Kyle James, FRCS (Ortho), MBBS; Paul Gibbons, MD; David G. Little, MD, PhD*
The Children's Hospital at Westmead, Sydney, AUSTRALIA

†**LOE-Diagnostic - Level II**

Purpose: Correlation of femoral head vascularity using intra-operative monitoring and post-operative SPECT-Bonescan (Photon Emission Computed Tomography) with radiological evidence of femoral head collapse at a mean of 1.3 years after treatment of slipped capital femoral epiphysis (SCFE) via a surgical hip dislocation approach.

Methods: From April 2011, intra-operative monitoring of the femoral head perfusion was performed using an ICP Pressure Probe (Codman®). All patients had a post-operative 3-phase bonescan at day 5-7 with delayed phase pin-hole and SPECT-CT (reported by a Nuclear Medicine Radiologist). A vascularised femoral head on SPECT-Bonescan was classified as viable and patients commenced weight-bearing at 6 weeks. A non-vascularised femoral head was classified as non-viable and patients were managed with 12 months non-weight-bearing (NWB) and Bisphosphonate treatment.

Results: Of the 77 SCFEs treated since April 2011, 38 slips had sufficient FU (mean 1.3 years (0.9-2.5). There were 22 stable [mean posterior slip angle (PSA) 58 (40-85)] and 16 unstable SCFEs [mean PSA 62 (35–82)]. In the stable group 21/22 were pulsatile on intra-operative monitoring; all 22 were viable on SPECT-Bonescan. The one case with no intra-operative pulse (chronic, severe slip PSA 85) later collapsed.
In the unstable group 12/16 were pulsatile on intra-operative monitoring, with 10/16 viable on SPECT. There was no collapse of SPECT viable cases. Of the 6 non-viable cases 3 showed collapse, defining the non-viable SPECT cases as the 'at risk group' for collapse.
Pulsatile intra-operative monitoring had a positive predictive value (PPV) of 100% for no collapse in stable and 83% in unstable slips, a negative predictive value (NPV) of 100% in stable and 25% in unstable SCFE. A viable SPECT-Bonescan had a 95% PPV in stable SCFE (0% NPV), and 100% PPV and 50% NPV in unstable SCFE. Pulsatile intra-operative monitoring combined with a viable SPECT-Bonescan had a 100% PPV for no collapse in stable and unstable SCFE, 100% NPV in stable and 50% in unstable SCFE.

Conclusion: In stable SCFE intra-operative monitoring, once established, may be sufficient alone to assess femoral head vascularity (100% PPV). In unstable SCFE a viable post-operative SPECT-Bonescan (100% PPV) complements the 83% PPV of intra-operative monitoring. A non-viable SPECT-Bonescan had a 50% NPV of collapse at 1.3y FU under NWB and Bisphosphonte treatment.

Significance: Intra-operative monitoring and SPECT-Bonescan are valuable in guiding post-operative return to weight-bearing and treatment in an aim to prevent collapse of non-viable 'at risk' cases.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Time and Money: Do Medicare RVUs Match Physician Time Requirements for Orthopaedic Procedures?

Apurva S. Shah, MD, MBA*; Jenniefer Y. Kho, MD; Phinit Phisitkul, MD; Peter Cram, MD, MBA; Alison L. Klaassen, MA*
University of Iowa Hospitals and Clinics, Iowa City, IA

†**LOE-Economic & Decision - Level I**

Purpose: Physician payments under Medicare and most private insurance programs are derived from Relative Value Units (RVUs). Physician work RVUs are assumed to capture physician time needed to provide a service over a 90-day global period. No independent validation of RVU allocation in orthopaedic surgery, or pediatric orthopaedics, has been reported. This study evaluated the correlation between work RVUs and physician time in orthopaedic surgery, in particular pediatric surgery, at a single academic institution.

Methods: We sampled 41 different orthopaedic procedures performed at a single institution in nine subspecialties. For each procedure, all cases assigned a single CPT code were queried between 2009-2012 (n=5,737). For each procedure, a process map characterizing the care pathway during the 90-day global period was constructed. Time stamps and process utilization were assigned to each process step using electronic medical record data (operative time, length of stay, number of pre- and postoperative clinic visits). For process steps without recorded time stamps (preoperative evaluation, surgical planning, inpatient care, and postoperative care), a blinded survey was administered to 37 providers (orthopaedic surgeons, midlevel providers, residents) and used to estimate time stamps. All recorded and estimated time stamps were averaged for each procedure and each of the three provider groups, and then totaled. Pearson correlation coefficient between work RVU and total time per procedure was determined for each subspecialty and all procedures combined. The ratio of time-to-RVU was compared based on volume and complexity, and among subspecialties.

Results: There was moderate correlation between RVU and total time for all cases combined (r=0.60), and a weak correlation between RVU and time in pediatrics (r=0.51). Complex procedures had a proportionate increase in RVU allocation. High volume procedures demonstrated a lower time-to-RVU ratio compared to low volume cases. Among subspecialties, pediatrics had one of the lowest time-to-RVU ratios, while foot and ankle had the highest ratio.

Conclusion: There was substantial amount of variability in the relationship between RVU and time across subspecialties at a single academic institution. There was weak correlation between RVU and time in pediatrics, and a low time-to-RVU ratio.

Significance: Work RVU does not accurately represent actual physician time expended in providing an orthopaedic surgical service. Future studies with objective time tracking in a broader range of orthopaedic facilities and procedures are required to further determine physician work effort in pediatric surgery, and orthopaedic surgery in general.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

♦ Local Administration of BMP-2 and Ibandronate Improves Bone Healing During Non-Weight Bearing Treatment of Ischemic Osteonecrosis of the Femoral Head in Immature Pigs

Harry K.W. Kim, MD*; Olumide Aruwajoye, MS; Justin Y. Du; Nobuhiro Kamiya*
Center for Excellence in Hip Disorders, Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level II**

Purpose: Local non-weight bearing (NWB) is a common treatment for Legg-Calvé-Perthes disease. In a recent study, NWB treatment was shown to decrease femoral head deformity but increase bone resorption without increasing new bone formation in a piglet model of ischemic osteonecrosis. It is unknown whether biological treatments can stimulate new bone formation during NWB treatment. The purpose of this study was to determine if local administration of BMP-2 with or without bisphosphonate can improve the bone healing during the NWB treatment in the large animal model of ischemic osteonecrosis.

Methods: Eighteen piglets were surgically induced with unilateral femoral head ischemia. Immediately following the ischemia surgery, all animals received an above knee amputation to induce local NWB treatment. One to 2 weeks later, 6 animals received local BMP-2 to the necrotic head (BMP+NWB group), 6 received local BMP-2 and ibandronate (BMP+IB +NWB group), and the remaining 6 received no biological treatment (NWB group). All animals were sacrificed at 8 weeks post-ischemia when moderate to severe deformity is expected in this model. Radiographic, micro-CT, and histomorphometric assessments were performed. Statistical analysis included analysis of variance (ANOVA).

Results: Radiographic and micro-CT assessments showed none to a mild femoral head deformity in all groups with no significant difference in the epiphyseal quotient. Micro-CT analyses, however, showed significantly higher femoral head bone volume in the BMP+IB+NWB group compared to the BMP+NWB group ($p=0.02$) and the NWB group ($p=0.008$). BMP+IB+NWB and BMP+NWB groups had a significantly higher trabecular number ($p<0.01$) than the NWB group. Histomorphometric analyses showed similar findings. In addition, the osteoclast number per bone surface was significantly lower in the BMP+IB+NWB group compared to the NWB group. Calcein labeling showed significantly higher bone formation in the BMP+NWB and BMP+IB+NWB groups compared to the NWB group ($p<0.05$). Interestingly, heterotopic ossification was found in the hip capsule of 4 out of 6 hips in the BMP+IB+NWB group (2 mild, 1 moderate, 1 severe) but none in the BMP+NWB group.

Conclusion: Local administration of BMP-2 and bisphosphonate can improve the bone healing during NWB treatment of ischemic osteonecrosis but heterotopic ossification is a concern.

Significance: Local administration of BMP-2 significantly improved bone volume and new bone formation during NWB treatment with the combined BMP-2 and bisphosphonate therapy providing the best results. Further studies are needed to improve the retention of BMP-2 within the femoral head during a combined BMP+IB therapy to prevent heterotopic ossification.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

♦ rhBMP-2 and Zoledronic Acid Treatment in an Animal Model of Congenital Pseudarthrosis/NF1

David G. Little, MBBS, PhD*; Nikita Deo, BMedSci/Hons; Aaron Schindeler, PhD*
The Children's Hospital at Westmead, Sydney, AUSTRALIA

†LOE-Therapeutic - Level I

Purpose: Congenital pseudarthrosis of the tibia (CPT) is a severe orthopaedic complication of the genetic condition, Neurofibromatosis type 1 (NF1) which develops following fracture of dysplastic tibiae. Healing is recalcitrant, involving multiple surgical interventions and even amputations. In light of previous preclinical studies, we hypothesised that recombinant human bone morphogenetic protein-2 (rhBMP-2) co-treated with a bisphosphonate (zoledronic acid/ZA) would improve bone union and reduce fibrosis tissue in a mouse model of *Nf1-/-* pseudarthrosis which replicates a high rate of non-union, poor new bone formation, excessive osteoclast-driven bone resorption and invasion of mesenchymal/fibrous tissue.

Methods: We have published a mouse model of NF1 pseudarthrosis where we locally inactivate the *Nf1* gene at the site of a tibial fracture. This model results in a high non-union rate and contains proliferative fibrous tissue, reflecting human NF1/CPT. Interventions included 10μg rhBMP-2 introduced locally at the fracture via a collagen sponge and 5 doses of 0.02mg/kg ZA delivered systemically starting 3 days post-operatively. Experimental groups assessed individual treatments as well as rhBMP-2/ZA combination to assess synergistic effects (n=15/group). Primary outcomes measures were x-ray, micro-CT and histology at 3 weeks post-fracture.

Results: Animals treated with rhBMP-2/ZA showed the highest rate of bone union (93%) compared to vehicle (7%*), ZA (0%*), and rhBMP-2 alone (86%) (*$p<0.0001$). Treatment with rhBMP-2 alone produced a 3-fold increase compared to vehicle ($p<0.0001$), and a 2-fold greater increase in BV compared to ZA ($p<0.0001$). Co-treatment with rhBMP-2/ZA led to significant increases in BV compared to vehicle**, ZA** and rhBMP-2** (**$p<0.0001$). Callus fibrous tissue was decreased with rhBMP-2/ZA co-treatment vs. vehicle and rhBMP-2 groups.

Conclusion: Co-treatment of rhBMP-2/ZA was beneficial to bone union rates, reducing callus fibrous tissue, and increasing callus BV in the repair of a model of *Nf1-/-* fractures featuring fibrosis and excessive osteoclastogenesis.

Significance: This data demonstrates the utility of our pre-clinical model for screening therapies for NF1/CPT. This data supports the advancement of clinical trials to assess the efficacy of rhBMP-2 and rhBMP-2/ZA combination therapy as adjunctive therapies for the treatment of NF1/CPT.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Pericytes as the Cell of Origin for Pediatric Osteosarcoma: Implications for the Development of a New Approach to Therapy

Shingo Sato, MD, PhD; Quingxia Wei, PhD; ***Benjamin A. Alman, MD, FRCSC***
Hospital for Sick Children, Toronto, ON, CANADA and Duke University, Durham, NC

†**LOE-Therapeutic - Level II**

Purpose: Identifying the cell of origin of sarcomas can be used to develop new therapies, as drugs which suppress cell growth, or drive cell death, in the cell of origin will do the same in the sarcoma. This study's purpose was to use human samples and mice that develop osteosarcomas to identify the cell of origin, and test a drug that targets this cell type as a treatment for osteosarcoma.

Methods: 8 human osteosarcomas from children and 10 osteosarcomas that developed in pediatric aged p53 mutant mice (equivalent of human Li–Fraumeni syndrome) were screened for cell surface markers for various cells in the mesenchymal lineage. Markers expressed in sarcomas from both species were then studies for the cell of origin in the mutant mice, by crossing them with a mouse that genetically labels the cell of origin with a marker, and determining if the marker was present in the sarcomas that developed. A p53 mutation was also expressed in theses cells using a similar genetic approach, and the mcie were observed for the development of osteosarcomas. Lastly, a drug that targeted the cell of origin was tested for its effects on viability in human osteosarcoma cell cultures

Results: The osteosarcomas all expressed markers of pericytes, which are connective tissue cells surrounding blood vessels. Osteosarcomas that developed in skeletally immature P53 mutant mice in which pericytes were genetically labeled (using a mouse driving expression in the gene, Ng2), all stained positive as originating from pericytes. Driving the p53 mutation in pericytes resulted in the development of osteosarcomas in the mice. Treating osteosarcoma cell cultures with a PDGF inhibitor, which targets pericytes, resulted in a 45% decrease in cell viability ($P<0.001$).

Conclusion: Pericytes are the cell of origin for pediatric osteosarcomas. A PDGF inhibitor, which targets pericytes, also significantly decreased cell viability in osteosarcoma cultures.

Significance: Understanding the cell of origin in pediatric osteosarcoma suggests a novel approach to identify therapeutic targets. PDGF inhibitors are in clinical development, and this data suggests that such drugs may be effective in the treatment of osteosarcomas in childhood.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Increased Incidence of Private Variants in the Marfan Syndrome Fibirillin-1 Gene in Adolescent Idiopathic Scoliosis Patients

Matthew B. Dobbs, MD
Washington University School of Medicine, St. Louis, MO

†**LOE-Prognostic - Level I**

Purpose: Adolescent idiopathic scoliosis (AIS) is a poorly understood spine deformity occurring in 3% of the population. Scoliosis is also a common feature of Marfan syndrome, a disorder caused by mutations in the fibrillin-1 gene (*FBN1).*

Methods: We sequenced all 65 exons of the FBN1 gene in 246 AIS patients of European ancestry using a combination of exome sequencing and a novel multiplexed BAC-based selection method that was developed in our laboratory. Ghent hypermobility testing was recorded on all patients. pSMAD2 levels in muscle tissue were tested in 10 of the patients in this cohort.

Results: Analysis of sequencing data revealed a higher incidence of *FBN1* private variants causing nonsynonymous amino acid substitutions in AIS patients (n=246) compared to controls (n=465) (4.1% vs. 0.6%; p=6.4x10-4; OR=6.41). AIS patients with *FBN1* private variants had severe spinal curvatures necessitating spinal fusion surgery, but only one patient met the criteria for Marfan syndrome after clinical genetics evaluation. The patient cohort had elevated Ghent hypermobility scores but did not meet the criteria for Marfan syndrome. Elevated pSMAD2 was present in muscle from 10 of the AIS patients with *FBN1* singleton variants.

Conclusions: We identified a subset of AIS scoliosis patients with a distinct hypermobility phenotype and severe progressive scoliosis. This cohort had FBN1 variants though did not have Marfan syndrome.

Significance: These findings may aid in the identification of a population of AIS patients at high risk for curve progression. In addition, these findings will lead to a better understanding of the etiology of AIS. Elevated pSMAD2 was present in muscle from AIS patients with *FBN1* singleton variants, underscoring the importance of rare fibrillin variants and activation of the TGF-β pathway in the pathogenesis of AIS.

.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Direct Growth Stimulation Using Local Growth Hormone: a Proof of Principle Study

*David Lebel, MD; Ben**jamin A. Alman, MD, FRCSC***
Hospital for Sick Children, Toronto, ON, CANADA and Duke University, Durham, NC

†**LOE-Therapeutic - Level V**

Purpose: Limb length discrepancy and angular deformities in the growing skeleton are traditionally treated by methods that induce a permanent or temporary growth arrest. An enticing alternative is to stimulate the growing skeleton to correct deformity. Direct stimulation around an isolated growth plate using human growth hormone will increase growth locally in hypophysectomized rats, but it is not clear if this will work in animals with normal growth hormone levels. The purpose of our study was to determine if direct injection of growth hormone near the epiphyseal growth plate could be used to stimulate growth locally, but not systemically, in healthy mice under physiologic conditions.

Methods: 4 week old mice (equivalent to a ten year old child) were injected adjacent to the proximal tibial growth plate with either a carrier, or with a carrier with low or high dose of slow release recombinant growth hormone (GH) added. As an additional control, GH was injected into the knee joint. Intra-peritoneal calcein was injected on the 8th and 13th days and animals were sacrificed on the day after the last injection. Following tibial bone harvest the length was measured, the bones were preserved in 10% formalin and then resin embedded to preserved the calcein label for growth rate calculation.

Results: Direct tibial length measurement revealed a modest increase in growth in animals that were injected with high dose GH. Growth rate calculation yielded response to PBS injection of 15%, while high dose GH resulted in a 26% increase in growth rate among the high dose injected animals (n=5 in each group). No systemic response to the injected GH was seen. The low dose GH or GH injected into the joint did not result in statistically significant local growth stimulation.

Conclusion: Direct injection of a slow release GH into the proximal tibial epiphysis in native mice has a positive affect on growth rate.

Significance: Selective growth stimulation may have a clinical application in patients with a deformed skeleton and functioning growth plates. Our proof of principle study used a drug already approved for use in patients. By refining the technique to allow slow release locally, it may be possible to develop a novel method to address limb and spine deformities in growing children.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

The Development of Vascularity in a Healing Fracture

Masato Yuasa, PhD; Nicholas Mignemi, BS; ***Jonathan G. Schoenecker, MD***
Vanderbilt University Medical Center, Nashville, TN

†**LOE-Diagnostic - Level IV**

Purpose: Fracture angiogenesis is an indispensable process in fracture and osteotomy healing. Despite incremental advances in our understanding of the bone specific cells and growth factors responsible for the development of new bone during fracture healing, there have been fewer advances in our comprehension of angiogenesis during fracture repair. As a result, our capacity to augment fracture associated vascularity is limited. In an effort to define the key stages of fracture angiogenesis, we adapted advanced vascular imaging techniques with our murine model of displaced/stabilized femur fractures to allow for resolution of the temporal and spatial development of vascularity in healing fractures relative to key biological points fracture healing.

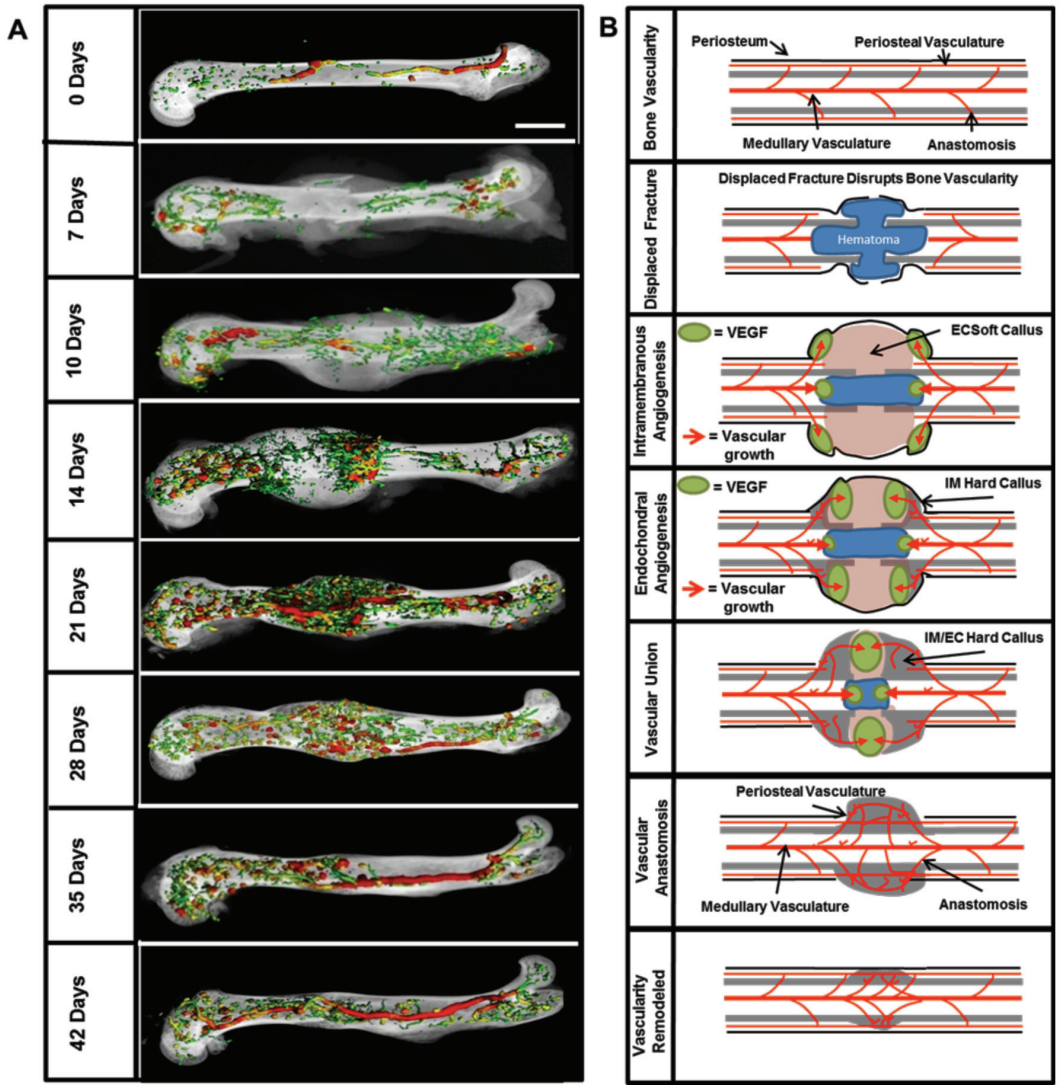
Methods: Mid-shaft femoral osteotomies (n=158) were fixed by a 23-gauge needle. Fracture healing was followed with the Faxitron X-ray system. Mice were sacrificed at 7-42 days after surgery and samples were processed for Microfil perfusion, μCT and histology.

Results: Representative data is presented in Figure A. Fractures with significant injury to the intramedullary vasculature revascularize initially through the development of a trans-periosteal vascular network as a result of increased flow diverted centrifugally resulting from interruption of downstream medullary vascularity. In support of this observation, many enhanced vascular anastomosis developed between the medullary vasculature and the areas of periosteal vascular engorgement. Following the initial phases of fracture revascularization there exists centrally, an avascular cartilaginous matrix predominated by VEGF-A/VEGFR-1 negative cells surrounded by peripherally, a richly vascular new bone matrix predominated by endothelial cells and osteoblasts expressing high levels of VEGF-A/VEGFR-1. Histological data revealed hypertrophic VEGF-A producing chondrocytes in all areas of transition from avascular/soft tissue to vascular hard tissue callus. The chondrocytes continued to hypertrophy and release VEGF-A in a manner which directs the polarized bone formation together, the periosteal vasculature and bone eventually unite. Following vascular union our results reveal that bone remodeling follows vascular remodeling in which intra-medullary vascularity is re-established.

Conclusions: From these data, in conjunction with classical studies of fracture angiogenesis, we propose a novel model defining the process of bone revascularization (Figure B).

Significance: As the most commonly associated diseases associated with fracture/osteotomy delay or non-union all impose vascular disease, it is proposed that addressing the vascular impairment in these patients will significantly reduce fracture healing complications. As such, it is our hope that this novel model of fracture revascularization of displaced/stabilized fractures/osteotomies will provide insight as to the cause, and potential means to restore bone healing.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.



A) Representative images defining the temporal and spatial development of vascularity during fracture healing.

B) Novel model defining the stages of vascular development following a displaced/ stabilized fracture or osteotomy. (VEGF- Vascular endothelial growth factor; EC- endochondral; IM- intramembranous)

†LOE - Level of Evidence - Please see page 16 for details.

See pages 17 - 62 for financial disclosure information.

Adult Trauma Surgeons More Frequently Offer Surgery to Adolescents with Displaced Clavicle Fractures

T. David Luo, BS; Ali Ashraf, MD; ***A. Noelle Larson, MD****; Amy L. McIntosh, MD; Anthony A. Stans, MD; William J. Shaughnessy, MD*
Mayo Clinic, Rochester, MN

†**LOE-Therapeutic - Level IV**

Purpose: Until recently, clavicle fractures in adolescents have been treated nonoperatively with good short-term results. Studies suggest improved biomechanics with surgical management of displaced, shortened fractures. The appropriate surgical indications for clavicle fractures in adolescents are not well-established. We hypothesized that adult traumatologists more frequently offer surgical management for adolescent clavicle fractures compared to pediatric orthopedists.

Methods: From 2005-2013, 120 adolescents (aged 10-17) were treated for 125 diaphyseal clavicle fractures, of which 104 were displaced. The medical records and radiographs were reviewed to determine fracture pattern, treatment, complications, and treating physician (pediatric orthopedist, adult traumatologist, and primary care/nonoperative physician). Patients with missing injury films were excluded. Mean radiographic shortening was 1.2 cm (range 0.2 – 3.4 cm). Mean follow-up was 122 days.

Results: Pediatric orthopaedic surgeons treated 54 displaced fractures (mean shortening of 1.2 cm, range 0-3), resulting in 8 surgeries (11%). Of the 8 fractures treated surgically, 7 had a vertical fragment. Adult traumatologists treated 31 displaced fractures with a mean shortening of 1.5 cm (0-3.4), of which 13 were treated surgically (42%, p=0.0006). Primary care physicians treated 19 fractures, none of which were treated surgically (mean shortening 0.5 cm, range 0-1.5). Adult surgeons operated on nearly all fractures with > 1.5 of shortening (Figure). Pediatric orthopedic surgeons offered surgery for only 7 of the 21 patients > 1.5 cm of shortening. Mean age of adolescents treated surgically was 15 years (range 14-17) vs. nonsurgical group 14 years (range, 10-17, p<0.001). No patient under age 14 had surgical management. There was one delayed union and no nonunions in the nonoperative group. Of the 22 patients treated surgically, four (18%) experienced complication or reoperation, including implant removal for prominence (1), refracture treated with immobilization (1), refracture treated with revision fixation (1), and nonunion with implant failure requiring revision surgery (1).

Conclusion: Most patients treated surgically by pediatric orthopedists had a vertical fragment with comminution. Adult traumatologists, however, operated on nearly all clavicle fractures in adolescents with 1.5 cm or more shortening. Refracture or additional surgery occurred in 18% of patients postoperatively.

Significance: There is wide practice variation for the management of adolescent clavicle fractures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

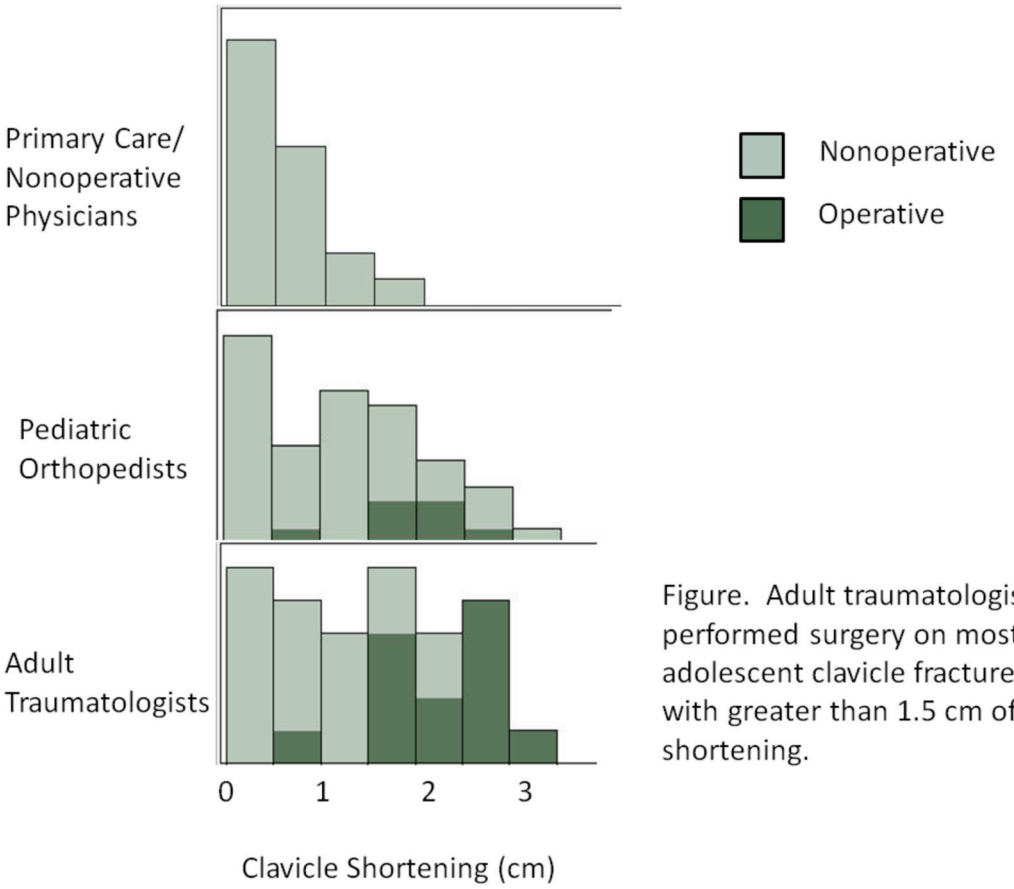


Figure. Adult traumatologists performed surgery on most adolescent clavicle fractures with greater than 1.5 cm of shortening.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Outcomes of Operative and Non-Operative Treatment of Adolescent Mid-Diaphyseal Clavicle Fractures

*Benton E. Heyworth, MD; **Sasha Carsen, MD, MBA**; Collin J. May, MD; Kyna S. Donohue, BA; Dennis E. Kramer, MD; Mininder S. Kocher, MD, MPH; Donald S. Bae, MD*
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level III**

Purpose: The optimal treatment approach to clavicle fractures in adolescents remains an area of significant controversy. The purpose of this study was to review the demographic characteristics, treatment approaches, and complications reported in a large series of clavicle fractures treated with surgical and non-surgical treatment in an exclusively adolescent population.

Methods: Radiographic and chart review was conducted for all cases of patients ages 10-18 years-old who presented to a single tertiary care children's hospital between 1999-2011 with a mid-diaphyseal clavicle fracture. Demographic data, radiographic features, such as fracture pattern, operative details when applicable, and post-treatment clinical course was analyzed, including the reported time to healing and any known complications.

Results: Out of 641 cases reviewed (79% male; mean age 14.3 years), 408 (64%) fractures were sustained during sports, most frequently football (25%), hockey (18%), soccer (12%), snowboarding (12%) and skiing (9%). Other common mechanisms of injury were falls sustained outside of athletic activity (19%) and motor vehicle accidents (5%), with similar distribution of mechanism and similar rates of associated injuries seen within the operative (5%) and nonoperative (6%) treatment groups. Greater numbers of clavicle fractures were seen annually over the study period. Among the overall cohort, 82% were treated non-operatively, while 18% were treated surgically, with increasing percentage of patients undergoing surgery over the course of the study period. The mean age was higher in the operative group (15.5 years) than the nonoperative group (14.1 years)($p<0.01$). Documented complications occurred in 59 patients (9.2%), were significantly more common in the operative (17%) group than the nonoperative (7%) group ($p<0.002$), and were more common in older patients ($p<0.01$). The rate of symptomatic hardware was 14% in the operative group (leading to plate removal in 11% cases), while the rate of symptomatic malunion was 2% in the nonoperative group, with older patients being more likely to have a symptomatic malunion ($p<0.03$). Rates of refracture were 2% and 4% and non-union 1% and 0.2% in the operative and nonoperative groups, respectively. No infections were reported in either group.

Conclusion: Greater numbers of clavicle fractures are being seen in the adolescent population, with over 60% of cases occurring during sports and an increasing trend towards operative treatment in recent years. Complication rates appear to be more common following operative management, the most common of which is symptomatic hardware.

Significance: Prospective clavicle fracture research is needed to better understand optimal treatment selection in the adolescent population.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Severity of Soft Tissue Injury is Associated with Neurovascular Injury in Pediatric Supracondylar Humerus Fractures

Christine Ann Ho, MD*; David A. Podeszwa, MD; Anthony I. Riccio, MD; Robert L. Wimberly, MD; William T. Gheen, BA*
Texas Scottish Rite Hospital-Children's Medical Center Dallas, Dallas, TX

†**LOE-Prognostic - Level IV**

Purpose: Neurovascular injury in pediatric supracondylar fractures has been associated with fracture classification but not with soft tissue injury. The purpose of this study is to correlate clinical soft tissue damage to neurologic and vascular injuries as well as outcome scores in pediatric supracondylar humerus fractures.

Methods: This is an IRB approved prospective study from January 2010 through May 2013 of 454 operatively treated pediatric supracondylar humerus fractures. Prospective data was gathered both pre-operatively and intra-operatively regarding detailed neurovascular exam as well as soft tissue status, with qualitative descriptives for swelling (mild/moderate/severe), ecchymosis, abrasions, skin tenting, and skin puckering. PODCI, QuickDASH, and Mayo elbow scores were obtained at final fracture follow-up at 3-4 months post injury.

Results: Average age at surgery was 4.80 years (standard deviation 2.85). 16 patients had a non-palpable pulse pre-operatively, and 33 patients had a neurologic injury (median nerve/AIN=20, ulnar nerve=7, radial nerve=6). An abnormal neurologic exam pre-operatively was associated with skin puckering and ecchymosis ($p<0.05$). A loss of a palpable radial pulse from initial orthopaedic consult to time of surgery (n=13) was associated with swelling severity ($p=0.0035$), tenting ($p=0.00092$), puckering, ($p=0.00076$) and ecchymosis ($p=0.011$). Pre-operative nerve injuries were associated with lower PODCI upper extremity scores at final follow-up ($p=0.049$). Nerve injuries that persisted at 3-4 weeks post-operatively were associated with worse outcomes as measured by the QuickDASH and PODCI upper extremity and Global scores at the final follow-up ($p<0.05$) although nerve injuries that persisted at final follow-up were not. Loss of forearm rotation >40deg and elbow flexion/extension >40deg at final follow-up were not associated with worse outcomes.

Conclusion: In this cohort of pediatric supracondylar humerus fractures, severity of soft tissue injury, as measured by swelling, ecchymosis, puckering, and tenting, was strongly associated with neurovascular compromise. Neurologic injury was associated with decreased outcomes as measured by the QuickDASH and PODCI Upper Extremity and Global domains at 3 months post-operatively. Prospective study evaluating ecchymosis, swelling severity, skin puckering, and skin tenting is needed to assess the predictive value of these variables for neurovascular injury.

Significance: Soft tissue injury has a clinically significant association with neurovascular compromise in pediatric supracondylar humerus fractures, and assessment of soft tissue injury is mandatory when assessing these patients. Even transient neurologic injury is associated with decreased outcomes as 3-4 months post-operatively.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Clinical and Radiographic Outcomes After Submuscular Plating (SMP) of Pediatric Femoral Shaft Fractures

Jason W. Stoneback, MD; *Katherine Davies; Patrick Carry; Zhaoxing Pan, MB, PhD; Ernest L. Sink, MD; Nancy H. Miller, MD*
University of Colorado, Children's Hospital Colorado, Aurora, CO

†**LOE-Therapeutic - Level III**

Purpose: A lack of consensus exists regarding the optimal treatment method for length-unstable pediatric femoral shaft fractures. Concern for injury to the extensor mechanism during submuscular plating (SMP) and hardware removal has been questioned. Distal valgus overgrowth has also been cited as a potential complication.

Methods: Following IRB approval, 36 pediatric subjects who underwent SMP for length-unstable femoral shaft fractures were reviewed at ≥2 year follow-up. 10 subjects met inclusion criteria and underwent isokinetic testing of the operative and non-operative limbs after hardware removal. The Pediatric Outcomes Data Collection Instrument (PODCI) was administered to all subjects. Anatomic Lateral Distal Femoral Angle (aLDFA) was measured to assess the mechanical alignment of operative and non-operative limbs. For the purpose of analysis, the difference in strength between the operative and non-operative limb was expressed as a percentage (non-operative torque – operative torque / non-operative torque). A difference in aLDFA of >5° and a difference in knee extensor torque of >19% between the operative and non-operative limbs were defined as clinically significant.

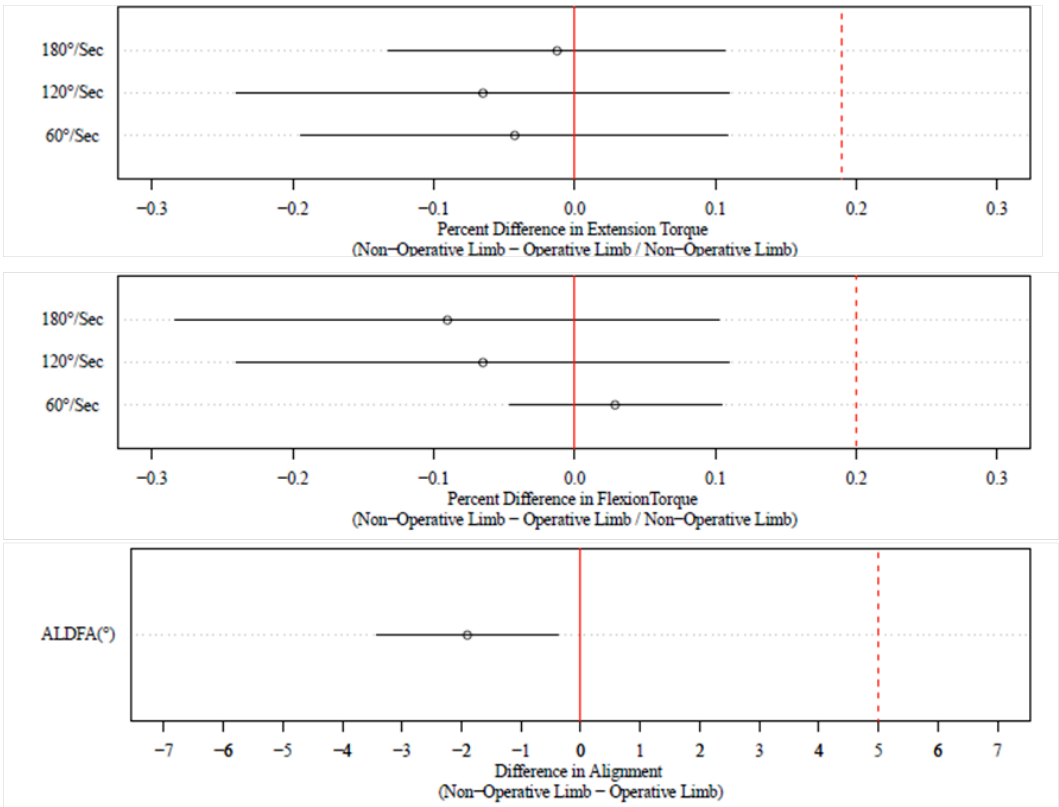
Results: At initial surgery, the average age/weight of subjects was 8.73 years and 29.53 kg. The plate was an average of 27.9mm from the distal femoral physis, and was removed 6.4 months after the initial surgery. The subjects returned for an isokinetic strength evaluation an average of 51.9 months (±16.7 months) after their initial surgery. The median PODCI scores for all subscales were ≥97 for all subjects. There was no significant difference in extension torque of the operative versus non-operative limbs at 60°/sec [p = 0.5400], 120°/sec [p = 0.4214] or 180°/sec [p = 0.8166]. More importantly, the percent difference in extension strength was not clinically significant at 60°/sec, -4.27% [95% CI:-19.43 to 10.89%], 120°/sec, -6.51% [95% CI: -24.00 to 10.98%], or 180°/sec, -1.26% [95% CI: -13.22 to 10.70%]. The aLDFA in the non-operative limb was an average of 1.9° [95 % CI: 0.38 to 3.43°] less than the corresponding angle in the operative limb. No operative limb had a clinically significant aLDFA of greater than 5°.

Conclusion: SMP achieves satisfactory clinical and functional results. In this series, extensor strength deficits and/or lower extremity mal-alignment were not clinically meaningful. High patient satisfaction can be expected after hardware removal.

Significance: Extensor torque and mechanical alignment are not adversely affected by the SMP technique in length-unstable pediatric femoral shaft fractures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Figure 1. Differences in Strength and Alignment Between the Operative and Non-Operative Limbs



*The vertical dashed lines represents a clinically meaningful threshold. The horizontal black lines represent 95% confidence intervals.

Transverse Femoral Shaft Fractures Are a Better Predictor of Non-Accidental Trauma Than Spiral Fractures in Young Children

Ryan P. Murphy, MD; Derek M. Kelly, MD; William C. Warner, Jr, MD; Alice Moisan, RN; Norfleet B. Thompson, MD; David D. Spence, MD; James H. Beaty, MD;
Jeffrey R. Sawyer, MD
Le Bonheur Children's Hospital; University of Tennessee/Campbell Clinic
Department of Orthopaedic Surgery, Memphis, TN

†LOE-Diagnostic - Level III

Purpose: Spiral fractures of long bones have long been cited as indications of non-accidental trauma (NAT) however recent studies have refuted this. In addition, in most studies there are no strict definitions of a spiral femur fracture. It has been shown recently that a simple morphologic method based on plain radiographs, the fracture ratio, can be used to classify these fractures. The purpose of this study is to determine if the fracture ratio can be used to predict whether or not a femoral shaft fracture in a young child is a result of NAT.

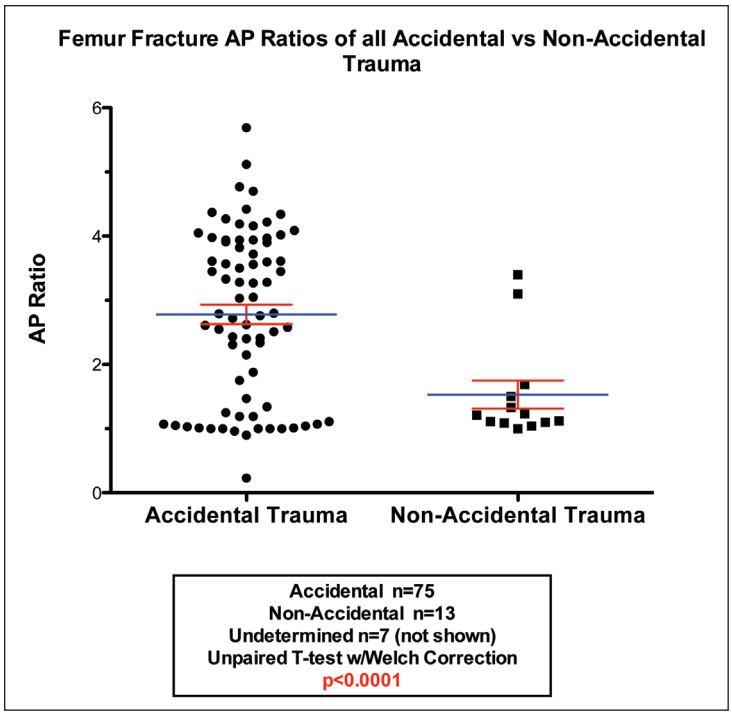
Methods: We identified 95 consecutive patients over a 7 year time, age $\leq$ 3years who sustained a closed isolated femoral shaft fracture. Patients with polytrauma, metabolic bone and/or genetic diseases and those with incomplete records/radiographs were excluded. For each patient, their AP and lateral fracture ratios were calculated (fracture length/bone diameter). The lower the fracture ratio, the more transverse the fracture. The presence or absence of a Child Protective Service (CPS) referral, outcome of the referral as well as the Modified Maltreatment Classification Score was recorded. An upaired T-test was used to compare the groups.

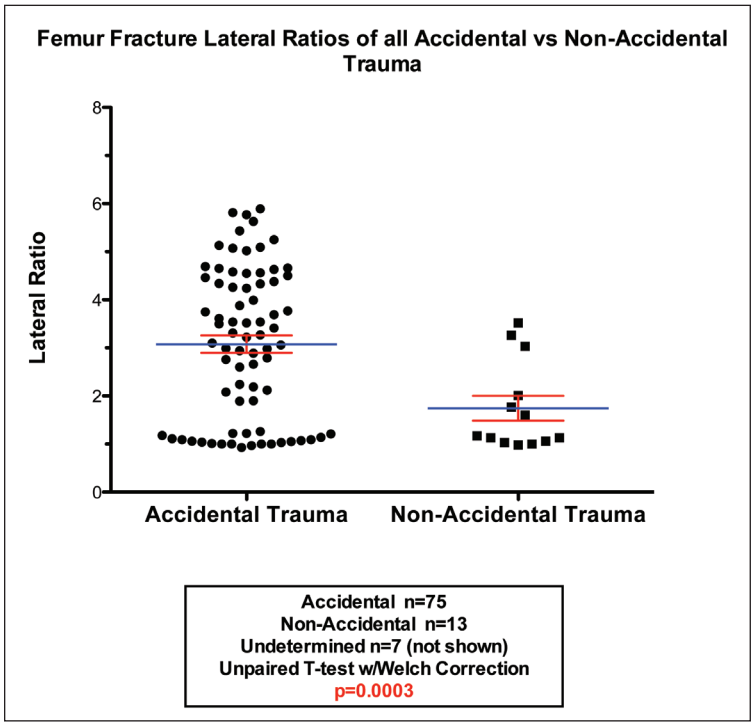
Results: Of the 95 patients, 51 patients had a CPS referral (54%). Of the referred patients there were 13 (25%) positive and 7 indeterminate (14%) for NAT. All 20 of these patients had a positive MMCS scoring for NAT. Patients referred to CPS had significantly lower fracture ratios on the AP (1.3 vs 2.6, p=0.0037) and lateral (1.7 vs 2.5, p=0.0019) radiographs. Patients with confirmed NAT had significantly lower fracture ratios on the AP (1.7 vs 2.4, p=0.0058) and lateral (2.6 vs 1.8, p<0.0001) radiographs.

Conclusion: Using a quantitative radiographic measure, the fracture ratio, the more transverse a fracture is on the AP and lateral radiograph the more likely the child is referred to DCS and the more likely the fracture is a result of NAT.

Significance: This study has shown that, contrary to numerous citations, the more "spiral" a femoral shaft fracture is, the less likely it is to be as a result of NAT.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.





†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Tibial Shaft Fractures in Adolescents: Analysis of Cast Treatment Successes and Failures

Christine Ann Ho, MD*; Gregory G. Dammann, MD; Jeffrey Levy, MD; David A. Podeszwa, MD*
Texas Scottish Rite Hospital-Children's Medical Center Dallas, Dallas, TX

†**LOE-Therapeutic - Level II**

Purpose: The purpose of this study is to analyze success and failure of cast treatment of closed tibial diaphyseal fractures in the adolescent population.

Methods: This is a retrospective study of a consecutive series of males age 12-18 years (76%, 57/75) and females age 10-18 years (24%, 18/75) with open physes, who sustained a closed tibia or tibia-fibula diaphyseal fracture treated initially with long leg cast treatment.

Results: Average age was 13.3 years (range, 10-17.4 years). 21% (16/75) of patients required a unplanned cast change or cast wedging in clinic for loss of reduction, and 3 patients (4%, 3/75) who were injured in vehicular collisions had failure of cast treatment, requiring an unplanned surgical intervention to restore alignment. The patients who required either an unplanned cast change/wedge or surgery were not statistically different from the patients who did not, in regard to patient age, gender, fracture pattern, or mechanism of injury, although initial and immediate post-reduction radiographic deformity was greater ($p<0.05$ for angulation and translation). 69% (52/75) of fractures were isolated tibia fractures, and 31% (23/75) were combined tibia/fibula fractures; there was no statistically significant difference between these groups in regard to the need for a cast change or wedge, need for surgical intervention, mechanism of injury, or fracture pattern. However, patients with an isolated tibia fracture had statistically significant decreased length of immobilization (93 days versus 120 days, $p=0.0018$) and time to return to full activities (13.8 weeks versus 15.8 weeks, $p=0.021$) compared to those with a combined tibia-fibula fracture. 59% of patients (44/75) required over 3 months of cast immobilization; tibia-fibula fractures were more likely to require prolonged immobilization compared to isolated tibia fractures ($p=0.022$). Other than prolonged immobilization and need for surgery, only one complication, a heel ulcer, was reported.

Conclusion: Despite the apparent increase in popularity of surgical treatment for pediatric tibial fractures, reduction and casting is still successful in the vast majority of adolescent patients, with only 4% requiring an intervention in the operating room. However, 25% of adolescent closed tibial diaphyseal fractures treated with reduction and casting required further intervention to maintain alignment, and time to union and return to full activities is prolonged compared what has been described to the younger population.

Significance: Orthopaedists can discuss realistic expectations with families regarding prolonged duration of treatment and possible need for further intervention in adolescents with closed tibial diaphyseal fractures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Hematoma Block versus Conscious Sedation: A Prospective Study Comparing Methods of Analgesia Used for the Reduction of Distal Radius Fractures in Children

Nicole A. Friel, MD; Charles Lupo, MD; David Bear, MD; Raymond Pitetti, MD, MPH;
W. Timothy Ward, MD
University of Pittsburgh Medical Center, Pittsburgh, PA

†**LOE-Therapeutic - Level II**

Purpose: Pediatric distal radius fractures represent a common fracture type requiring reduction in the Emergency Department (ED). While conscious sedation (CS) has been shown to provide excellent pain relief, it can have several side effects and may increase the cost of care and time in the ED. Hematoma block (HB) carries less risk and can be performed rapidly, but may not provide as significant pain relief as CS. The goal of this study was to determine which mode of anesthesia is optimal for the reduction of distal radius fractures in children.

Methods: Forty-six children (ages 8-18) presenting with distal radius fractures requiring reduction and casting were prospectively enrolled into this study. Patients were offered either CS or HB for fracture reduction. Following reduction and casting, the child and family were asked to complete a survey consisting questions regarding satisfaction with mode of anesthesia and overall care (rated 0-10, with 10 being the best score). Time spent in the ED was recorded. Radiographic alignment was evaluated pre-reduction, post-reduction, and at final follow-up.

Results: Forty-six patients aged 12.8 +/- 2.2 years participated; 22 underwent reduction with CS, and 24 with HB. One patient was converted from HB to CS due to an inadequate block. There was no significant difference in pre-reduction and post-reduction angulation between the 2 groups, and all reductions had satisfactory alignment. Overall satisfaction and satisfaction with anesthesia were excellent in both groups, with respective means of 9.7 and 9.5 in the CS group, compared to 9.6 and 9.4 in the HB group. Time spent in the ED was significantly less for patients in the HB group, with patients spending a mean of 2 hours and 8 minutes less in the ED($p<0.001$). All but three patients were successfully treated with closed reduction until final fracture healing. Of the patients requiring further intervention, one patient in each group required revision closed-reduction and casting in the OR, and one patient in the CS group went to the OR for closed-reduction and pinning.

Conclusion: Hematoma block use for the reduction of pediatric distal radius fractures provides similar excellent satisfaction and pain control as conscious sedation, while significantly decreasing the time spent in the ED.

Significance: While the vast majority of distal radius fractures in pediatric EDs are currently reduced under conscious sedation, this study demonstrates that hematoma blocks can be equally effective, while saving significant time and resources in the ED.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Pediatric Non Fracture Related Compartment Syndrome: A Review of 39 Cases

Kristin O. Livingston, MD; Patricia Miller, MS; Michael P. Glotzbecker, MD; Daniel J. Hedequist, MD; ***Benjamin J. Shore, MD, MPH, FRCSC***
Boston Children's Hospital, Harvard Medical School, Boston, MA

†**LOE-Prognostic - Level II**

Purpose: The diagnosis of compartment syndrome in children is challenging. Compartment syndrome in the absence of fracture is a rare phenomenon, poorly described in the pediatric literature. The purpose of this study was to report the varying etiologies, risk factors and treatment outcomes associated with pediatric non-fracture related compartment syndrome (NFRCS).

Methods: We conducted a retrospective chart review on 37 children treated at a single pediatric trauma center between 2003 and 2013 who had suffered a NFRCS. Demographic, diagnostic, treatment and outcome characteristics were reviewed for all subjects. Five causal groups were generated: trauma (without fracture), exertional (acute presentation after activity without traumatic event), infectious, vascular and postoperative (in the absence of osteotomy). Univariate and multivariate analysis was performed to identify risk factors associated with NFRCS. P values <0.05 were considered statistically significant.

Results: There were 39 cases of NFRCS in 37 children [6 females, 31 males, mean age of 11.7 years (SD $\pm$7.2 years)]. The leg was most commonly involved limb (29 cases, 74%). Diagnosis of NFRCS was made by either clinical exam (41%, 16/39 cases) or compartment pressure monitoring [mean pressure 66 mmHg (SD$\pm$28)]. According to etiology, vascular was most common (11/39, 28%), followed closely by trauma (10/39, 26%) and postoperative (8/39, 21%) with exertion and infection representing a small proportion (6/39, 15% and 4/39, 10% respectively). Pain was present in 33 cases (85%), swelling was present in 28 cases (72%), paresthesias were seen in 13 cases (33%), and poor perfusion was noted in 11 cases (28%). Average time from symptom onset to diagnosis was 48 hours (IQR 9-96 hours). At surgery, 21 patients (54%) had documented myonecrosis and children required an average of 3 surgeries for wound closure. The median time to follow-up was 232 days (IQR 73-608), with only 54% making a full recovery and 12 patients (31%) suffering a permanent nerve deficit. There was no interaction effect found between time to presentation and compartment pressures across causal groups.

Conclusions: Non-fracture related compartment syndrome in children is associated with a delay in diagnosis and a high rate of myonecrosis. Timely assessment with a combination of clinical examination and compartment pressure monitoring is necessary to prevent a delay in diagnosis.

Significance: Outcomes of non-fracture related compartment syndrome are much worse than previously reported for acute compartment syndrome in children and orthopaedic surgeons should be aware of this entity to prevent a delay in diagnosis.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Syndesmosis Injuries in the Pediatric Population: An Analysis of Risk Factors Related to Operative Intervention

Benjamin J. Shore, MD, MPH, FRCSC; Mark X. Cleary, BS; Patricia Miller, MS;
***Yi-Meng Yen, MD, PhD**; Dennis E. Kramer, MD*
Boston Children's Hospital, Harvard Medical School, Boston, MA

†**LOE-Therapeutic - Level II**

Purpose: Pediatric ankle injuries are common, accounting for 40% of all lower extremity sports injuries. However, the incidence and characteristics of ankle syndesmotic injuries in children has yet to be described. The purpose of this study was to review all pediatric ankle syndesmotic injuries occurring at our institution and identify risk factors associated with operative intervention.

Methods: We performed an IRB approved, retrospective, single center study of 220 consecutive children (115 boys and 105 girls) treated for a syndesmotic ankle injury between January 2003 and January 2013. Medical records were reviewed to determine demographic, injury event and radiographic details for all ankle syndesmotic injuries. Univariable and multivariable logistic regression modeling was performed to identify risk factors associated with operative intervention after a syndesmotic ankle injury.

Results: The average age at injury was 15.8 years (8.9 to 19.0 years), with a median follow up of 13 weeks (IQR 5-30 weeks). A sports related injury was the most common mechanism of injury (168/220, 76%), with similar rates for indoor and outdoor related activities. Eighty-two of 220 (37%) patients were treated with operative fixation, of which 76 (93%) had an associated fibular fracture at the time of injury. Patients undergoing surgery had a higher incidence of swelling and inability to weight bear on presentation ($p<0.001$). Statistically significant differences were recorded in Tibio-fibular (TF) clear space, TF overlap and medial clear space between the operative and nonoperative cohorts (6.0 vs 4.6mm, 5.4 vs 6.9mm, 6.4 vs. 3.5mm, $p<0.001$ respectively). Univariate analysis revealed that a TF clear space > 6mm (AP or Mortise) had a 4.7 times odds of requiring surgical fixation, TF overlap ≤0mm had a 12.5 times odds of requiring surgical fixation and medial clear space >5mm had 22 times odds of requiring surgical fixation. Multivariable analysis revealed patients with an open physis had an 86% lower odds of surgery while those with a fracture had a 41 times odds of surgical intervention and for every one mm increase in medial clear space the odds of requiring surgery increased by almost three times.

Conclusions: Operative ankle syndesmotic injuries in the pediatric population are transitional injuries, often associated with a closed distal tibial physis and concomitant fibular fracture.

Significance: This is the largest study characterizing ankle syndesmotic injuries in the pediatric population. This study will form the foundation for future prospective multi-center studies investigating indications for surgery within this population.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Open Reduction of Fully Displaced Pediatric Femoral Neck Fractures Results in Higher Quality of Reduction and Lower Rates of Osteonecrosis Than Closed Reduction

Eduardo N. Novais, MD*; Joseph D. Stone, MD; Mary K. Hill, BA; Zhaoxing Pan, MB, PhD*
Department of Orthopaedic Surgery, Children's Hospital Colorado - University of Colorado School of Medicine, Aurora, Colorado

†**LOE-Therapeutic - Level III**

Purpose: The purpose of this retrospective study was to compare the clinical and radiographic outcomes of open reduction and internal fixation (ORIF) versus closed reduction and internal fixation (CRIF) of fully displaced pediatric femoral neck fractures.

Methods: Following IRB approval, all patients treated for femoral neck fractures from 2003-2012 at our institution were identified. Only patients diagnosed with a fully displaced fracture between 4 and 17 years of age were included. The minimum follow-up for inclusion was one year. Medical records and radiographs were reviewed to determine: 1) occurrence of complications; 2) need for secondary procedures; 3) Ratliff clinical classification; and 4) adapted Clavien-Dindo complication classification. The recorded complications were osteonecrosis, malunion, nonunion, infection, proximal physeal closure, heterotopic ossification, osteoarthritis, and leg length discrepancy. Immediate postoperative radiographs were evaluated to determine quality of reduction. Based on final radiograph assessments, fracture healing was categorized as anatomic union, nonunion, malunion, or residual deformity due to proximal physeal closure. Treatment groups were compared using Fisher's exact tests with a significance level of 0.05.

Results: Fifty-three unilateral femoral neck fracture cases were identified. Subjects were excluded on the basis of ineligible age (n=4), non-fully displaced fracture diagnosis (n=16), inadequate follow-up (n=10), and insufficient radiographs (n=1). Of the 22 fully displaced femoral neck fractures (13 male, 9 female) included in the study, six were managed by ORIF and 16 by CRIF. Mean follow-up was 2.3 years (range 1.0-8.7) for the ORIF group and 2.0 years (range 1.0-5.8) for the CRIF group. Only three hips (50%) in the ORIF group versus 15 hips (94%) in the CRIF group were treated within the first 24 hours after injury (p=0.05). There was no significant difference in the postoperative Ratliff clinical assessment (p=0.48) between groups. ORIF achieved a significantly higher quality of reduction (p=0.01) and a more anatomic union (p=0.05) with fewer Grade IV Clavien-Dindo complications (p=0.05) and less need for secondary procedures (p=0.05) than CRIF. The incidence of osteonecrosis was significantly (p=0.05) higher after CRIF (50%) than after ORIF (0%).

Conclusion: Despite delays in treatment after injury, fully displaced femoral neck fractures managed by ORIF exhibited significantly higher quality of reduction with fewer complications, including osteonecrosis, than those managed by CRIF.

Significance: When compared to CRIF, ORIF of fully displaced femoral neck fractures achieves superior short-term results.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

One Brace, One Visit: Treatment of Distal Radius Buckle Fractures in Children with a Removable Wrist Brace and No Follow-Up Visit

Megan H.M. Kuba, MD; Krister P. Freese, MD; ***Byron H. Izuka, MD***
Kapi'olani Medical Center for Women and Children, Honolulu, HI

†**LOE-Therapeutic - Level IV**

Purpose: Multiple previously published studies have shown the efficacy of brace treatment for distal radius buckle fractures. There is also literature to support the fact that these inherently stable injuries do not require additional radiographic imaging. However, no study has looked at a treatment protocol combining both of these aspects. We aim to determine if the treatment of pediatric buckle fractures of the distal radius, with a removable brace and no further physician follow-up or imaging after the initial visit, is a safe and satisfactory therapeutic protocol.

Methods: 42 consecutive patients with a diagnosis of distal forearm buckle fracture seen by a single practicing pediatric orthopaedic surgeon were recruited to participate in this IRB approved study. 2 patients refused participation, leaving 40 patients treated with a standard protocol as follows: immobilization with a removable wrist brace, worn for a prescribed time period; no additional imaging or clinical follow-up. Two telephone surveys were administered to each of the 40 patients. The first call was made within 1 week of the designated brace-removal date to determine the exact date the brace was discontinued. The second call was made 5-10 months post-injury to determine patient outcomes and parent satisfaction after the treatment via a series of 17 questions.

Results: 100% of patients were reached for the initial phone call. 36/40 patients (90%) were available to answer the second phone survey questionnaire. There were no complications, including re-fracture or residual pain, following the treatment. Only 4/36 (11%) required any type of pain medication, and all took only over-the-counter ibuprofen or acetaminophen. No patients required narcotics for pain control. 100% of parents said they would choose to have the same treatment again, as 68% would have had to miss work and 78% would have had to pull the child out of school if they had been required to attend a follow-up appointment.

Conclusion: Treatment of distal forearm buckle fractures with a removable brace and no follow-up visit results in both good patient outcomes and parental satisfaction.

Significance: This treatment method is both directly and indirectly cost-effective, prevents additional radiation exposure, and increases access to care as it leaves additional appointments available in the busy pediatric orthopaedic practice.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Lower Bone Strength, Density and Trabecular Microstructure at the Distal Radius is Associated with Increased Risk of Forearm Fracture in Young Girls

Mikko Määttä, PhD; Christa Hoy, MSc; Douglas Race, MA; Lindsay Nettlefold, PhD; Leigh Gabel, MSc; Kishore Mulpuri, MD; ***Firoz Miyanji, MD****; Christopher W. Reilly, MD; Heather M. Macdonald, PhD; Heather A. McKay, PhD*

†**LOE-Prognostic - Level III**

Purpose: Differences in bone structure during growth in children with and without fractures are not well known. We aimed to compare bone microstructure and strength at the distal radius between girls and boys with (Fx) and without (NF) a history of low to moderate energy forearm fracture.

Methods: We assessed bone microstructure and strength at the non-dominant (NF) and non-fractured (Fx) distal radius (7% site) using high-resolution pQCT (Scanco Medical AG) in 200 pre- and early pubertal girls (10.0±1.5 y; 39 NF, 49 Fx) and boys (11.4±1.5 y; 45 NF, 67 Fx). Standard morphological outcomes included total bone mineral density (Tt.BMD), trabecular bone volume ratio (BV/TV), trabecular thickness (Tb.Th) and number (Tb.N). We used a customized auto-segmentation algorithm to determine total bone area (Tt.Ar), cortical BMD (Ct.BMD), thickness (Ct.Th) and porosity (Ct.Po), and applied finite element analysis to estimate bone strength (ultimate stress, UStress; and Load-to-Strength ratio, calculated as the ratio between estimated fall load and failure load). We used ANOVA to compare bone outcomes across Tanner stages I, II and III in girls and boys. Sex-specific logistic regression models for each bone outcome were adjusted for height, maturity (Tanner stage) and percent body fat (DXA, Hologic QDR 4500W).

Results: Girls with lower UStress and higher Load-to-Strength ratio had an increased risk of fracture (OR=0.5 and OR=2.1, respectively, $p \leq 0.02$). Further, lower Tt.BMD, BV/TV and Tb.Th were also associated with 2-fold increase in risk of fracture in girls ($p < 0.040$), while lower Ct.Th showed a similar trend (OR=0.4, $p=0.051$). More specifically, at Tanner stage II, Fx girls had significantly lower Tt.BMD (11% difference), BV/TV (11%), Tb.Th (9%) and UStress (8%) compared with their NF peers. No differences between the FX and NF boys were observed.

Conclusion: The bone outcomes that underpin fracture risk appear to be sex-specific. Our findings suggest that in young girls maintaining sufficient bone density and trabecular microstructure at the distal radius may be necessary to prevent forearm fracture. Further, pre-puberty may be an especially relevant time for identifying risk factors for fracture in young girls.

Significance: As the incidence of forearm fractures among children has been increasing, there is an urgent need to better characterize underlying risk factors so that effective interventions can be implemented to prevent fractures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Reconstruction of Symptomatic Congenital Anterior Cruciate Ligament Insufficiency

Jeffrey Nepple, MD; Adam Y. Nasreddine, BS, MA; ***Mininder S. Kocher, MD, MPH***
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level IV**

Purpose: The purpose of this study was to characterize the surgical treatment and outcomes of congenital Anterior Cruciate Ligament (ACL) insufficiency.

Methods: A retrospective review of the surgical treatment of congenital absence of the ACL at a tertiary care institution from 1995 to 2012 was performed. Fourteen knees (13 patients) underwent surgical reconstruction for congenital insufficiency of the ACL. In each case, the diagnosis was confirmed by the combination of intraoperative and preoperative clinical records. All patients reported persistent knee instability despite conservative treatment measures, generally including bracing and activity modification. Patients with a minimum of one year of clinical follow-up were eligible for inclusion in the current study.

Results: The mean age at time of surgery was 12.6 (range 3 to 22), including 6 patients < 12 y/o. Mean follow-up was 2.9 years (range 1 to 6). Ten patients (10 knees) had underlying congenital abnormalities/associated syndromes, including proximal femoral focal deficiency/congenital short femur (n=4) and fibular hemimelia (n=3). Preoperative Lachman and pivot shift examination was IKDC grade C or D in all patients. Five knees had preoperative knee hyperextension of ≥10 degrees.

ACL reconstruction was performed in all cases with combined intra-articular/extra-articular iliotibial band (n=5), autograft hamstring or bone-patellar tendon-bone (n=5), or allograft (n=4). Autograft tissues were utilized for all cases of ACL absence not associated with other congenital abnormalities. Reconstruction of associated ligamentous deficiency of the PCL (n=3), MCL (n=3), and LCL (n=2) was performed in 7 knees (50%). Meniscal tears were present in 5 knees.

One patient underwent revision stabilization including revision ACL reconstruction and reconstruction of previously untreated PCL insufficiency, but had residual laxity at final follow-up. Additional surgery was performed in two patients including lysis of adhesions and manipulation for arthrofibrosis (n=1) and patellar stabilization (n=1). Postoperative Lachman and pivot shift testing was IKDC grade A or B in all but one knee.

Conclusions: Patients with congenital ACL insufficiency can present with symptomatic instability at a wide range of ages, as well as a variety of associated ligamentous deficiencies. Surgical stabilization of symptomatic congenital ACL insufficiency results in improved stability and symptoms in this population at early follow-up, with low complication rates.

Significance: The treatment of congenital insufficiency of the ACL has traditionally relied on bracing and conservative measures. Only small case series of surgical treatment of this patient population has been previously reported. The present study demonstrates that surgical treatment for congenital ACL insufficiency is a safe and beneficial treatment option.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Computer-Simulated Arthroscopic Knee Surgery: Effects of Distraction

James B. Cowan, MD; Mark A. Seeley, MD; Todd A. Irwin, MD; Deborah M. Rooney, PhD; ***Michelle S. Caird, MD***
University of Michigan Hospital, Ann Arbor, MI

†**LOE-Therapeutic - Level III**

Purpose: Knee arthroscopy is a fundamental skill for orthopaedic surgery resident education, yet it requires high levels of psychomotor coordination and three-dimensional perception. Learning these skills in the operating room increases operative time, potentially increases operative complications, and places the resident in an environment with numerous distractions. The purpose of this prospective cohort study was to use a knee arthroscopy simulator to investigate the effects of distraction on resident surgical performance.

Methods: Fourteen "junior" and eleven "senior" orthopaedic surgery residents were enrolled but were not informed that the purpose of the study was to evaluate the effects of distraction on surgical performance. Using a knee arthroscopy simulator, they each performed a diagnostic knee arthroscopy according to a checklist of structures to identify and tasks to complete. Participants were evaluated on arthroscopy time, number of chondral injuries, instances of looking down at their hands, and completion of checklist items. At a minimum of two weeks after their initial diagnostic arthroscopy, residents repeated this task under similar conditions but while simultaneously answering distracting questions posed by the evaluators.

Results: Under distracting conditions, residents had a significantly greater number of missed checklist items ($p<0.02$) and a statistically non-significant increase in chondral injuries ($p<0.16$), increase in instances of looking down ($p<0.35$), and decrease in arthroscopy time ($p<0.15$) as compared to non-distracted conditions. Without distraction, senior residents completed the simulation in less time ($p<0.001$), with fewer chondral injuries ($p<0.005$), and with fewer instances of looking down ($p<0.012$) as compared to junior residents. While distracted, senior residents continued to perform the simulation more quickly ($p<0.003$), but with no significant difference regarding chondral injuries ($p<0.06$) or instances of looking down ($p<0.08$) as compared to junior residents. While distracted, there was a statistically non-significant increased likelihood that senior residents would incompletely evaluate the lateral recess ($p<0.08$) and meniscus ($p<0.08$), and that junior residents would incompletely evaluate the lateral recess ($p<0.04$), ACL ($p<0.08$), and popliteus ($p<0.08$). Most residents became visibly frustrated when asked distracting questions, though they answered most questions correctly (85–92%).

Conclusions: While senior residents expectedly demonstrated greater arthroscopic proficiency when compared with junior residents, residents at all levels appear susceptible to the detrimental effects of distraction when performing arthroscopic simulation.

Significance: While it is impossible to anticipate or eliminate all intraoperative distraction, the results of this study suggest that addressing even straightforward questions intraoperatively may have an effect on surgeon performance.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Prevalance of Bilateral JOCD of the Knee and Associated Risk Factors

Trent Cooper, DO, MS; Walter P. Samora, III, WP, MD; ***Kevin E. Klingele, MD***
Nationwide Children's Hospital, Columbus OH

†**LOE-Therapeutic - Level IV**

Purpose: Juvenile osteochondritis dissecans (JOCD) of the knee is a condition affecting the cartilage and subchondral bone surface. Multifocal JOCD (MJOCD), described as multiple lesions within the knee or presence of lesions in other joints, has recently been described. The true prevalence of bilaterality of JOCD is unknown. The purpose of this study was to determine the prevalence of bilateral JOCD and to identify potential risk factors for multifocal disease.

Methods: From January 2011 to September 2013, 108 consecutive patients who presented for JOCD at a single pediatric hospital system were evaluated. If an OCD knee lesion was found, contralateral knee x-rays were performed. Patient demographics were recorded and lesions individually analyzed. Lesion location was documented according to Cahill and Berg, and MRI grading documented according to Dipaola. If surgical treatment was undertaken, intraoperative grading was performed according to Guhl. Patients with unilateral JOCD were compared to those with bilateral disease. Statistical analysis of categorical data was performed**.**

Results: There were 85 males (79%) and 23 females (21%) with an average age of 12.3 years (range 6-18). Sixty-three percent of lesions were located on the MFC and 33% on the LFC. Ninety percent of all lesions were considered weight bearing lesions. Eighty percent were considered stable on MRI evaluation. Of those lesions requiring surgical intervention, 61% were either grade I or II lesions. Seventy-three of 108 patients (68%) underwent some form of surgical intervention. Thirty-one patients (29%) were found to have bilateral JOCD lesions. Thirty-nine percent of bilateral lesions were asymptomatic at presentation, and nearly all of those evaluated with MRI (16/18) were stable. Sixty-nine percent of bilateral lesions were located on the MFC, 27% on the LFC, and 94% were considered weight bearing lesions. Twelve of 31 bilateral lesions (39%) underwent surgical intervention. Comparing patients with unilateral and bilateral disease, female gender ($p<0.05$) and younger age at presentation ($p<0.009$) were risk factors for multifocal JOCD. No statistical difference among other variables was seen.

Conclusion: In our consecutive series of 108 patients with JOCD, we found a 29% incidence of bilateral disease. Almost 40% of bilateral lesions were asymptomatic upon presentation. Female gender and younger age at presentation were significant risk factors for multifocal disease. Lesion location, stability, and pain were not statistically significant variables.

Significance: The authors recommend bilateral radiographic knee evaluation for all patients found to have JOCD.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Glenoid Bone Loss in Traumatic Glenohumeral Instability in the Adolescent Population

Henry B. Ellis, Jr*; Kelsey Wise, BA; Max Seiter, BS; Philip L. Wilson, MD*
Children's Medical Center Dallas, Dallas, TX

†**LOE-Diagnostic - Level II**

Purpose: The purpose of this study is to review the incidence and severity of glenoid bone loss in traumatic glenohumeral instability in the adolescent age group, and to investigate any presenting factors that may be more likely to be associated with glenoid bone loss in this age group.

Methods: One hundred and fourteen consecutive adolescent patients with recurrent glenohumeral instability between 2004 and 2012 were identified at a tertiary pediatric sports medicine practice. Patients were younger than 19 years old and presented with more than one shoulder traumatic anterior shoulder dislocation. Chart analysis included demographic, presenting, and radiographic data. Glenoid bone loss was interpreted from plain radiographs, CT (2D and/or 3D), MRI, and/or arthroscopic visualization. We compared possible risk factors between bone defected and not defected subjects with the χ^2-test or two sample *t*-tests, as appropriate.

Results: Glenoid bone loss was seen in fifty-five patients (48.2%) in this population with eleven patients (or 20%) having 15% or greater bone loss. Forty-five percent of glenoid bone loss was not seen on plain radiographs. The average age was 15.1 years old (range 6.5-18.1) with male to female ratio 3.7:1. A male gender, older age, and taller patients were all statistically associated with glenoid bone loss compared to patient's without bone loss (p=0.02, p=0.01, and p=0.02, respectively). Compared to adolescent without bone loss, primary dislocations that occurred during sports were more likely to have glenoid bone loss (55.9% versus 78.2%, p=0.01). Between the two group, the incidence of an emergency room reduction was roughly equal (35.5% no bone loss versus 30.9% bone loss), however, spontaneous reductions more likely occurred in the group with bone loss (5.1% versus 18.2%, p=0.009, respectively). The presence of an apprehension sign was positively correlated with patient with bone loss compared to those without (p=0.008).

Conclusion: The presence of glenoid bone loss in primary traumatic glenohumeral instability in the adolescent population is high. Factors associated with glenoid bone loss including male gender, older age, taller, sports injuries, and the presence of apprehension on physical exam.

Significance: A high index of suspicion for glenoid bone loss in an adolescent with recurrent shoulder instability may guide advanced imaging technique and pre-operative planning. Despite status as a young patient, 1 in 10 patients in this population may have 'critical' bone loss requiring more than standard arthroscopic soft tissue reconstruction.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Traumatic Anterior Instability of the Adolescent Shoulder: A Comparison of Arthroscopic and Open Bankart Repairs

Stephen J. Shymon, BA; Joanna H. Roocroft, MA; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

†**LOE-Therapeutic - Level III**

Purpose: Bankart lesions occur as a result of anterior shoulder dislocation or recurrent anterior instability. Adult literature suggests recurrent instability after arthroscopic repair occurs at an incidence of 1.5% to 5%. Recent reports suggest that re-dislocation rate after arthroscopic repair in this adolescent population is higher with rates ranging from 13.5% to 21%. The purpose of this study was to compare the functional outcomes and re-dislocation rates of adolescent patients treated by open versus arthroscopic Bankart repair.

Methods: A retrospective chart review was performed for all open Bankart repairs between 2006-2008 and all arthroscopic Bankart repairs completed between 2008-2010. Those with brachial plexus injury, soft tissue disorder, or incomplete charts were excluded. Demographics, number of dislocations, size of tear, MRI findings and sport were recorded. Upon completion of the review, patient outcomes were acquired by telephone interview. The QuickDASH (Disability Arm, Shoulder, or Hand), WOSI (Western Ontario Shoulder Instability Index), SF-12 (Short Form 12), SANE (Single Assessment Numeric Evaluation), and verbal pain scores were recorded. Follow-up questions about recurrent instability/dislocation and secondary surgeries were also obtained.

Results: Ninety-nine patients, mean age 16.9 years (range 13.4-23.6 years) at time of surgery, met inclusion criteria (28 open, 71 arthroscopic). Football was the most common mechanism of injury (41%). All patients were contacted to participate; 50 patients completed the questionnaires (11 (39%) open, 39 (55%) arthroscopic). No significant differences in the outcomes scores were seen between the two groups. Patients who experienced a re-dislocation or second surgery for the same shoulder were categorized as failing treatment, whether completing the questionnaire or not. Of the 99 patients, 21 had failures (21%), and there was no significant difference between the open (4 shoulders, 14%) or arthroscopic (17 shoulders, 23%) cohorts. The survivorship curve for the entire group demonstrated that 86% remained stable at 2 years and only 49% were stable at 5 years.

Conclusion: In adolescents, there is no significant difference in functional outcomes between open and arthroscopic Bankart repair; however, both demonstrate a high risk for recurrent instability after surgical intervention in this adolescent population.

Significance: Our study confirms the previously reported high rate of recurrent instability after arthroscopic Bankart repair in adolescents; and moreover, demonstrates an equally high rate of surgical failure in open Bankart repair for this younger population.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Results of Non-Operative and Operative Management of Apophyseal Avulsion Fractures of the Hip and Pelvis in Adolescent Athletes

Benton E. Heyworth, MD*; Bryant Bonner, MD; Yi-Meng Yen, MD; Michael B. Millis, MD; Mininder S. Kocher, MD, MPH; Lyle J. Micheli, MD*
Boston Children's Hospital, Boston, MA

†**LOE-Therapeutic - Level IV**

Purpose: Apophyseal avulsion fractures of the hip and pelvis occur in the pre-adolescent and adolescent population, with greater numbers being seen recently as the popularity and intensity of youth sports increases. The goal of the current study was to present a comprehensive perspective on the demographic characteristics and clinical course of 437 of these fractures.

Methods: All cases of apophyseal avulsion fracture of the hip or pelvis between the years of 1981-2012 at a tertiary care pediatric center underwent radiologic and chart review, including operative details when applicable. Demographic data was analyzed, along with radiographic displacement, and time to healing and return to sports.

Results: Of the 413 patients who underwent definitive non-operative treatment, (72% male, mean age was 14.5 years. The anatomic site of injury was widely distributed: anterior inferior iliac spine (AIIS) 29%, anterior superior iliac spine (ASIS) 27%, ischial tuberosity (IT), 17%, lesser trochanter 15%, and iliac crest 11%. One-half of all injuries occurred during soccer (26%), track (13%), or baseball/softball 11%, with a wide range of other sports in the overall cohort. In the 287 non-operative cases with adequate follow up data to confirm mean radiographic union and time of return to sports, respectively, healing occurred at 2.7 months and at 2.8 months, with PT initiated before healing in most cases. Of the 25 patients who ultimately required operative treatment (mean age 15.7 years), 78% of cases were initially treated nonoperatively. The most common site anatomic site was IT (64%), with others including AIIS 16%, iliac crest 16%, and ASIS 4%. Excision of the apophyseal fragment was the intervention pursued for 48% of cases, with the mean time to union of 4.8 months in 11 cases which underwent fixation and had adequate follow up data.

Conclusion: In over 400 cases of apophyseal avulsion fractures in an adolescent population, 94% were successfully treated nonoperatively, with mean times of healing and return to sports under 3 months. Most cases requiring surgery failed primary conservative care, many of which underwent fragment excision, rather than fixation, due to the chronic nature of their preoperative period.

Significance: Apophyseal avulsion fractures of the hip and pelvis can be treated successfully nonoperatively or surgically after failed conservative care, though better understanding of the rare indications for early fixation is warranted.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Risk Factors for Multiple Surgeries to Treat Musculoskeletal Infections in Children

Matthew C. Starke, BS; Wei Zhang, PhD; John R. Dawson, MD; William A. Phillips, MD;
Vinitha R. Shenava, MD
Texas Childrens Hospital, Houston, TX

†**LOE-Prognostic - Level III**

Purpose: For most children with musculoskeletal (MSK) infections a single operative procedure in addition to antibiotic therapy is adequate to treat the infection. However, a small subset of patients require additional procedures to control the infection. The purpose of this study was to determine the incidence of and risk factors associated with a return to the operating room to treat MSK infections.

Methods: We performed an IRB approved retrospective review of children treated for septic arthritis and/or osteomyelitis. All healthy children between 1-18 years of age with complete medical records who received operative treatment of their infection at our institution between 2003-2010 were included. The following parameters were collected from the medical record: sex, age, temperature, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), location of infection (upper or lower extremity), type of infection (osteomyelits, septic arthritis, or both), presence of infection in more than 1 site, organism and number of surgeries. Univariate and multivariate regression analysis was performed to identify risk factors for the need for more than one surgical procedure to adequately treat the infection.

Results: 40 of 286 (14%) of patients required a return to the OR for additional surgery to treat their musculoskeletal infection. When comparing the 2 cohorts, children with one surgical debridement (ONE) vs children requiring more than 1 debridement (MULT), there was a statistical difference noted in the average age (ONE=5.7 $\pm$ 4.1 years; MULT=7.4 $\pm$ 4.9, p-value 0.02) and CRP (ONE=10.9 $\pm$ 11.1; MULT=24.6 $\pm$ 15.5, p-value <0.0001). There was a trend toward statistical significance with regard to temperature (ONE=100.8 $\pm$ 2.1; MULT=101.5 $\pm$ 1.8, p-value 0.059). 11% (26/243) of patients with single site infection returned to the OR compared to 33% (14/43) of patients with multiple sites of infection. There was a 4-fold increase in the likelihood of requiring another surgical procedure to treat the MSK infection in patients with multiple sites of infection (p-value 0.0003).

Conclusion: These finding suggests that the clinical parameters of patient age, temperature, CRP, and presence of multiple sites of infection can predict the need for multiple surgical procedures to eradicate the infection.

Significance: This data can assist the physician in identifying patients who are at risk of requiring multiple surgeries to treat their infection. This may allow for advance counseling of families and coordination of care with other treating medical services regarding the likely treatment plan and course.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Validating an Algorithm to Predict Adjacent Musculoskeletal Infections in Septic Arthritis

Benjamin D. Welling, BS; Wei Zhang, PhD; ***Scott B. Rosenfeld, MD***
Texas Children's Hospital, Houston, TX

†LOE-Diagnostic - Level III

Purpose: Adjacent infections such as osteomyelitis, subperiosteal abscesses, and intramuscular abscesses are common in pediatric septic arthritis. We previously developed a clinical prediction algorithm to determine which patients were more likely to have an adjacent infection and should therefore benefit from preoperative MRI. Patients meeting 3 of 5 criteria (age greater than 4 years, CRP >8.9, platelet count > 310,000, ANC >7.2, duration of symptoms >3 days) were likely to have septic arthritis with adjacent infection. The purpose of this study was to validate this algorithm using a new patient population.

Methods: An IRB approved retrospective review was performed of 57 children treated for septic arthritis. MRI reports were reviewed to determine presence of adjacent infection. 20 patients had isolated septic arthritis and 37 had adjacent infections. Five variables were gathered from the EMR: age, CRP, duration of symptoms, platelet count, and ANC. Patients were stratified by how many predictors were met. The threshold of 3 positive predictors was used to indicate high risk of adjacent infection. Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV) and area under the curve (AUC) were measured. The results were compared to those of the previous test using Chi squared analysis.

Results:

Table 1: *Probability of Adjacent Infection Based on Number of Predictors*

Number of Predictors Met	Isolated	Adjacent Infections	Total	Correctly Classified
0	3(15%)	0(0%)	3	100%
1	7(35%)	1(3%)	8	88.00%
2	7(35%)	4(11%)	11	74%
3	3(15%)	10(27%)	13	77%
4	0(0%)	16(43%)	16	100%
5	0(0%)	6(16%)	6	100%

Table 2: *Comparison of two study results*

Data set	Threshold	Sensitivity	Specificity	NPV	PPV	AUC
previous study	≥3	90%	67%	83%	80%	0.88
current study	≥3	86%	85%	77%	91%	0.93
p value previous vs current		0.84	0.24	0.21	0.89	0.35

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Conclusion: The ability of this algorithm to predict risk of adjacent infections was reproducible and not significantly different from results of the previous study when tested on a new population.

Significance: Patients with septic arthritis who meet 3/5 predictive factors are at higher risk for having adjacent infections and should undergo preoperative MRI.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Management of Pediatric Hip Synovial Fluid WBC Values Between 25,000-75,000 following Aspiration

*Benton E. Heyworth, MD; **Michael P. Glotzbecker, MD**; Kyna S. Donohue, BS; Aubrey M. Wasser, MPH; Mininder S. Kocher, MD, MPH; Benjamin J. Shore, MD, FRCSC*
Boston Children's Hospital, Boston, MA

†**LOE-Diagnostic - Level III**

Purpose: Decision-making regarding the optimal management of children who undergo hip aspiration with synovial fluid white blood cell (WBC) values between 25,000 and 75,000 is often difficult. This study sought to describe the treatments pursued and final diagnoses obtained in a series of children with these values in order to identify potential risk factors for an ultimate diagnosis of septic arthritis.

Methods: Records were reviewed of patients under 19 years who underwent arthrocentesis of the hip between 2005-2012 at a single, tertiary-care, pediatric referral center. After excluding patients with known oncologic or rheumatologic disorders, the demographic data, laboratory values, final diagnosis and treatment details were recorded in patients with aspirate WBC count between 25-75K. The number of established risk factors for septic arthritis, including fever, refusal to bear weight, ESR >40mm/hr, serum WBC >12 ($x10^9$ per L), CRP ≥ 0.7 mg per dL, was analyzed and compared between the final diagnostic groups and sub-groups of patients above and below 50K.

Results: 47 children (27 male, 20 female) with a mean age of 7.6 years, met inclusion criteria, with near equal distribution of patients in the 'High WBC' (50-75K) sub-group (23 patients, 51%) and the 'Low WBC' (25-50K) sub-group (24 patients, 49%). Ultimate diagnoses consisted of septic arthritis (n=19, 40%), Lyme arthritis (n=12, 26%), transient synovitis (n=9, 19%), or 'other' diagnoses (n=7, 15%).

While septic arthritis was the most common ultimate diagnosis amongst those patients in the 'High WBC' sub-group (13 patients; 57%), it also represented a substantial percentage (6 patients, 25%) of the 'Low WBC' group. Almost all of the septic arthritis patients underwent early surgery (18 patients, 95%, $p<0.001$). However, univariate and multivariate analysis yielded no statistically significant findings, regarding the individual risk factors or number of risk factors in the septic arthritis group compared to the non-septic arthritis group, or the operatively treated group compared to the non-operatively treated group.

Conclusion: Septic arthritis was the most common ultimate diagnosis following hip aspiration in children with synovial fluid WBC values between 25-75K. The presence or number of established risk factors were not shown to be appropriate for influencing treatment decisions in this population.

Significance: Septic arthritis should be high on the differential diagnosis of patients with 'intermediate range' synovial WBC, even in cases under 50K. Further research is warranted to determine what factors may successfully guide operative versus non-operative treatment in order to improve the diagnostic model.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Osteoid Osteoma About the Hip in Children and Adolescents

Collin J. May, MD*; Sarah Bixby, MD; Megan E. Anderson, MD; Young Jo Kim, MD, PhD; Yi-Meng Yen, MD; Michael B. Millis, MD; Benton E. Heyworth, MD*
Children's Hospital Boston, Boston, MA

†**LOE-Diagnostic - Level IV**

Purpose: The purpose of this study was to assess the clinical course, radiologic findings, and treatment approaches for pediatric osteoid osteoma about the hip. Potential diagnostic and treatment pitfalls were identified.

Methods: A single-center tertiary care departmental database was queried for all cases of osteoid osteoma seen between 2003 and 2013. Medical records were reviewed to identify those with lesions identified within or around the hip joint. Clinical, demographic, and radiologic data were analyzed.

Results: Forty-four children and adolescents (50% female, mean age 12.5 years) were identified with osteoid osteoma about the hip. Lesion locations included: femoral head/neck (43%), subtrochanteric (27%), pertrochanteric (20%), and acetabular (9%). The primary presenting complaint ranged from isolated hip (32%) or knee (30%) pain to some combination of hip/thigh/knee pain (38%). Night pain was common (91%), as was symptom relief with NSAIDs (84%). The most frequent signs were limp (45%), decreased hip range of motion (32%), and pain with hip rotation (32%). Sclerosis and/or cortical thickening was visible in 60% of radiographs, though a lucent nidus was visible in only 40%. In the 21 hip MRI studies, intracapsular lesions were present in 14 patients, with common findings in all MR studies including synovitis (42%), effusion (57%), medial retinacular thickening (38%), and focal bony edema (100%). CT was diagnostic with a lucent nidus present on all 41 scans. Intial incorrect diagnoses were recorded in 50% of cases with the most common being femoro-acetabular impingement, hip synovitis, stress fracture, and infection. Significant delay in diagnosis of >3 months was seen in 40% of patients. Two patients underwent operative procedures for incorrect diagnoses. While conservative measures were frequently pursued initially, 84% ultimately underwent radiofrequency ablation (RFA). Of those undergoing RFA, 90% reported complete resolution of symptoms. Complications included persistent symptoms requiring repeat RFA in 2 patients and one case of fracture at the RFA site, requiring ORIF.

Conclusion: Incorrect and delayed diagnosis is common in pediatric osteoid osteoma about the hip, with femoro-acetabular impingement representing the most common incorrect diagnosis in our series. While varying presenting complaints and nonspecific MRI findings may contribute to diagnostic uncertainty, night pain was present in 91% and CT provided definitive diagnosis in all patients

Significance: As recognition of hip disorders such as femoro-acetabular impoingement in young active patients increases, osteoid osteoma should not be overlooked in the differential diagnosis of pain about the hip.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

CT-Guided Radiofrequency Thermoablation in the Treatment of Osteoid Osteoma in Children

Elizabeth R.A. Joiner, BS; David Ibrahim, MD; Philip Stanley, MD; Javier F. Descalzi, MD; J. Dominic Femino, MD; ***Alexandre Arkader, MD***
Children's Hospital Los Angeles, Los Angeles, CA

†**LOE-Therapeutic - Level IV**

Purpose: CT-guided radiofrequency ablation (RFA) has been used increasingly for the treatment of osteoid osteoma (OO). It is an outpatient procedure with a relatively short recovery periods, and several reports in the literature support its effectiveness. However, most of these case series are small or include both children and subjects well into adulthood, although OO more commonly affects the pediatric population. The purpose of this study was to evaluate if CT-guided RFA is a reproducible and effective adjuvant in the treatment of OO in children.

Methods: A single-center retrospective review was performed on 51 consecutive CT-guided RFA procedures for OO from 2002 to 2011 in 49 patients (mean 12 years, range 3-19 years). All procedures were outpatient, performed under general anesthesia.

Results: All RFA procedures were technically successful, defined as the probe tip being correctly placed within the nidus of the lesion by CT guidance. 88% of patients had complete resolution of preoperative pain after one RFA (primary success rate). 9% had a recurrence of OO or an incomplete ablation, two who underwent a second RFA procedure and one who was managed conservatively. Our secondary success rate (complete resolution of preoperative pain after two RFAs) was 91%. There was 1 minor complication, peroneal tendonitis, and 2 major complications, thermal injury to local skin and muscle leading to osteomyelitis and an avascular necrosis of the talus with collapse of the talar dome.

Conclusion: In the treatment of osteoid osteoma in children, CT-guided radiofrequency ablation does yield successful outcomes in the majority of patients and offers the benefit of being an outpatient procedure with a short recovery period. However, although few in number, the severity of complications seen in this series, combined with only an 88% primary success rate brings into question whether this procedure is truly the treatment of choice.

Significance: CT-guided radiofrequency ablation for children with osteoid osteoma results in successful outcomes in the majority of patients, but may result in rare but potentially severe complications.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Can You Retain Spinal Hardware in Acute Post-Operative Infections?

*Michael P. Glotzbecker, MD; **Jaime A. Gomez, MD**; M. Timothy Hresko, MD; Michael J. Troy, BS; Patricia Miller, MS; Brian Snyder, MD, PhD; Lawrence I. Karlin, MD; John B. Emans, MD; Daniel J. Hedequist, MD*
Boston Childrens Hospital, Boston, MA

†**LOE-Therapeutic - Level IV**

Purpose: To examine the natural history of acute spinal infections after pediatric spinal deformity surgery (PSDS) and to understand factors that may indicate whether instrumentation should be retained or removed when treating these events.

Methods: Between 1999 and 2011 patients with spinal infections who required irrigation and debridement (I&D) within 3 months of PSDS were identified. Demographic and clinical data was collected. Univariable and multivariable regression analysis was used to identify risk factors associated with failure of treating the acute infection.

Results: 41 patients, including 25 females and 16 males with a mean age of 14.4 (8.6 to 23.4) years were identified. 29 had syndromic or neuromuscular disease. Median follow up after initial surgery was 2.1 yrs. Twenty-nine (70.7%) were successfully treated with serial I&D or acute implant exchange (group A); twelve (29.3%) returned later with persistent chronic infection (group B). Group B patients presented at a median of 620 days [IQR: 469.8- 972] after index procedure; patients in group A were followed from first I&D to last evaluation for a median of 755 days (502-1518). Eleven (91%) patients in Group B underwent removal or exchange of hardware. Median number of I&D was not significantly different between groups A and B (2, p=0.59). The incidence of syndromic and neuromuscular patients in Groups A (72%) and B (67%) was not statistically significant (p=0.7). Patients with stainless steel instrumentation presented with chronic failures (8/19; 42%) more frequently than patients with other metal types (1/16; 6%) P=0.03. No significant difference was found regarding the initial time of presentation after index procedure between failures (18 d) and those treated successfully (14d) p=0.53. Positivity of cultures was not different between the 2 groups (67% vs. 76% p= 0.55); nor type of isolated bacteria. The time on antibiotic treatment was not significantly different between Groups A and B (215.4 vs 305.7; p=0.32).

Conclusions: 70.7% of patients with acute spinal infections after PSDS were treated successfully with serial I&D's and antibiotics. Majority of patients (91%) presenting with recurrent infection required hardware removal with immediate or deferred reinstrumentation. Patients with retained stainless steel instrumentation are more likely to present with a late infection compared to other metals.

Significance: Acute postoperative spinal infections can often be treated with retention of implants. Patients with stainless steel instrumentation are more likely to present with a late recurrent infection compared to other metals.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

Mid-Term Results of Percutaneous Osteotomies and Fassier-Duval Nailing in Children with Osteogenesis Imperfecta

Khalid Azzam, MD, Bridget Burke, PA-C, Aleisha Menning, BS, ***Paul W. Esposito MD***
Childrens Hospital and Medical Center and the University Nebraska Medical Center, Omaha, NE

†**LOE-Therapeutic - Level IV**

Background: Surgical realignment and stabilization of long bones in children with osteogenesis imperfecta (OI) has evolved from wide exposures and massive soft tissue dissections to percutaneous osteotomies and intramedullary rods performed through small incisions. The Fassier-Duval rod system (Pega Medical, Quebec, Canada) allows bony realignment through percutaneous osteotomies while avoiding the need for knee and ankle arthrotomies and violation of the articular cartilage. The purpose of this study was to investigate the outcome of this system with special emphasis on complications and reoperation rates.

Materials and Methods: A consecutive series of patients with OI who underwent osteotomies and nailing with the telescoping Fassier-Duval (FD) nail by one surgeon between 2003 and 2010 were followed prospectively both clinically and with radiographs. Complications, re operations and demographic criteria were collected from the charts. At final follow up, patients were assessed using the Brief Assessment of Motor Function (BAMF) score, the walking scale subset of the Gillette Functional Assessment Questionnaire (FAQ) and the Pediatric Outcomes Data Collection Instrument.

Results: A consecutive series of 59 patients (22 males and 37 females) was included. There were 136 femoral and 98 tibial procedures that involved treatment with a FD rod. Forty-three procedures in which non-telescoping rods were used to treat younger children too small for the use of this rod were included. Average age at initial surgery was 51 months (range 13-166), and average follow-up from the most recent surgery was 4 years (range 1-8). Indications for reoperation included recurrent bowing, fractures, bending of the rods with subsequent arrest of telescoping, and out growing the nail. Fifty-seven (27%) rods required exchange. Complications included delayed union, non-union of the osteotomy, and implant migration. Walking ability improved significantly in 67% of patients. Average BAMF and FAQ scores at follow-up were 8 and 7 respectively, indicating a significant ability to walk.

Conclusion: Midterm results with the Fassier-Duval telescopic system demonstrated satisfactory improvement in walking ability and overall functional outcome in children with OI. The reoperation rate is acceptable when compared with other telescopic intramedullary systems.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Outcomes of Tibial Derotational Osteotomies in Patients with Myelodysplasia

*Erik B. Eller, MD; **Vineeta T. Swaroop, MD**; Luciano Dias, MD; Rachel E. Mednick, MD*
Ann and Robert H. Lurie Childrens Hospital of Chicago, Chicago, IL

†**LOE-Therapeutic - Level IV**

Purpose: Rotational deformities of the tibia are common in patients with myelodysplasia. The current recommended treatment is tibial derotational osteotomy to realign the distal limb. Reported complication rates have been widely variable in the literature. A recent study by Martin et al demonstrated a high complication (28%) and reoperation rate (31%). In contrast, Selber et al reported a much lower rate of major complications (5.3%). The purpose of the present study is to review the outcomes of derotational osteotomies as a function of complication and revision surgery rates as compared to these previous studies.

Methods: A retrospective chart review was performed of all tibial derotational osteotomies performed in patients with myelodysplasia from 1985 to present in patients >5 years old with >2 years follow-up. Charts were reviewed for demographics, amount of derotation performed at index surgery, incidence of complications, and the need for repeat derotation surgery.

Results: 82 patients (128 limbs) had sufficient data for inclusion. The average follow up was 7.15yrs. Of patients undergoing derotational osteotomies 35 were female and 47 were male. Sixty-seven patients had myelomeningocele, 13 had lipomeningocele, and 2 had diastomatomyelia. Surgery was indicated for symptomatic torsion >20°. The average amount of derotation was 28 +/- 12°. The incidence of complications (including infection, fracture, wound dehiscence, and hardware failure) was 7.8%. The repeat derotation rate was 16%, all in patients initially treated for external tibial torsion. The total reoperation rate for complications and repeat derotation was 20%. Age at initial surgery had no effect on complication rate or need for reoperation. Level of spinal involvement was not associated with complication rate, however lumbar level patients had significantly higher rate of repeat derotation compared to sacral level patients.

Conclusion: Derotation can be obtained and maintained through distal tibial derotational osteotomies for myelodysplasia. The complication rate and rederotation rate in this retrospective review are lower than noted in previous studies which we attribute to meticulous operative technique. Risk for repeat derotation was higher in patients with external tibial torsion or lumbar level of involvement.

Significance: The present study reaffirms that derotational osteotomy of the tibia in patients with myelomeningocele is a safe and effective method to treat tibial torsion, with a low overall complication rate of 7.8%. In addition, this data assists providers to counsel patients regarding the risk of recurrence and subsequent need for repeat derotation surgery of 16%.

†LOE - Level of Evidence - Please see page 16 for details.
See pages 17 - 62 for financial disclosure information.

High Incidence of Cervical Deformity and Instability Requires Surveillance in Loeys-Dietz Syndrome

Sara K. Fuhrhop, BS; Mark J. McElroy, BS, MS; Harry C. Dietz, MD; ***Paul D. Sponseller, MD***
Johns Hopkins University, Baltimore, MD

†**LOE-Therapeutic - Level IV**

Purpose: Loeys-Dietz syndrome (LDS) is a connective tissue disorder characterized by vascular, craniofacial, and musculoskeletal abnormalities. Cervical spine abnormalities are common but have not been fully quantified. We report cervical manifestations in children with LDS, including treatment and complications.

Methods: We retrospectively reviewed clinical and imaging data of 58 children with LDS. Some imaging modalities were not available for all patients, so results are reported as a fraction of those imaged.

Results: Mean age was 9 years (range 8 months to 18 years).
Atlas anomalies: Twenty-one (44%) of 48 patients had atlas anomalies, including anterior arch defects in 17 (35%), posterior arch defects in 11 (23%), and hypoplasia in 2 (4%) patients. Nine patients with atlas anomalies had cervical spine instability; 5 required surgery.
Axis anomalies: Twenty-eight (56%) of 50 patients had axis malformation, including elongation in 23 (46%) patients, dorsal angulation in 8 (16%), and spondylolysis in 2 (4%). Eight patients with axis anomalies had cervical spine instability; 5 required surgery.
Subaxial anomalies: Five (10%) of 48 patients had hypoplastic subaxial vertebrae, leading to focal kyphosis in 4. All had subaxial cervical instability requiring surgery.
Cervical Malalignment and Instability: Focal kyphosis was present in 11 (19%) of 58 patients. Cervical instability was present in 16 (28%) of 58 patients; 11 were symptomatic and 8 had cord compression. Of the patients with cervical instability, 7 (12%) had atlanto-axial instability, and 13 (22%) had subaxial instability (Figure 1). Thirteen patients with instability had vertebral anomalies, and 10 had focal kyphosis.
Treatment and Complications: Treatment for cervical instability included surgical fusion in eight patients and halo application in one patient. Mean age at surgery was 4.5 years (range 17 months to 11 years). All patients requiring surgery were symptomatic and had vertebral anomalies. Postoperative complications included pseudarthrosis in 5 patients, failure of fixation in 3, junctional kyphosis in 2, and development of occipital-cervical instability in 1 patient, requiring 13 re-operations.

Conclusions: Cervical midline defects are common in LDS, with anterior arch defects of the atlas more common than posterior arch defects. Cervical instability, particularly subaxial instability, is also common. Patients with cervical instability often have vertebral anomalies or focal kyphosis. Patients requiring surgery often present in early childhood. Periodic surveillance is recommended.

Significance: This is the first study to report the high frequency of bony anomalies and cervical instability, treatment, and complications in a large cohort of LDS children.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Figure 1: 8 month old boy with C2-C3 focal kyphosis and subluxation

YOUNG MEMBERS FORUM

Thurs., May 1, 2014 • 5:00 PM–6:30 PM • Hollywood Ballroom

5:00 PM–5:20 PM	**Research: Obtaining and Using Protected Time, Finding Research Mentors, Collaborating with Colleagues in Multi-center Studies** *Mininder S. Kocher, MD*
5:20 PM–5:40 PM	**Perspectives on Pediatric Orthopaedics at Mid-Career** *John (Jack) M. Flynn, MD*
5:40 PM–6:00 PM	**Mentors in Pediatric Orthopaedics** **Finding and Using Mentors, Being a Mentor, The Value of Mentoring** *James H. Beaty, MD; Vernon T. Tolo, MD*
6:00 PM–6:30 PM	Discussion *Brian G. Smith, MD*

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

NP/PA SYMPOSIUM

Thurs., May 1, 2014 • 1:00 PM–2:30 PM • Hollywood Ballroom

Moderator: *James O. Sanders, MD*
Chair: *Jill Ariagno, MSN, RN, CPNP*
Co-Chair: *Jessica Staschak MSN, RN, CPNP*

PREVENTION OF SURGICAL SITE INFECTIONS IN PEDIATRIC ORTHOPAEDIC SURGERY

1:00 PM–1:35 PM **Presentation I: Evidenced Based SSI Prevention Strategies**
Presenter: *Jason Newland, MD, MEd, Kansas City, MO*

1:35 PM–1:45PM DISCUSSION

1:45 PM–2:20 PM **Presentation II: Continuum of Care Approach in Preventing SSIs in Spinal Fusion Cases**
Presenter: *Josh Schaffzin MD, PhD, FAAP, Cincinatti, OH*

2:20 PM–2:30 PM DISCUSSION

CME credit is not available for the NP/PA symposium.

See pages 17 - 62 for financial disclosure information.

POSNA

SYMPOSIA • THURSDAY, MAY 1, 2014

COUR SYMPOSIUM

Thurs., May 1, 2014 • 1:00 PM–3:30 PM • Doheny/Beachwood

Chair: *Richard H. Gross, MD*

SERVING THE PEDIATRIC ORTHOPAEDIC NEEDS IN RESOURCE CHALLENGED ENVIRONMENTS: AN INTERNATIONAL PERSPECTIVE

PART I. THE PAST

1 **The History of Pediatric Orthoapedics in Developing Countries**
Hugh G. Watts, MD

2 **The COUR Committee – How it Started, What it does**
Sanjeev Sabharwal, MD, MPH

PART II. THE PRESENT

3 **Perspectives from Developing Countries – "What We Need and What We Don't Need"**
a . *Benjamin Joseph, MD, India*
b . *AlaaEldin A. Ahmad, MD, Palestine*

4 **Other Organizations**
a . SICOT
Joshua E. Hyman, MD
b . The SIGN Program and the Pediatric Nail
Greg A. Schmale, MD

5 **The POSNA – COUR International Scholar Program – The First 7 Years**
Eric Fornari, MD

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

PART III. THE FUTURE

6 **A Proposal for Curriculum Development for COUR Programs in Developing Countries**
Richard H. Gross, MD

PART IV. FREEWHEELING PANEL AND AUDIENCE DISCUSSION

PART V. COUR SCHOLAR PRESENTATIONS

See pages 17 - 62 for financial disclosure information.

POSNA

2014 SUBSPECIALTY DAY AGENDA

HIP SUBSPECIALTY DAY

Fri., May 2, 2014 • 1:00 PM–5:15 PM • Ray Dolby Ballroom

Co-Chairs: *Pablo Castaneda, MD and Ira Zaltz, MD*

PERIOD 1

1:00 PM–2:15 PM
Infant DDH Indications and Complications
Moderator: *Pablo Castaneda, MD*

1:00 PM–1:09 PM **Timing and Technique for an Anterior Open Reduction**
Simon P. Kelley, FRCS

1:10 PM–1:19 PM **How I Approach Redislocation after Open Reduction**
Colin F. Moseley, MD

1:20 PM–1:29 PM **Indications and Techniques for an Acetabuloplasty and/or Femoral Osteotomy**
Travis Matheney, MD

1:30 PM–1:39 PM **What Do I Do When AVN Occurs**
Perry L. Schoenecker, MD

1:40 PM–2:15 PM **Discussion/Case-based Problem Solving**
Simon P. Kelley, FRCS; Colin F. Moseley, MD; Travis Matheney, MD; Perry L. Schoenecker, MD

2:15 PM–2:30 PM BREAK

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

PERIOD 2

2:30 PM – 3:45 PM
SCFE
Moderator: *Ira Zaltz, MD*

2:30 PM – 2:39 PM **When Do I Pin a Hip In-Situ?**
Wudbhav N. Sankar, MD

2:40 PM – 2:49 PM **Closed Reduction of Unstable SCFE: Can it be Done Safely?**
Tim Schrader, MD

2:50 PM – 2:59 PM **How Do I Manage Symptomatic FAI following In-Situ Pinning?**
Daniel J. Sucato, MD, MS

3:00 PM – 3:09 PM **Discussion/Cases** *Wudbhav N. Sankar, MD; Tim Schrader, MD; Daniel J. Sucato, MD, MS*

Hip Fractures

3:10 PM – 3:19 PM **How Do I Approach a Hip Fracture in the Era of Locking Plates?**
Scott B. Rosenfeld, MD

3:20 PM – 3:29 PM **What Do I Do if Fixation Fails?**
Fergal Monsell, MD, FRCS

3:30 PM – 3:45 PM **Discussion/Cases**
Scott B. Rosenfeld, MD; Fergal Monsell, MD; Ira Zaltz, MD; Pablo Castaneda, MD

3:45 PM – 4:00 PM BREAK

See pages 17 - 62 for financial disclosure information.

PERIOD 3

4:00 PM–5:15 PM
Free Papers
Moderators: *Pablo Castaneda, MD; Ira Zaltz, MD*

4:00 PM–4:04 PM
1 *(page 231)*
Risk Factors for Failed Pavlik Harness Treatment in Developmental Hip Dysplasia
Jill E. Larson, MD; Brian Weatherford, MD; Brittany Patrick, MPH, CCRP; ***Joseph A. Janicki, MD***
Northwestern University, Ann and Robert H. Lurie Children's Hospital, Chicago, IL

4:05 PM–4:09 PM
2 *(page 232)*
Acetabular Retroversion after Salter Innominate Osteotomy in the Patients with Developmental Dysplasia of the Hip
Daisuke Kobayashi, MD; *Shinichi Satsuma, MD; Maki Kinugasa, MD*
Kobe Children's Hospital, Kobe, JAPAN

4:10 PM–4:14 PM
3 *(page 233)*
How Much Acetabular Coverage is Too Much? A Study of Acetabular Overcoverage using Wiberg CE Angles
Raghav Badrinath, BS; ***Daniel R. Cooperman, MD***
Department of Orthopedics and Rehabilitation, Yale University School of Medicine

4:15 PM–4:19 PM
4 *(page 234)*
How does Ultrasound Influence Paediatric Orthopaedic Surgeons in Making the Diagnosis of Developmental Dysplasia of the Hip and in Making Treatment Decisions?
Elizabeth Ashby, FRCS; *Andreas Roposch, MD*
London, UK

4:20 PM–4:32 PM
DISCUSSION

4:33 PM–4:37 PM
5 *(page 235)*
A Concomitant Arthrotomy does Not Improve Outcome for Adolescents with Hip Dysplasia Undergoing a Periacetabular Osteotomy
Daniel J. Sucato, MD, MS; *David A. Podeszwa MD, Andriana De La Rocha, MS; John C. Clohisy, MD; Ernest L. Sink, MD; Ira Zaltz, MD; Young-Jo Kim, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

4:38 PM – 4:42 PM
6 *(page 236)*
Early Clinical and Radiographic Outcomes of Combined Hip Arthroplasty and Periacetabular Osteotomy
James Ross, MD; Angela D. Keith, MS; Gail Pashos; Stephen T. Duncan, MD; Perry L. Schoenecker, MD; ***John C. Clohisy, MD***
Washington University, St Louis, MO

4:43 PM – 4:47 PM
7 *(page 237)*
Commonly Used Adult Outcome Scores do Not Accurately Assess Pediatric Patients Undergoing Hip Surgery
Travis Matheney, MD; *Ira Zaltz, MD; Young-Jo Kim, MD, PhD; John C. Clohisy, MD; David Zurakowski, PhD; Michael B. Millis, MD; The ANCHOR Study Group*

4:48 PM – 4:57 PM
DISCUSSION

4:58 PM – 5:02 PM
8 *(page 239)*
Prognosticators for Femoral Head Deformity in the Early Stages of Legg-Calvé-Perthes Disease: MR Diffusion and Perfusion Indices
Won Joon Yoo, MD; *In Ho Choi, MD; Tae-Joon Cho, MD; Eun Seok Choi, MD; Chin Youb Chung, MD; Moon Seok Park, MD; Jung-Eun Cheon, MD*
Seoul National University Children's Hospital, Seoul, KOREA

5:03 PM – 5:07 PM
9 *(page 240)*
Open Anatomic Reduction of SCFE: Risks and Benefits in Adopting New Treatment Methods
Christopher D. Souder, MD*; James D. Bomar, MPH; Dennis R. Wenger, MD*
Rady Children's Hospital, San Diego, CA

5:08 PM – 5:12 PM
10 *(page 241)*
Treatment of Unstable SCFE via the Modified Dunn Procedure: A Single Surgeon Experience
Freddie D. Persinger, DO; Walter P. Samora, MD; ***Kevin E. Klingele, MD***
Nationwide Children's Hospital, Columbus, Ohio

5:13 PM – 5:22 PM
DISCUSSION

See pages 17 - 62 for financial disclosure information.

Risk Factors for Failed Pavlik Harness Treatment in Developmental Hip Dysplasia

Jill E. Larson, MD; Brian Weatherford, MD; Brittany Patrick, MPH, CCRP;
Joseph A. Janicki, MD
Northwestern University, Ann and Robert H. Lurie Children's Hospital, Chicago, IL

†**LOE-Prognostic - Level IV**

Purpose: The Pavlik Harness is widely used as the initial treatment of children with Developmental Hip Dysplasia (DDH) with success rates from 65-95%. However, a significant number of children still fail Pavlik harness therapy and require additional interventions to prevent long-term sequelae. This study compares demographic and socioeconomic risk factors in children who had successful Pavlik harness treatment for hip instability to those who failed. We hypothesize that socioecominic factors play an important role in Pavlik harness failure.

Methods: A retrospective review of medical records between 2004 and 2010 was completed. Patients were included if they,were prescribed Pavlik harness therapy for hip instability or dislocation. Pavlik harness failure was defined as requiring at least one operative procedure for definitive management of a congenital hip dislocation. Risk factors evaluated included sex, ethnicity, language, insurance status, birth order, comorbid conditions, hip examination, income by zip code, and family composition.

Results: A total of 146 children had successful Pavlik harness treatment (SUC) while 44 failed (FAIL) (77% success). Mean age at commencing Pavlik treatment was 1.5 months (SD 1.7) in the SUC group & 1.4 months (SD 1.4) in the FAIL group (p=0.7). The SUC group had 9% Spanish speaking patients while the FAIL group had 32% (p=0.0001) (OR: 4.8, CI 2.0 - 11.2). Medicaid insurance status (SUC=23%, FAIL=50%)(p=0.0007) (OR: 3.3, CI 1.6 - 6.7) and Hispanic ethnicity (SUC=20%, FAIL=52%)(p<0.001)(OR:4.9, CI 2.2 - 11.1) were found to be significant risk factors of failure. Patients with one or more comorbidities (SUC=7%, FAIL=23) (p=0.026) also had an increased failure risk. Factors that were not statistically significant included, sex (p=.29), family composition (p=0.18), birth order (p=0.13) and income by zip code (p=0.86).

Conclusion: Hispanic ethnicity, insurance status, language, and the presence of medical comorbidies are factors that significantly increase the risk for failure of Pavlik harness treatment in DDH. While possible genetic effects cannot be excluded, the totality of the findings implies social and compliance reasons for failure.

Significance: Socioeconomic factors play a significant role in the treatment of hip dysplasia, as in many other pediatric conditions such as low birth weight, primary hypertension and obesity. While these risk factors are not directly modifiable, their effects can be minimized. These findings have patient specific implications on DDH treatment protocols and family education, and also call for public health strategies to address these risk factors on a population basis. By identifying risk factors for failure, increased focus can now be given to improving the rates of successful Pavlik harness therapy in at risk patient populations.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Acetabular Retroversion after Salter Innominate Osteotomy in the Patients with Developmental Dysplasia of the Hip

Daisuke Kobayashi, MD; *Shinichi Satsuma, MD; Maki Kinugasa, MD*
Kobe Children's Hospital, Kobe, JAPAN

†**LOE-Prognostic - Level III**

Purpose: Acetabular retroversion can cause femoroacetabular impingement and subsequent osteoarthritis. Salter innominate osteotomy (SIO) has been recognized as an effective additional surgery for the residual subluxation of the hip. In this procedure, the distal segment of the pelvis is displaced laterally and anteriorly, therefore it may predispose the patient to acetabular retroversion. This study aimed to determine whether SIO may be a cause of acetabular retroversion during the period when the skeleton has matured.

Materials & Methods: In this study, 99 hips in 99 patients who underwent SIO for the unilateral developmental dysplasia of the hips (DDH) at our institute were retrospectively reviewed. Here, patients who were skeletally immature (under 18 years) at the final visit, who underwent SIO for bilateral hips, who had an additional pelvic osteotomy, and who had a neuromuscular disease were excluded. The average age at surgery was 4.1 years (range: 2.0 to 8.6 years) and the average age at the most recent follow-up was 20.7 years (range: 18.0 to 28.5 years). Acetabular retroversion was diagnosed based on the presence of a positive cross-over (CO) sign and a prominence of the ischial spine (PRIS) sign on the anteroposterior radiographs at the final visit. The center edge angle, acetabular angle of Sharp, and acetabular index were measured at preoperative and final visits. Contralateral hips were used as controls, and a paired comparison was made in each patient.

Results: A positive CO sign was noted in 20 of the 99 hips (20.2%) in the SIO group compared with that in 17 of the 99 hips (17.2%) in the control group. On the other hand, a positive PRIS sign was noted in 22 of the 99 hips (22.2%) in the SIO group, and in 18 of the 99 hips (19.2%) in the control group. Hips with positive CO and PRIS signs were significantly and bilaterally coexistent. In addition, significant coexistence was observed between positive CO and PRIS signs in both groups. Final or preoperative radiographic parameters of the acetabulum did not have any correlation with positive CO and PRIS signs.

Conclusions: Our results suggest that SIO does not consistently cause acetabular retroversion in adulthood. We believe that remodeling of the acetabulum may occur after SIO, when performed at an accurate age.

Significance: The procedure of SIO does not prevent normal acetabular version. Long-term anterior over-coverage and retroversion are not a matter of concern with this surgery.

See pages 17 - 62 for financial disclosure information.

How Much Acetabular Coverage is Too Much? A Study of Acetabular Overcoverage using Wiberg CE Angles

Raghav Badrinath, BS; ***Daniel R. Cooperman, MD***
Department of Orthopedics and Rehabilitation, Yale University School of Medicine

†**LOE-Prognostic - Level IV**

Purpose: Since Wiberg's seminal thesis in 1939, it has been accepted that dysplastic hips (Wiberg angle<20°) develop accelerated osteoarthritis. It is hypothesized that the opposite situation, global overcoverage, would predispose patients to labral tears, and consequently, osteoarthritis. Although CE angles over 40° often indicate overcoverage, no studies have determined the accuracy of this number or its implications for hip pathology.

Methods: After IRB approval, we collected all hip x-rays from our institution read as "normal", taken in patients over sixty-five from 2003-2013. 2000 of these were randomly selected. Patients with unread osteoarthritis, or predisposing conditions such as RA were excluded. The remaining images underwent CE angle measurement using custom software coded on MATLAB (Mathworks Inc, MA). Statistical analysis was conducted using SPSS 19.0 (IBM Corporation, NY). Twenty randomly-selected hips were re-measured using the program, and manually by an orthopedic surgeon to assess intra- and inter-observer agreement, using intraclass correlation coefficient (ICC) and Pearson's correlation coefficient (r).

Results: Interobserver (ICC:0.898, r:0.808, p<0.001) and intraobserver (ICC:0.968, r:0.951, p<0.001) agreement were excellent. 788 hips (461 images, mean age 75.7, 56.8% female) were analyzed. Average Wiberg angle was 36.84° (99% CI: 19.04-54.64). Angles did not differ by gender (p=0.854), side (p=0.994) or age (linear regression, p=0.167).

When hips with opposite side osteoarthritis and hip replacements were excluded, the mean angle was 37.14° (99% CI: 20.04-54.20). Hips outside the interval were reexamined for signs of osteoarthritis. The lowest angle in a blameless hip was 17.66° (although severe degeneration was noted opposite), while the largest such angle was 54.23°.

Conclusion: Our results mirrored the literature with a mean of 37° and 99% CI of 19°-55°. Acetabular coverage was unrelated to age, gender or laterality. Although almost all arthritis-free hips were over 20°, we saw pristine hips with lower angles. 55° was the upper limit of CE angles in hips that 'made it' to 65.

Significance: Wiberg's angle has long been a reliable predictor of osteoarthritis secondary to dysplasia. Interestingly, we found hips under 20° that did not demonstrate degeneration, possibly implying a need to revisit this threshold.

Additionally, a CE angle below 55° resulted in conservation of hips. Prevailing wisdom holds that an angle greater than 40° denotes femoroacetabular impingement, leading to osteoarthritis. We show that this number significantly underestimates the threshold above which individuals develop osteoarthritis. Future prospective studies measuring the functional impact of these overcovered hips are needed to conclusively identify this upper threshold.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

How does Ultrasound Influence Paediatric Orthopaedic Surgeons in Making the Diagnosis of Developmental Dysplasia of the Hip and in Making Treatment Decisions?

Elizabeth Ashby, FRCS; *Andreas Roposch, MD*
London, UK

†**LOE-Diagnostic - Level III**

Purpose: To determine the impact of ultrasound information on surgeons' diagnostic thinking and decision-making in the management of infants with a possible diagnosis of DDH.

Material and Methods: This study was approved by the institutional review board. Five experienced orthopaedic surgeons examined 66 hips referred for a possible diagnosis of DDH and reported for each hip a confidence level about the diagnosis of DDH using a visual analogue scale (VAS) before and after hip ultrasound was obtained. In addition, they reported a management plan. We determined the efficiency in diagnostic thinking by calculating the mean gain in diagnostic confidence as the percent point change in VAS scores, and the impact of ultrasonography on the management plan (therapeutic efficiency).

Results: Ultrasonography led to a change in diagnosis in 34/66 (52%) hips. The management plan changed in 21/66 (32%) hips. The mean gain in reported diagnostic confidence was 19.4 (95% CI = 17.27, 21.5), but it was 46 (30.53, 60.79) in cases where the management changed as a result of ultrasonography (difference = 37.8, $p < 0.0001$). The greatest yield of ultrasonography was found in hips demonstrating limited abduction. Management plans changed in a third of cases with the knowledge of ultrasound results. Ultrasound obviated the need for further followup 15/66 (23%) of cases.

Conclusion: In the majority of cases, ultrasound refined the diagnostic thinking of clinicians or reassured them about the correctness of their clinical diagnosis. The diagnostic yield was modest.

Significance: This study shows that hip ultrasound can prevent a missed or delayed clinical diagnosis of DDH. Ultrasound reduces the number of infants requiring surveillance for DDH preventing unnecessary costly outpatient appointments and expediting definitive treatment. Hip ultrasound leads to the greatest change in management plan in infants with limited abduction but rarely alters the management plan in infants with a positive Barlow or Ortolani test.

See pages 17 - 62 for financial disclosure information.

A Concomitant Arthrotomy Does Not Improve Outcome for Adolescents with Hip Dysplasia Undergoing a Periacetabular Osteotomy

Daniel J. Sucato, MD, MS; *David A. Podeszwa MD, Andriana De La Rocha, MS; John C. Clohisy, MD; Ernest L. Sink, MD; Ira Zaltz, MD; Young-Jo Kim, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level III**

Purpose: The Bernese periacetabular osteotomy (PAO) is an effective procedure to treat adolescent hip dysplasia. The indications for a concomitant open arthrotomy to address labral pathology and/or correct femoral neck are not defined.

Methods: This is a retrospective analysis of an IRB approved prospective, multi-center database of consecutive patients who underwent a PAO for acetabular dysplasia. Standard radiographic measurements and functional scores were collected pre-op and 2 yrs post-op. Patients were divided into those who had an arthrotomy (A group) and those with no arthrotomy (NA group) and were analyzed with $p<0.05$.

Results: There were 140 patients (107 females, 33 males), of which 94 (67%) had an arthrotomy (A group) and 46 (37%) who did not (NA group). The preoperative physical examinations were similar between the A and NA groups with respect to hip flexion (105 vs 102°) and a positive impingement sign (76% vs 71%). The groups were equal for: pre-operative lateral center edge angle (LCEA) (6.7° vs 3.9°, p=0.245), acetabular index (AI) (24.4° vs 24.2°, p=0.914) and ventral center edge angle (VCEA) (4.7° vs 2.2°, p=0.384). Both groups also had similar femoral head neck offset and alpha angles (p=0.683), Harris Hip Scores (HHS) (64 vs 64.7, p=0.817), and UCLA Scores (7.3 vs 7, p=0.497). The prevalence of labral pathology seen at surgery in the A group was 41%. Osteochondroplasty was done in 71 (76%) and 6 (6%) had labral repair. At 2 yrs, the A and NA groups achieved and maintained similar radiographic parameters and functional scores: HHS (84.1 vs 88.6, p=0.109) and UCLA (7.3 vs 7.7, p=0.334). Pre- to post-op changes within the A and NA groups were also similar in the LCEA (22.4° vs 26.8°, p=0.154), AI (-17° vs -18°, p=0.647), VCEA (23.2° vs 29.5°, p=0.177), HHS (20.8 vs 24.0, p=0.392), and UCLA (0.0 vs 0.8, p=0.093).

Conclusions: The use of an open arthrotomy in combination with a Bernese PAO is common in adolescent and young adult patients with hip dysplasia, and more commonly done in the older patient, however postoperative satisfaction was similar between the two groups. These early 2 year data call into question the routine use of an open arthrotomy, labral repair and osteochondroplasty.

Significance: Performing an arthrotomy in combination with a PAO may not be routinely indicated for adolescents with hip dysplasia.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Early Clinical and Radiographic Outcomes of Combined Hip Arthroplasty and Periacetabular Osteotomy

James Ross, MD; Angela D. Keith, MS; Gail Pashos; Stephen T. Duncan, MD; Perry L. Schoenecker, MD; ***John C. Clohisy, MD***
Washington University, St Louis, MO

†**LOE-Therapeutic - Level III**

Purpose: The Bernese periacetabular osteotomy (PAO) addresses extra-articular deformity correction by redirecting the acetabulum into an improved mechanical position but does not address the concomitant intra-articular pathology of acetabular dysplasia. There is limited information on the combination of hip arthroscopy with periacetabular osteotomy for treating symptomatic acetabular dysplasia and associated intra-articular abnormalities. The purpose of this study was to report the early clinical and radiographic outcomes of combining hip arthroscopy with PAO compared to PAO combined with open arthrotomy and femoral head-neck osteochondroplasty.

Methods: We retrospectively reviewed 42 patients (43 hips) who underwent hip arthroscopy combined with periacetabular osteotomy (HS-PAO) and compared this to a control group of 37 patients (37 hips) who underwent PAO combined with an open arthrotomy and femoral head-neck osteochondroplasty. The average clinical follow-up of the HS-PAO group was 25.7 months (range, 7-52 months) and the control group was 42.1 months (range, 23-85 months). We used the Harris hip score to evaluate hip function. To evaluate clinical performance, we used the SF-12 and WOMAC scores. Radiographically, we calculated lateral center-edge angle (LCEA), acetabular index, anterior center-edge angle (ACEA), and Tönnis osteoarthritis grade. Perioperative complications were graded and compared between groups.

Results: The patient demographics were similar between groups. Both groups saw major improvements in Harris hip score (HS-PAO and control $p<0.0001$), SF-12 Physical scores (HS-PAO $p<0.0001$; Control $p=0.005$), WOMAC pain scores (HS-PAO $p<0.0001$; Control $p=0.0019$), and WOMAC function scores (HS-PAO $p<0.0001$; Control $p=0.001$). We observed an increase in the LCEA, decrease in the acetabular index, and increase in the ACEA in each group. There were two grade III complications in each group and a total of six grade I complications.
Conclusion: At short term follow-up, hip arthroscopy with PAO shows equivalent clinical and radiographic outcomes without increase in major complications versus PAO with femoral head-neck osteochondroplasty.

Significance: At short-term follow-up, hip arthroscopy with PAO shows equal to improved clinical outcomes with similar radiographic changes when compared to PAO alone without an increase in major complications.

See pages 17 - 62 for financial disclosure information.

Commonly Used Adult Outcome Scores Do Not Accurately Assess Pediatric Patients Undergoing Hip Surgery

Travis Matheney, MD; *Ira Zaltz, MD; Young-Jo Kim, MD, PhD; John C. Clohisy, MD; David Zurakowski, PhD; Michael B. Millis, MD; The ANCHOR Study Group*

†**LOE-Prognostic - Level III**

Purpose: Numerous Patient Reported Outcome measures (PROs) that are used to assess patients following hip surgery include both generic and condition-specific measures proven to be reliable, valid, and responsive in adult patients with hip and/or knee arthritis. As there are no pediatric-specific PROs to assess outcomes following hip surgery, these same measures are commonly used in pediatric patients. The purpose of this study was to compare the ability of four commonly used PROs to detect change (*responsiveness*) in both pediatric and adult patients undergoing Bernese periacetabular osteotomy (PAO).

Methods: IRB approval was obtained and a total of 82 hips ≤ 18 years at surgery and 171 hips > 18 years at surgery were assessed pre- and post-operatively. Short Form-12 mental and physical components (SF-12 mcs and pcs), Hip disability and Osteoarthritis Outcome Quality of Life Score (HOOS QOL), Western Ontario and McMaster osteoarthritis score (WOMAC), and modified Harris Hip Score (mHHS) were assessed at an average 2.5 years (range 1-4.9) following surgery. The scores of these outcome measures were calculated and analyzed to determine the parameters of responsiveness including: percent change in raw score, effect size, standardized response mean (SRM), minimal detectable change (MDC), and the percentage of hips that exceeded the minimal detectable change at a 90% confidence level (MDC 90, 90% likelihood that there is an actual change not due to measurement error).

Results: All outcome measures showed large percentage changes indicating improvement in raw scores (see Table). Comparison of the effect size, SRM, and MDC for all four PROs demonstrated that the effect sizes and SRM were smaller and the MDC values were larger in the pediatric group. This indicates that they were less sensitive to change in the pediatric patients. For all PROs the percentage of hips exceeding the MDC 90 was lower in the pediatric group indicating that all four measures were less responsive in the pediatric population (see Table).

Conclusion: The SF-12, HOOS QOL, WOMAC, and mHHS measures were less responsive to change over time in pediatric patients compared to adult patients undergoing PAO. Further work should focus on either modifying of current measures or developing new measures to assess outcomes following reconstructive pediatric hip surgery.

Significance: Based upon this data, current outcome measures are inaccurate, suggesting there is a major need to improve how we measure outcomes in pediatric hip patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Table Results of PROs in Pediatric and Adult Patients Undergoing PAO					
Measure	**% Increase Raw Score**	**Effect Size**	**SRM**	**MDC**	**MDC 90**
Patients ≤ 18 years					
mHHS	**82%**	**1.126**	**1.188**	**42.73**	**15%**
HOOS QOL	**87%**	**1.25**	**1.339**	**46.572**	**34%**
SF12 mcs	**63%**	**0.23**	**0.309**	**19.146**	**7%**
SF12 pcs	**80%**	**0.778**	**0.933**	**20.466**	**16%**
WOMAC total score	**85%**	**0.884**	**1.009**	**46.278**	**16%**
Patients > 18 years					
mHHS	**87%**	**1.764**	**1.614**	**28.067**	**49%**
HOOS QOL	**89%**	**1.832**	**1.517**	**37.264**	**52%**
SF12 mcs	**60%**	**0.247**	**0.407**	**16.855**	**9%**
SF12 pcs	**77%**	**0.911**	**1.087**	**17.476**	**21%**
WOMAC total score	**89%**	**1.257**	**1.385**	**33.724**	**29%**

See pages 17 - 62 for financial disclosure information.

Prognosticators for Femoral Head Deformity in the Early Stages of Legg-Calvé-Perthes Disease: MR Diffusion and Perfusion Indices

Won Joon Yoo, MD; *In Ho Choi, MD; Tae-Joon Cho, MD; Eun Seok Choi, MD; Chin Youb Chung, MD; Moon Seok Park, MD; Jung-Eun Cheon, MD*
Seoul National University Children's Hospital, Seoul, KOREA

†**LOE-Diagnostic - Level IV**

Purpose: To find prognosticators for later femoral head deformity using the diffusion and perfusion MRI performed in the early stages before collapse of the femoral head.

Methods: Diffusion and perfusion MRI was performed in 46 patients (M:F=37:9) with unilateral Legg-Calvé-Perthes disease in the stages of increased density (n=38) and early fragmentation (n=8). The average age was 7.5 years (range, 3.3-11.9). Perfusion coefficient was measured in the femoral epiphysis (total epiphysis, lateral third, central third, and medial third) and the metaphysis of the proximal femur. Apparent diffusion coefficient (ADC) was measured in the femoral epiphysis and the metaphysis of the proximal femur. Perfusion difference ratio and ADC difference ratio were defined as a percent increase or decrease compared to the normal side. Presence or absence of physeal abnormalities and metaphyseal cyst were investigated in the conventional MRI. Deformity index was calculated on plain radiographs taken at 1.9 years after symptom onset (range, 1.2-2.8). Correlations between the deformity index set at 0.3 and the significant MR indices determined from the univariate analysis (correlation coefficients) were investigated using the multiple logistic regression test. Statistical significance was set at p=0.05.

Results: Significant variables based on the univariate analysis were ADC difference ratio in the metaphysis, perfusion difference ratio in the central epiphysis, perfusion difference ratio in the metaphysis, physeal abnormalities and metaphyseal cyst. However, multiple logistic regression analysis revealed that only ADC difference ratio in the metaphysis (p=0.003) and perfusion difference ratio in the central epiphysis (p=0.034) were significantly associated with the deformity index.

Conclusion: Increased diffusion in the metaphysis and decreased perfusion in the central epiphysis in the early stages before collapse of the femoral head were associated with the deformity index at 1.9 years after symptom onset.

Significance: Perfusion and diffusion MRI performed at the early stages of Legg-Calvé-Perthes disease before collapse of the femoral head provides prognostic information for later deformity.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Open Anatomic Reduction of SCFE: Risks and Benefits in Adopting New Treatment Methods

Christopher D. Souder, MD*; James D. Bomar, MPH; Dennis R. Wenger, MD*
Rady Children's Hospital, San Diego, CA

†**LOE-Therapeutic - Level IV**

Purpose: Slipped Capital Femoral Epiphysis (SCFE) can be treated with a variety of methods. The traditional method of in situ pin fixation is most commonly used. More recently, the Modified Dunn (Mod. Dunn) procedure consisting of capital realignment has been popularized. We began use of the Mod. Dunn procedure in our hospital about four years ago for select cases of SCFE. This paper reports our avascular necrosis (AVN) rate, reoperation (ReOp) rate, and complication rate.

Methods: Eighty-eight hips that were surgically treated for SCFE between July 2004 and June 2012 met our inclusion criteria (≥6 months follow up, treated with in situ fixation or Mod. Dunn). The in situ treatment group included 71 hips, while 17 hips were anatomically reduced with the Mod. Dunn procedure. Loder classification, severity, acuity, complication rate, and ReOp rate were determined for the two cohorts. Chi-square analysis was performed to evaluate the relationship between the treatment method and outcome. The binomial test was used to determine statistical differences in AVN rate between in situ fixation and Mod. Dunn for stable and unstable slips.

Results: As expected, stable slips did well with in situ pinning (n=64) with no cases of AVN, even in more severe slips. Ten stable slips were treated with the Mod. Dunn approach and two (20%) developed AVN ($p<0.001$). Unstable slips were more difficult to treat with three of the seven hips stabilized in situ developing AVN (43%). Two of seven unstable slips treated by the Mod. Dunn procedure developed AVN (29%) ($p=0.321$) (table). The other outcomes studied (ReOp rate and complication rate) were not significantly correlated with the surgical treatment method ($p=0.732$ and $p=0.261$ respectively).

Conclusion: In situ pinning remains a safe and predictable method for treatment of stable SCFE with no AVN noted, even in severe slips. Attempts to anatomically reduce stable slips by open methods led to AVN in 20% of cases, thus this treatment approach should be considered with extreme caution for stable slips. Treatment of unstable slips remains problematic with a high AVN rate noted whether treated by in situ fixation or capital realignment. Anatomic reduction is a suitable treatment choice.

Significance: Currently, we advise that stable slips be treated with in situ fixation to minimize the risk for AVN. As major referral institutions gain more experience with anatomic reduction of severe unstable slips, the AVN rate in this group may be reduced.

	In Situ	Mod. Dunn	p-value
Stable	0/64 (0%)	2/10 (20%)	$p<0.001$
Unstable	3/7 (43%)	2/7 (29%)	$p=0.321$

Table. Differences in AVN rate between stable and unstable slips by treatment method.

See pages 17 - 62 for financial disclosure information.

Treatment of Unstable SCFE via the Modified Dunn Procedure: A Single Surgeon Experience

Freddie D. Persinger, DO; Walter P. Samora, MD; ***Kevin E. Klingele, MD***
Nationwide Children's Hospital, Columbus, Ohio

†**LOE-Therapeutic - Level IV**

Purpose: The modified Dunn procedure has been shown to be a safe and effective way of treating unstable slipped capital femoral epiphysis (SCFE). Both single and multicenter analyses have shown restoration of anatomy and function with low rates of avascular necrosis or additional complication. We present a consecutive series of unstable SCFE managed by a single surgeon focused on timing of surgical intervention, postoperative complications and radiographic results.

Methods: From November 2006 to July 2013, 31 consecutive unstable SCFEs, defined by Loder classification and verified with intraoperative documentation, were treated with the modified Dunn procedure (open subcapital realignment via a surgical dislocation approach). Patients with underlying endocrinopathy or syndromes were excluded. Operative reports, inpatient and outpatient charts, and postoperative radiographs were reviewed. Demographics, presentation to time of operation, surgical times, and complications were recorded. Bilateral hip radiographs at last follow-up were used to record slip angle, greater trochanteric height, and femoral neck length.

Results: Thirty-one consecutive hips in 30 patients were reviewed: 15 male (50%) and 15 female (50%), average age 12.37 years (range 8.75-14.8), 20 left hips (65%) and 11 right hips (35%). Mean follow-up was 22.4 months (2-57). Time from ER presentation to surgery averaged 13.9 hours (2.17-23.4). Mean total operative time was 112 minutes (75-162). Two patients (6%) developed avascular necrosis (AVN) at an average of 21 weeks postoperative. Both of these hips underwent initial surgery >20 hours after presentation. Three patients (10%) developed mild heterotopic ossification requiring no treatment. Two patients (6%) required removal of symptomatic hardware. One patient had hardware failure. In no patients was nonunion or delayed union seen. No patients showed hip subluxation or dislocation. Three patients (10%) presented with bilateral, stable SCFE requiring contralateral in situ pinning. Five patients (16%) had sequential SCFE requiring treatment, with one patient having an acute, unstable SCFE 10 months following previous realignment. Mean postoperative slip angle measured 2.5 degrees (-9.4 - +19 degrees), greater trochanteric height averaged 3.5 mm below the center of femoral head (-17.5 - +25 mm) and mean femoral neck length difference measured (-) 7.75mm (- 1.8 - -18.6 mm).

Conclusion: A single surgeon series of 31 consecutive unstable SCFEs treated via a modified Dunn procedure showed a 6% incidence of AVN and low complication rates at latest followup. No cases of AVN were seen in patients treated within 20 hours of presentation. Radiographic analysis showed restoration of the slip angle with minimal change in greater trochanteric height and mild femoral neck shortening.

Significance: This consecutive series reveals the safety and effectiveness of the modified Dunn procedure for unstable SCFE.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

POSNA

2014 SUBSPECIALTY DAY AGENDA

SPINE SUBSPECIALTY DAY

Fri., May 2, 2014 • 1:00 PM–5:15 PM • Hollywood CDE

Co-Chairs: *Suken A. Shah, MD and Firoz Miyanji, MD*

PERIOD 1

1:00 PM–2:15 PM
Moderators: *Firoz Miyanji, MD; Suken A. Shah, MD*

DEBATES:
a. Early Onset Scoliosis – Timing of Surgical Intervention

1:03 PM–1:10 PM **"Growth Modulation at Early Stage is Best"**
Robert M. Campbell, MD

1:11 PM–1:18 PM **"Definitive Fusion at Late Stage is Best"**
Peter O. Newton, MD

b. AIS – Lenke 1C Curves

1:19 PM–1:26 PM **"Selective Fusion Remains Treatment of Choice"**
Stephen Lewis, MD

1:27 PM–1:34 PM **"Non-selective Fusion Provides Better Outcomes"**
B. Stephens Richards, III, MD

c. The Ponte Osteotomy…

1:35 PM–1:42 PM **"…is Over-rated in AIS Surgery"**
Burt Yaszay, MD

1:43 PM–1:50 PM **"…should be Routine Practice in AIS surgery"**
Harry L. Shufflebarger, MD

1:51 PM–2:15 PM **Case Presentations/Panel Discussion** -
Panel: *Robert M. Campbell, MD; Peter O. Newton, MD; Stephen Lewis, MD; B. Stephens Richards, III, MD; Burt Yaszay, MD; Harry L. Shufflebarger, MD*

2:15 PM–2:30 PM BREAK

See pages 17 - 62 for financial disclosure information.

PERIOD 2

2:30 PM – 4:00 PM
Free Papers
Moderators: *Patrick J. Cahill, MD; Paul D. Sponseller, MD*

2:30 PM – 2:34 PM
1 *(page 246)*
Spinal Cord Monitoring Data in Pediatric Spine Deformity Patients with Spinal Cord Pathology
Alexander W. Aleem, MD; Earl Thuet; Anne Padberg;
Scott J. Luhmann, MD

2:35 PM – 2:39 PM
2 *(page 248)*
♦ **SHILLA Growth Guidance Graduates**
Kwan J. Park, MD; Frances L. McCullough, MNSc;
Richard E. McCarthy, MD

2:40 PM – 2:44 PM
3 *(page 249)*
Results of Serial Casting in Idiopathic and Non-idiopathic Cases of Early Onset Scoliosis
Pooya Hosseinzadeh; ***Vishwas R. Talwalkar, MD;***
Joshua Philbrick; Ryan D. Muchow, MD; Henry J. Iwinski, MD;
Janet L. Walker, MD; Todd A. Milbrandt, MD, MS
Shriners Hospital for Children at Lexington, KY

2:45 PM – 2:52 PM
DISCUSSION

2:53 PM – 2:57 PM
4 *(page 250)*
♦ **Predictive Validity of the Classification for Early Onset Scoliosis (C-EOS): Examining the Timing, Rate, and Severity of Post-operative Complications**
Michael G. Vitale, MD, MPH, *Hiroko Matsumoto, MA;*
The Chest Wall and Spine Deformity Study Group;
The Growing Spine Study Group; Howard Y. Park, BA;
Daren McCalla, BS; Evan P. Trupia BS; Hasani W. Swindell, BS;
David P. Roye, MD; John (Jack) M. Flynn, MD
Columbia University, New York, NY;
University of Pennsylvania, Philadelphia, PA

2:58 PM – 3:02 PM
5 *(page 251)*
Surgeon Experience Does Not Reduce Complications Associated with VEPTR Surgery in Early Onset Scoliosis
John T. Smith, MD
University of Utah

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

3:03 PM–3:07 PM
6 *(page 252)*
♦ **Magnetically Controlled Growing Rods for Early Onset Scoliosis: Preliminary Results**
Karsten Ridderbusch, MD; Martin Rupprecht, MD; Philip Kunkel, MD; ***Ralf Stuecker, MD***
Childrens Hospital, Hamburg Altona, GERMANY

3:08 PM–3:12 PM
7 *(page 253)*
Complication Rates following Bone Morphogenetic Protein Use in Children: A Multi-center Study
Amy Pohlman, BS; ***James J. McCarthy, MD;*** *Ryan C. Goodwin, MD; Joel Kolmodin, MD; Sumeet Garg, MD; Wudbhav N. Sankar, MD; Corinna Franklin, MD*

3:13 PM–3:20 PM
DISCUSSION

3:21 PM–3:25 PM
8 *(page 254)*
Internal and External Perceptions of Appearance in Adolescent Idiopathic Scoliosis (AIS)
Sarah Burr, MSN, BSN, APRN, ACCNS-P; Valoria Thomas, MSN, BSN, APN-BC; Julia Leamon, MSN, BSN, RN; Sridhar Pinnamaneni; ***Richard M. Schwend, MD***
Children's Mercy Hospital, Kansas City, MO

3:26 PM–3:30 PM
9 *(page 255)*
Smoke, Mirror and 3D Analysis – The Truth About the "Hypokyphosing Effect of Pedicle Screws" in AIS
Peter O. Newton, MD; *Takahito Fujimori, MD; Josh Doan, MEng; Frederick G. Reighard, MPH; Daiana A. Glaser, PhD; Amirhossein Misaghi, MD*
Rady Children's Hospital, San Diego, CA

3:31 PM–3:35 PM
10 *(page 256)*
10 Early Complications in the First Year following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis
F. Patterson Owings, MD; David E. Lazarus, MD; Robert J. Owen, BS; Benjamin J. Geddes, BS; Phillip Mitchell, MD; ***Robert W. Bruce, Jr, MD;*** *Nicholas Fletcher, MD*
Emory University, Department of Orthopaedics, Tucker, GA

3:36 PM–3:43 PM
DISCUSSION

3:45 PM–4:00 PM
BREAK

See pages 17 - 62 for financial disclosure information.

PERIOD 3

4:00 PM – 5:00 PM
Moderators: *Firoz Miyanji, MD; Suken A. Shah, MD*

Evidence Based Approach in Pediatric Deformity:
a. Studies that have Changed my Practice (top 3 papers, past 10 years):

4:00 PM – 4:07 PM **Surgical Management of AIS**
Muharrem Yazici, MD

4:08 PM – 4:15 PM **Non-operative Treatment of AIS**
Charles E. Johnston II, MD

4:16 PM – 4:23 PM **Management of Early Onset Scoliosis**
James O. Sanders, MD

4:24 PM – 4:31 PM **Management of Spondylolisthesis**
Kit M. Song, MD

4:32 PM – 4:42 PM DISCUSSION

Pediatric Cervical Spine:

4:43 PM – 4:50 PM **a. "Atlanto-axial Rotatory Instability – Management Strategies"**
Haemish A. Crawford, MD

4:51 PM – 4:58 PM **b. "Pediatric Cervical Trauma – Treatment Algorithm"**
William C. Warner Jr, MD

4:58 PM – 5:15 PM **Case Presentations/Panel Discussion**
Panel: *Haemish A. Crawford, MD; William C. Warner Jr, MD; William G. Mackenzie, MD*

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Spinal Cord Monitoring Data in Pediatric Spine Deformity Patients with Spinal Cord Pathology

Alexander W. Aleem, MD; Earl Thuet; Anne Padberg; ***Scott J. Luhmann, MD***

†**LOE-Therapeutic - Level III**

Purpose: The purpose of this study is to review the efficacy of intraoperative monitoring in pediatric patients with spinal cord pathology.

Methods: This was a single-center retrospective review of 119 spinal surgery procedures in 82 patients with spinal cord pathology (age 1-20, average 12). Surgeries were performed between 1984 and 2012. Diagnosis included Arnold-Chiari malformation (ACM), syringomyelia (S), myelomeningocele, spinal tumor, tethered cord, and diastematomyelia. Baseline neurologic function and history of prior neurosurgical intervention were identified. Outcome measures included ability to obtain reliable monitoring data during surgery and presence of post-operative neurologic deficits. Results were compared to data obtained in 82 patients with adolescent idiopathic scoliosis (AIS) having surgery during the same time period.

Results: IOM data sensitive to surgical variables were obtained in 82% of cases (97/119). 22 cases (18%) had no lower extremity data. 95% of cases with a diagnosis of ACM or S pathologies in isolation had usable IOM data (20/21). ACM and S in combination (n=55) had data in 100% of procedures. Patients with ACM or S pathologies, in isolation or combination, had a significantly higher rate of reliable data compared to other pathologies (see Table 1).

Prior neurosurgical intervention occurred in 103 cases (86%), and was not associated with difficulty in obtaining data. Among study group cases with usable data there were 85 true negative (88%), 7 false positive (7%), 1 false negative (1%) and 4 true positive (4%) outcomes. There were no permanent neurologic deficits. The AIS control group had 100% sensitivity and specificity. In contrast, the spinal cord pathology group demonstrated 80% sensitivity and 92% specificity. Cases with ACM and S had 100% sensitivity and 96% specificity.

Conclusion: Spinal cord monitoring is a valuable tool in pediatric patients with spinal cord pathology undergoing spinal deformity surgeries. The ability to obtain normal data is decreased when compared to patients with idiopathic scoliosis, and there is a higher rate of false positives. When obtainable, data is able to detect changes in spinal cord function, and no permanent deficits occurred. Patients with a diagnosis of Arnold-Chiari or syringomyelia have monitoring data similar to those patients with AIS.

Significance: The findings from this study suggest that IOM data should be reliable in patients with ACM or S pathologies. Patients with other spinal cord pathologies have less reliable data and surgeons should have a lower threshold for performing wake-up tests to assess spinal cord function intraoperatively.

See pages 17 - 62 for financial disclosure information.

Table 1

Spinal Cord Pathology	Complete Data	Partial Data	No Data
ACM + S (n = 55)	50 (91%)	5 (9%)	0 (0%)
Myelomeningocele (n = 16)	3 (19%)	5 (31%)	8 (50%)
S (n = 13)	12 (92%)	0 (0%)	1 (8%)
ACM (n = 8)	8 (100%)	0 (0%)	0 (0%)
ACM + S + Other (n = 8)	1 (13%)	0 (0%)	7 (87%)
Other (n = 12)	2 (17%)	6 (50%)	4 (33%)
Spinal Cord Tumor (n = 7)	2 (29%)	3 (44%)	2 (29%)

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

♦ **SHILLA Growth Guidance Graduates**

Kwan J. Park, MD; Frances L. McCullough, MNSc; ***Richard E. McCarthy, MD***

†**LOE-Therapeutic - Level IV**

Purpose: SHILLA growth guidance has been used since 2004 to treat early onset scoliosis. Thus far seventy one patients have been treated at our institution. This system does not use distraction but rather the child's own growth to lengthen the spine. This paper analyzes the 19 patients that have reached enough maturity to "graduate" this system.

Method: Retrospective chart review of the patient who underwent SHILLA for EOS was performed. Clinical, radiographic, and operative data of the 19 graduates were analyzed.

Results: Over the nine-year period, 19 out of 71 patients received final treatment with either spinal arthrodesis and final correction (15) or implant removal alone (4). The arthrodesis group had 5 nonambulators, 10 ambulators, and the removal group had 1 nonambulator and 3 ambulators. Diagnoses were: neuromuscular (7), syndromic (7), idiopathic (4), and congenital scoliosis (1).

Mean age at index surgery was 8 years (range 3 to 11), the mean age at the time of definitive surgery was 13 (range was 9 to 15). The average growth period for these patients was 4+4 years (range 8 mo to 8 year). Average # of surgeries from index procedure was 1.8. The mean T1-T12 spinal height increased from preindex procedure 180mm to 203 mm post index to 232mm after SHILLA growth guidance (prior to graduation) and to 246mm at post final fusion. The 19 graduates experienced a total of 14 returns to surgery for implant related problems (12 (including broken rods, screw pullout, implant prominence) or infection (2). By our calculations, if these patients had undergone distraction growing rod procedures, the average # of surgeries one patient would have undergone is 8.8 (assuming planned lengthening q 6 mo). This would have been 167 returns to surgery for distraction technique.

Conclusion: Fifteen of these nineteen graduates underwent definitive fusion and four of the patients underwent implant removal only. Mean spinal height improved from 183mm pre-treatment to 232mm after growth rod and to 246mm after final fusion.

Significance: The SHILLA growth guidance system was able to achieve similar end results compared to distraction growing rods for early onset scoliosis with fewer returns to the operating room (14 vs. 167).

See pages 17 - 62 for financial disclosure information.

Results of Serial Casting in Idiopathic and Non-idiopathic Cases of Early Onset Scoliosis

Pooya Hosseinzadeh; ***Vishwas R. Talwalkar, MD;*** *Joshua Philbrick; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet L. Walker, MD; Todd A. Milbrandt, MD, MS*
Shriners Hospital for Children at Lexington, KY

†**LOE-Therapeutic - Level III**

Purpose: Early onset scoliosis (EOS) is known to progress rapidly, impairing thoracic growth and pulmonary development. Growing instrumentation has been effective in controlling deformity but is associated with high complication rates. Serial casting has been shown to slow curve progression and delay surgery in patients with early onset scoliosis. We studied the effects of serial casting on thoracic volume, vertebral growth, and need for growing instrumentation in our patients that presented with both idiopathic and non idiopathic early onset scoliosis. Our hypothesis was serial casting would allow for thoracic growth while delaying or avoiding the need for growing instrumentation in both idiopathic and non-idiopathic cases of EOS.

Methods: Retrospective chart review of patients treated at our institution with serial casting for scoliosis was performed. Age at presentation, type of scoliosis, number of casts, Cobb angles, T1-T12 length, and Space Available for Lung (SAL) was reviewed before and after the treatment. The curves were divided into idiopathic and non- idiopathic groups .T test was used to measure the effect of casting.

Results: 27 patients met our inclusion criteria (Average age: 3.7 years). 17 patients had idiopathic and 10 patients had non- idiopathic diagnoses and average follow up was 5.4 years. Mean Cobb angle at presentation and final follow up was 50 and 42 degrees, respectively. At the time of follow up 63% of patients are being treated in cast or brace, and 37% have been treated surgically (15% with growing rods and 22% with spinal arthrodesis).The average time to surgery from initial presentation was 70 months. SAL in idiopathic curves was 0.98 and 1.05 at start and completion of casting respectively. SAL for non- idiopathic curves was 0.93 and 1.20 at start and completion of casting. T1-T12 length increased from 147 cm to 184 cm in idiopathic curves and from 130 cm to161 cm for non- idiopathic curves (P-value<0.05).

Conclusion: Our data show improvement in SAL and near normal spinal growth during serial casting. Growing instrumentation was unnecessary in 85% of our patients with high risk early onset scoliosis.

Significance: Serial casting is a viable option for treating early onset scoliosis even in patients who present with larger curves and/or associated diagnoses.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

♦ Predictive Validity of the Classification for Early Onset Scoliosis (C-EOS): Examining the Timing, Rate, and Severity of Post-operative Complications

Michael G. Vitale, MD, MPH, *Hiroko Matsumoto, MA;*
The Chest Wall and Spine Deformity Study Group; The Growing Spine Study Group;
Howard Y. Park, BA; Daren McCalla, BS; Evan P. Trupia BS; Hasani W. Swindell, BS;
David P. Roye, MD; John (Jack) M. Flynn, MD
Columbia University, New York, NY; University of Pennsylvania, Philadelphia, PA

†LOE-Therapeutic - Level III

Purpose: Gaps in the evidence-base and related variability in management of early onset scoliosis (EOS) have driven improvements in the research infrastructure. One such initiative is the Classification of EOS (C-EOS), now in its final form following initial validation. The purpose of this study is to examine the ability of the C-EOS to predict timing of VEPTR proximal anchor failure and identify patients at higher risk for device-related complications following surgery.

Methods: 105 EOS patients treated with Vertical Expandable Prosthetic Titanium Rib were retrospectively queried from an EOS database; another 78 EOS patients were identified with a minimum of 5 years post-operative follow-up from 2 multi-center EOS databases. All patients were classified using the C-EOS, which includes a term for etiology (C: Congenital, M: Neuromuscular, S: Syndromic, I: Idiopathic), Cobb (1:<20°, 2:20-49°, 3:50-89°, and 4: ≥90°) and kyphosis (- : < 20°; N: 20-49°; + : ≥ 50°). Outcomes included time and number of lengthenings to failure, and device-related complications as categorized by the Classification System in Growing Spine Surgery, which differentiates device from disease related complications and groups them into mild, moderate, and severe.

Results: In studying C-EOS classes with more than three subjects, survival analysis demonstrates that the C-EOS discriminates low, medium, and high risk of rapid failure. The low risk of rapid failure group consisted of the Congenital/51-90/Hypokyphosis (C3-) class. The medium risk group consisted of Congenital/51-90/Normal & Hyperkyphosis (C3N, C3+) and Neuromuscular/51-90/Hyperkyphosis (N3+) classes. The high risk group consisted of Neuromuscular/51-90/Normal kyphosis (N3N) and Neuromuscular/>90/Normal & Hyperkyphosis (N4N, N4+) classes. Of patients with 5 post-operative years of follow-up, 67% experienced some complication, although only 18% of patients experienced a complication affecting outcome (Severity > 2A). The greatest frequency of device-related complications with the highest severity (>2A) occurred within non-idiopathic, hyperkyphotic ("+") classes with large Cobb angles (>51°). Within the idiopathic etiology, no patients experienced a severe complication (>2A) requiring a return to the operating room or a change in treatment, irrespective of Cobb angle and Kyphosis severity.

Conclusions: The ability of the C-EOS to both discriminate among patients who will have varying times to anchor failure and identify subsets of patients which suffer a disproportionate share of complications support its predicate validity and demonstrates its potential use in guiding decision making.

Significance: Further experience with the C-EOS may allow more tailored treatment, and perhaps better outcomes of patients with EOS.

Chest Wall and Spine Deformity Study Group received support from DePuy, A Johnson & Johnson Company and OREF for this study.
Growing Spine Study Group received support from Growing Spine Foundation for this study.

See pages 17 - 62 for financial disclosure information.

Surgeon Experience Does Not Reduce Complications Associated with VEPTR Surgery in Early Onset Scoliosis

John T. Smith, MD
University of Utah

†**LOE-Therapeutic - Level II**

Background: Children with Early Onset Scoliosis (EOS) are diverse and complex, and frequently have multiple associated co-morbidities. The use of growth friendly techniques to manage EOS is associated with frequent complications. The purpose of this study is to determine if surgeon experience over time results in a decreased frequency of complications related to repetitive surgeries.

Methods: This is a retrospective review of an IRB approved prospective database 915 consecutive VEPTR surgeries including initial implants, expansion and exchanges by a single surgeon between 2003 and 2012. Population demographics and complications were collected. Statistical analysis including Pearson correlation was conducted to examine the association between the rate of complication and the number of surgeries performed.

Results: 95 patients underwent 915 surgeries during the study period. The average age was 7.7 years (0-17). There was an average of 11.5 surgeries per patient (2-25). 173 complications were reported with a mean of 2.35 per patient. Sixteen patients had no complications, while the majority of patients had 1-2 complications, with one patient having 15. The rate of complications did not increase with increasing numbers of surgeries ($r=0.028$; $p=.831$). 61 complications were classified as disease related and 112 were device related. The rate of complications remained steady at approximately 20% per year despite increasing experience of the surgeon.

Conclusion: Complications are a relatively common and expected event in managing EOS using growth-friendly instrumentation. Despite increasing surgeon experience with VEPTR expansion and exchange surgeries, the rate of complications remained consistent over a 9 year period. This may be a reflection more of the complexity of this patient population rather than the experience of the surgeon.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

♦ Magnetically Controlled Growing Rods for Early Onset Scoliosis: Preliminary Results

Karsten Ridderbusch, MD; Martin Rupprecht, MD; Philip Kunkel, MD; ***Ralf Stuecker, MD***
Childrens Hospital, Hamburg Altona, GERMANY

†LOE-Therapeutic - Level IV

Purpose: Growth-sparing techniques for treatment of progressive early-onset scoliosis (EOS) have developed significantly over the last years. Traditional growing rods require repeated surgical lengthenings and carry the risk of significant complications which could theoretically be reduced if repeat surgery for lengthenings is avoided. The purpose of this study from one single center is to review the preliminary experience with magnetically controlled growing rods (MCGR) and to evaluate their efficiency and safety.

Methods: 10 out of 27 patients with EOS who were treated by MCGR at our institution and who had a minimum follow-up of 12 months and at least 3 repeated lengthenings as an outpatient procedure formed the basis of the study. The average age of the 8 female and 2 male patients was 7.4 (4.6-10.6) years at the time of the index procedure. Lengthenings procedures were performed every 4 months for all patients. Clinical, radiographic, and operative data were reviewed. Correction of Cobb angle, development of spinal length (T1-T12, T1-S1) and complications were analyzed.

Results: Mean Cobb angle decreased from 69.5 (46°-96°) to 33.6° (22°-46°) after the index procedure resulting in a correction of 52%. ($p < 0,05$) After a mean follow-up of 17 months the average Cobb angle after the most recent lengthening was 30.3° (13-56°). Mean preoperative T1-T12 length was 167mm (128-199) and increased to 181mm (142-215) ($p < 0,05$) immediately postoperatively and to 189mm (150-220) after the last lengthening. The mean preoperative T1-S1 length measured 280mm (217-327) and increased to 308mm (267-344) postoperatively ($p < 0,05$) and to 321mm (279-353) after most recent lengthening. In one patient loss of distraction occurred, necessitating a complete rod exchange. One other patient developed a junctional kyphosis which will need revision. There were no neurologic complications.

Conclusion: Our preliminary data suggest that treatment with MCGR is safe and effective. Correction of the primary curve is similar to results reported for conventional dual rod techniques. Lengthenings can safely and reliably be performed as an outpatient procedure every 4 months. However, the most effective protocol for lengthening has still to be determined. Longer follow up with this new technology is needed to determine if drawbacks of conventional growing rods like infection, autofusion and diminished amounts of lengthening with time may be avoided.

Significance: MCGR provides similar correction and distraction in a short term as reported for conventional growing rods for EOS with less morbidity by avoiding repeated surgical lengthenings.

See pages 17 - 62 for financial disclosure information.

Complication Rates following Bone Morphogenetic Protein Use in Children: A Multi-center Study

Amy Pohlman, BS; ***James J. McCarthy, MD;*** *Ryan C. Goodwin, MD; Joel Kolmodin, MD; Sumeet Garg, MD; Wudbhav N. Sankar, MD; Corinna Franklin, MD*

†**LOE-Therapeutic - Level IV**

Purpose: The use of bone morphogenetic protein (BMP) has been associated with a number of complications in adult patients. However, this association is less established in children. The aim of this study was to evaluate the safety of BMP use in children by determining the complication rates following BMP use at multiple institutions.

Methods: In a retrospective study (2000-2013), the medical records of all patients who received BMP at any of the five institutions were reviewed. Demographic information, operative data, and postoperative follow-up data were collected on those patients who were under the age of 18 at the time of surgery.

Results: A total of 298 pediatric patients underwent surgery with BMP application during the study period. The surgical procedures consisted of 241 spinal fusions, 46 non-unions, and 11 other various procedures. Of the patients who received BMP, 13.9% had evidence of wound dehiscence, 8.2% persistent swelling, 4.9% neurologic problems, 4.1% respiratory problems, 3.3% generalized inflammation, 2.5% spinal stenosis, 2.5% bony overgrowth, 0.8% systemic toxicity, 0.8% reproductive toxicity, and 0.3% carcinogenesis. The remaining complications, which were thought less likely to be directly related to BMP use, included the following: pain in 32% of patients, infection in 16.4% of patients, and other complications (including hardware failure, pressure ulcers, gait abnormality, muscle spasms, and vomiting) in 14.8% of patients. 55 of the 298 patients (18.5%) returned to surgery due to complications. The average follow-up was 27 months (range: 3- 96 m), with 57.4% of patients having a follow-up period of greater than 12 months. The average age at the time of surgery was 13 years (range: 1-17 y). Males and females were close to being equally represented in the study, with 136 males (46.5 %) and 162 females (54.4 %).

Conclusion: This multicenter study demonstrates a relatively high rate of complications following the use of BMP in children. However, further study is needed to attribute the complications directly to the use of BMP.

Significance: This is the first and largest multicenter study to assess the complication rates following BMP use in pediatric patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Internal and External Perceptions of Appearance in Adolescent Idiopathic Scoliosis (AIS)

Sarah Burr, MSN, BSN, APRN, ACCNS-P; Valoria Thomas, MSN, BSN, APN-BC; Julia Leamon, MSN, BSN, RN; Sridhar Pinnamaneni; ***Richard M. Schwend, MD***
Children's Mercy Hospital, Kansas City, MO

†**LOE-Prognostic - Level II**

Purpose: We hypothesized that an adolescent with idiopathic scoliosis will have a different internal perception of their appearance than how they actually appear physically when viewing a photograph of themself (external perception). We also hypothesized that an adolescent's perception of their appearance will differ from that of their parents and healthcare providers'.

Methods: This is a level II, prospective, IRB approved study of 52 patients with AIS between the ages of 10 to 17 years seen at tertiary pediatric facility were enrolled. Patients included those being seen for initial or follow-up evaluation of scoliosis as well as patients scheduled for surgery. Parents completed the Walter Reed Visual Assessment Scale (WRVAS) from his/her point of view. Subjects completed the SRS-22 and the first WRVAS independently. After these forms were completed, photographs of the subject were obtained. Three photographs of the subject's back were taken in 3 different positions: standing upright from behind and bending forward at a 90 degree angle towards followed by away from the examiner. The subject was then given the second WRVAS form to complete while looking at their photographs as an image of their "actual" physical appearance.

Results: Subjects perceived their body curve ($p = 0.02$) and shoulder level ($p = 0.03$) to be worse than their actual appearance as seen on photograph. Parental ratings were found to be worse than patients' post-picture WRVAS with both head-pelvis ($p = 0.03$) and shoulder level ($p = 0.03$). Parents' ratings when compared to examiners' ratings for body curvature, head-rib-pelvis, head-pelvis, and shoulder level were all significantly worse than examiners' WRVAS ratings ($p = 0.003$, $p = 0.04$, $p = 0.00$, $p = 0.00$, respectively).

Conclusion: Adolescents with AIS had different internal vs. external perception of their body curve and shoulder level. After viewing their photos, the subject's perception became more similar to that of the examiner. The parent perceived his/her child to have more deformity than did the subject and the examiner.

Significance: This information about an adolescents' perception may help the child, family and physician better understand the differences between what they feel internally about their appearance compared to what they objectively see, which may represent a distortion of body image. Viewing photographs may give objective information for the adolescent and family to assist in the decision to undergo surgery and in evaluating the postsurgical results.

See pages 17 - 62 for financial disclosure information.

Smoke, Mirror and 3D Analysis – The Truth About the "Hypokyphosing Effect of Pedicle Screws" in AIS

Peter O. Newton, MD; *Takahito Fujimori, MD; Josh Doan, MEng; Frederick G. Reighard, MPH; Daiana A. Glaser, PhD; Amirhossein Misaghi, MD*
Rady Children's Hospital, San Diego, CA

†**LOE-Diagnostic - Level II**

Purpose: To evaluate the true 3D changes in thoracic kyphosis of patients with adolescent idiopathic scoliosis (AIS) from preop to postop when thoracic pedicle screw instrumentation was utilized.

Methods: 60 consecutive (Lenke 1 and 2) pre- and postop EOS images of AIS patients treated with segmental thoracic pedicle screw instrumentation were analyzed in the "3D sagittal plane". The technique measured 3D kyphosis or lordosis in the specific plane of sagittal motion for each spinal motion segment. The kyphosis (+) and lordosis (-) values for the segments between T5 and T12 were summed to give the "3D T5-T12 kyphosis". These values were compared to the standard 2D T5–T12 kyphosis measured on the lateral radiographs.

Results: The average age of the patients was 14 ± 2 years and the preop Cobb was 46 +/- 8°. The preop 3D T5–T12 kyphosis was 7.4 +/- 13.8° and the kyphosis significantly increased to 23.3 +/- 5.6° postop. The standard 2D T5–T12 kyphosis measured 17.8 +/- 15.3° preop and 23.9 +/- 5.7° postop. The difference between the 2D and 3D T5-T12 kyphosis measurements strongly correlated with apical vertebral rotation (r = -0.88, p= 0.01).

Conclusion: Routine 2D measures of thoracic kyphosis erroneously underestimate the preoperative loss of kyphosis in AIS due to errors associated with axial plane rotation inherent as a component of thoracic scoliosis.

Significance: Thoracic pedicle screws do not lordose the spine per se. The thoracic spine in AIS is segmentally hypokyphotic (if not lordotic) especially at the apex, which can only be measured by a segmental 3D analysis. Posterior instrumentation with thoracic pedicle screws in this series of patients was associated with an increase in thoracic kyphosis of nearly 16°.

	Preop Cobb	Postop Cobb	Preop T5-T12 Kyphosis	Postop T5-T12 Kyphosis
2D	46.3±8.0	8.1±6.3	17.8±15.3	23.9±5.7
3D	45.5±9.4	8.8±6.1	7.4±13.8	23.3±5.6

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

10 Early Complications in the First Year following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

F. Patterson Owings, MD; David E. Lazarus, MD; Robert J. Owen, BS; Benjamin J. Geddes, BS; Phillip Mitchell, MD; ***Robert W. Bruce, Jr, MD;*** *Nicholas Fletcher, MD*
Emory University, Department of Orthopaedics, Tucker, GA

†**LOE-Prognostic - Level IV**

Purpose: Few studies have reported specifically on the early complications related to posterior spinal fusion for correction of adolescent idiopathic scoliosis. The purpose of this study was to determine the types of complications, their prevalence and the rate of readmission and/or reoperation within the 1st year following posterior spinal fusion for AIS and to identify factors that affect that can increase the prevalence of complications.

Methods: All patients who underwent posterior spinal fusion for adolescent idiopathic scoliosis during the period from January 2006-December 2008 were included. Patient charts were retrospectively reviewed for demographic data and to determine length of surgery, number of fusion levels, ASA score, estimated blood loss, length of hospital stay, and any subsequent complications that developed within 1 year of the date of surgery.

Results: Of a cohort of 364 patients undergoing posterior spinal fusion for AIS, there were 52 non neurologic complications for an overall prevalence of 14.0%. There were 37 surgical site/wound complications (10.2%) including deep and superficial surgical site infections, hematoma/seroma and dehiscence although only 8 of these (21.6%) required surgical drainage with the rest being managed with dressing changes or antibiotics. There were, 12 medical complications (3.3%) and 2 hardware related complications (0.6%). Eleven patients (3.0%) required reoperation (8 with surgical site infections, 2 with hardware failure and 1 with retained surgical equipment. In addition to the 10 patients readmitted for reoperation, 5 others were readmitted: 3 for IV antibiotics and 2 for medically unrelated reasons. The only parameter that correlated with a higher prevalence of complications was the numbers of levels fused as complications increased in a linear fashion for each additional level fused ($p=0.02$). Age at time of surgery, length of hospital stay, length of surgery, ASA class, and estimated blood loss did not correlate with increased risk of early postoperative complications.

Conclusions: The prevalence of early postoperative complications following posterior spinal fusion for adolescent idiopathic scoliosis in this study was 14%. 4.1% of our patients required readmission and 3.0% required reoperation. The only factor noted to be associated with an increased risk of complications within the 1st postoperative year was the number of levels fused.

Significance: Wound issues are the most common non-neurologic complications seen following PSF for AIS with an incidence of 10%, however the majority of these may be treated conservatively without requiring surgical drainage. This data provides patients and surgeons with information regarding expectations in the early post operative period.

See pages 17 - 62 for financial disclosure information.

POSNA

2014 SUBSPECIALTY DAY AGENDA

SPORTS SUBSPECIALTY DAY

An Interactive Case Based Approach to Pediatric Sports Dilemmas

Fri., May 2, 2014 • 1:00 PM–5:15 PM • Mt. Olympus

Co-Chairs: *Jennifer M. Weiss, MD and John D. Polousky, MD*

PERIOD 1 1:00 PM–2:15 PM
Moderator: *Jennifer M. Weiss, MD*
Panel: *Mininder S. Kocher, MD; Henry (Hank) G. Chambers, MD; Theodore J. Ganley, MD; Kevin G. Shea, MD*

1:00 PM–1:02 PM	**Welcome** *Jennifer M. Weiss, MD; John D. Polousky, MD*
1:02 PM–1:22 PM	**ACL Reconstruction in the Young Female Athlete** *Bert Mandelbaum, MD*
1:23 PM–1:31 PM	Q and A
1:32 PM–1:40 PM	**Ankle Instability: Which Patient Needs Surgical Stabilization?** *Paul M. Saluan, MD*
1:41 PM–1:49 PM	**Os Trigonum: A Case of Symptomatic Os Trigonum, When to Excise and How** *Michael T. Busch, MD*
1:50 PM–2:00 PM	**Ankle OCD Cases, from Stable to Unstable, Which Patient is the Surgical Candidate?** *Roger M. Lyon, MD*
2:01 PM–2:10 PM	Q and A
2:15 PM–2:30 PM	BREAK

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

PERIOD 2

2:30 PM – 3:45 PM
Free Papers
Moderators: *Jennifer M. Weiss, MD; John D. Polousky, MD*

2:30 PM – 2:34 PM
1 *(page 260)*
The Pediatric International Knee Documentation Committee (Pedi-IKDC) Subjective Knee Evaluation Form: Normative Data
Susan Nelson, MD, MPH; Adam Nasreddine, MA; Leslie A. Kalish, ScD; ***Mininder S. Kocher, MD***

2:35 PM – 2:39 PM
2 *(page 261)*
Gene Expression Differences in Young Male and Female Ruptured Anterior Cruciate Ligament Tissue
Jeffrey S. Johnson, MD; Susan Moen, MD; Robin Jacquet, MS; Melanie A. Morscher, BS; Christopher Klonk, MD; William J. Landis, PhD; ***Kerwyn C. Jones, MD***
Akron Children's Hospital, Akron, OH

2:40 PM – 2:44 PM
3 *(page 262)*
Meniscal Tears in Adolescents with Anterior Cruciate Ligament Rupture: Relation to Medical Insurance Type
Richard E. Bowen, MD; *S.C. Gamradt; P. Wang, MD; K.A. Toy*

2:45 PM – 2:49 PM
4 *(page 263)*
Asymmetric Knee Kinematics and Kinetics after ACL Reconstruction in Adolescent Athletes
Matthew D. Milewski, MD; *Erin J. Garibay, MS; Nicholas Giampetruzzi, PT, MS; Danielle Suprenant, DPT; Jessica R. Woods, BSBE; Carl W. Nissen, MD; Sylvia Õunpuu, MSc*
Connecticut Children's Medical Center, Hartford, CT; Elite Sports Medicine, Farmington, CT

2:50 PM – 3:02 PM
Q and A

3:03 PM – 3:07 PM
5 *(page 264)*
OCD and ADHD: Is There a Connection?
Kevin M Dale, MD; Andrew Livermore, MD; Susan Laham PAC; Tamara A. Scerpella, MD; Jeffery A. Cassidy, MD; Blaise A. Nemeth, MD; Kenneth J. Noonan, MD;
Matthew A. Halanski, MD
University of Wisconsin Hospitals and Clinics, Madison, WI

3:08 PM – 3:12 PM
6 *(page 265)*
The Progression to Surgery in Osteochondritis Dissecans in Children
Jennifer M. Weiss, MD; *Hooman Nikizad; Kevin G. Shea, MD; John C. Jacobs, Jr; Judith Bebchuk; Rita Ishkhanian; Jeffrey I. Kessler, MD*
Kaiser Permanente Southern California, Los Angeles, CA

See pages 17 - 62 for financial disclosure information.

3:13 PM–3:17 PM
7 *(page 266)*
Stress Sonography of the Ulnar Collateral Ligament of the Elbow in Adolescent Baseball Pitchers
Alfred Atanda Jr, MD; *Lauren Averill, MD; Levon Nazarian, MD; Michael G. Ciccotti, MD*

3:18 PM–3:22 PM
8 *(page 267)*
Adolescent Multi-directional Shoulder Instability: Arthroscopic Treatment Outcomes
Michael T. Busch, MD; *Mackenzie Marie Herzog, BA; Drew E. Warnick, MD; Samuel C. Willimon, MD*
Children's Healthcare of Atlanta/Children's Orthopaedics of Atlanta

3:23 PM–3:27 PM
9 *(page 268)*
Trends in the Presentation, Management, and Outcomes of Little League Shoulder
Benton E. Heyworth, MD*; Daniel Martin, BS; Dennis Kramer, MD; Mininder S. Kocher, MD; Donald S. Bae, MD*
Boston Children's Hospital, Boston, MA

3:28 PM–3:42 PM Q and A

3:43 PM–4:00 PM BREAK

PERIOD 3

4:00 PM–5:15 PM
Moderator: *John D. Polousky, MD*

4:15 PM–4:23 PM
Throwing Elbow: Which Patient is Treated with Rest, Who Gets an MRI, and When is Surgery Necessary?
Carl W. Nissen, MD

4:24 PM–4:32 PM
Shoulder Instability: The Case of the Traumatic Dislocator, Who Gets an MRI, Who Gets Surgery?
John D. Polousky, MD

4:33 PM–4:41 PM
Shoulder Instability: The Case of the Atraumatic Subluxator/ Dislocator, Is Surgery Ever Indicated?
Cordelia W. Carter, MD

4:42 PM–5:00 PM
Hip: Labral Tears: To Fix or Debride?
Jaren Riley, MD

5:01 PM–5:09 PM
Pelvis Avulsion Fractures: When is Surgery Indicated?
Kerwyn C. Jones, MD

5:09 PM–5:15 PM Q and A, Wrap-up

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Pediatric International Knee Documentation Committee (Pedi-IKDC) Subjective Knee Evaluation Form: Normative Data

Susan Nelson, MD, MPH; Adam Nasreddine, MA; Leslie A. Kalish, ScD;
Mininder S. Kocher, MD

†LOE-Diagnostic - Level II

Purpose: To aid in the interpretation of Pedi-IKDC scores by characterizing normative data in children and adolescents. Secondarily, to validate the PediIKDC by examining differences in PediIKDC scores between those with and without a history of knee problems.

Methods: Crosssectional survey of 2000 children and adolescents aged 10-18 years living in the United States, recruited by ORC International to obtain equal numbers by sex and by integer age group. In addition to completing the Pedi-IKDC for one studydesignated "index" knee (right or left), subjects were asked demographic questions and for information on history of knee surgery and recent (four weeks) activity limitations. Raw Pedi-IKDC total scores were rescaled to a 0-100 scale. Non-parametric Wilcoxon or Kruskal-Wallis tests were used to compare subgroup scores and the van Elteren test was used to adjust for age. Unadjusted and adjusted pvalues were similar and only unadjusted values are reported.

Results: Numbers of respondents are uniform with respect to age and sex, with 11% in each age group (10-18) and 50% female. 68% identified themselves as white, and 86% as non-Hispanic. 49 states and DC are represented. 136 (7%) reported prior surgery in one or both knees; 79(4%) in the index knee. The PediIKDC score distribution is skewed left with mean score (±SD) of 86.7(±16.8), median 94.6 and 34% reaching the ceiling value of 100. Subjects reporting prior surgery or limited activity in the index knee had median PediIKDC scores about 25 points lower than those without these histories ($p<0.0001$ for both comparisons). In contrast, although statistically significant, the variation by age ($p=0.02$), race ($p=0.02$), ethnicity ($p=0.01$), and level of sports/exercise participation ($p=0.04$) was much smaller (all ranges of median scores <4.5). There were no significant differences by sex or geographic region.

Conclusion: There is only minor variation in PediIKDC scores across demographic factors. The strong association between PediIKDC score and prior knee surgery and also with recent limitation of activity in the index knee supports the construct validity of the Pedi-IKDC.

Significance: The knee is one of the most commonly injured joints in both adult and pediatric populations. Patient reported outcomes have become common in orthopedic research. Using a large, broadly representative sample, this study supports the validity of the Pedi-IKDC as a knee specific outcome instrument for pediatric patients aged 10-18, and provides normative values to aid the interpretation of scores in this age range.

See pages 17 - 62 for financial disclosure information.

Gene Expression Differences in Young Male and Female Ruptured Anterior Cruciate Ligament Tissue

Jeffrey S. Johnson, MD; Susan Moen, MD; Robin Jacquet, MS; Melanie A. Morscher, BS; Christopher Klonk, MD; William J. Landis, PhD; ***Kerwyn C. Jones, MD***
Akron Children's Hospital, Akron, OH

†LOE-Prognostic - Level III

Purpose: There is a greater incidence of anterior cruciate ligament (ACL) injuries among female athletes compared to males. Anatomic, hormonal, and neuromuscular factors have been associated with this disparity. Research into whether genetic differences exist is limited. The purpose of this study was to compare gene expression in ruptured ACL tissue from young male and female athletes particularly as it relates to the extracellular matrix (ECM). Since X-and Y-chromosome-linked genetic differences are expected, this study focused on identified genes that were not found on the X- or Y-chromosome.

Methods: In an IRB approved study, a biopsy of normally discarded ruptured ACL tissue was obtained intraoperatively from 7 male and 7 female young athletic patients. Biopsies were divided into groups for histological and gene expression analyses. Histological specimens were stained with hematoxylin and eosin and trichrome. The specimens for gene expression analysis were frozen-ground and RNA was extracted and purified. Microarray analysis was performed using RNA isolated from 4 male and 4 female participants with non-contact injuries. Significant genes identified by microarray analysis were grouped into functionally associated networks using Ingenuity Systems (IPA) software analysis. Three genes of interest were chosen for further verification by reverse transcription-quantitative polymerase chain reaction (RT-qPCR) analysis from all 14 patients. Several statistical methods were used with $p < 0.05$ considered significant.

Results: Microarray analysis identified 32 significantly differentially expressed genes in RNA isolated from young male and female ruptured ACL tissue, 14 of which were not X- or Y-chromosome linked. The IPA analysis grouped these genes in skeletal muscular development and function and cellular growth, maintenance, and proliferation pathways. In females compared to males, RT-qPCR confirmed statistically significant upregulation of gene expression in aggrecan and fibromodulin (FMOD) and downregulation in WNT1 inducible signaling pathway protein 2 (WISP2). On histological examination, no apparent morphological differences were identified between young male and female ruptured ACL tissue.

Conclusion: Genes identified in this study as distinctly different produce major molecules in the ACL extracellular matrix. The significant upregulation of proteoglycans (aggrecan) and FMOD (extracellular matrix-regulating protein) and downregulation of WISP2 (involved in collagen turnover and production) may account for weaker ACLs in females than in males.

Significance: The gene expression differences identified by microarray in this study may contribute to the reported gender discrepancy in ACL injuries. With additional research, gene therapy may be included in the female ACL injury prevention regime currently focusing on neuromuscular and anatomic differences.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Meniscal Tears in Adolescents with Anterior Cruciate Ligament Rupture: Relation to Medical Insurance Type

Richard E. Bowen, MD; *S.C. Gamradt; P. Wang, MD; K.A. Toy*

†LOE-Prognostic - Level III

Purpose: Medical care access for pediatric orthopaedic patients differs by medical insurance type. In patients with anterior cruciate ligament (ACL) rupture, impaired access might lead to further meniscal damage before definitive surgery. This study quantifies meniscal tear rates and severity in these patients with commercial versus government insurance.

Methods: 54 consecutive adolescent (14-18 years) ACL rupture patients undergoing primary ACL reconstruction were studied. Patients had commercial insurance (CI) or government insurance (GI). 29/54 patients had preoperative International Knee Documentation Comitee (IKDC) and Lysholm scores, and documented time between initial injury and surgery. All patients had meniscus tear status documented at surgery. Meniscal tear status categories were: none; insignificant = radial tears less than 4mm, partial thickness, or vertical longitudinal stable <8mm; repairable = vertical longitudinal tears in the red/red zone >8mm in length; irrepairable = all other tears. Odds ratio analysis between groups assessed the relationship between irrepairable tears and insurance type. Student's t-test analysis and Mann-Whitney U tests compared continuous normal and non-normal variables between groups.

Results: 54 patients included 32 and 22 patients with GI and CI. Thus, there were 64 and 44 "menisci at risk". There was increased time between injury and surgery in GI (184 vs 72 days, p=.0006). Mean preoperative IKDC scores were 56 versus 65 in GI and CI, and Lysholm scores were 62 versus 83 (p=0.005).

At surgery 44% of all menisci were torn, and 31% were significantly torn (37% lateral, 24% medial). Significant lateral meniscal tear rates were higher in GI (50 vs 18%; OR = 4.5; 95% CI 1.2-16.3; p=.02), whereas significant medial meniscal tear rates were similar between groups (27 vs 22%).

When considering irrepairable meniscal tears, there was an increased risk in GI (OR = 5.35; 95% CI 1.14 - 25.06; p=.03). Time between initial injury and surgery was increased in irrepairable versus salvagable overall (median 234 vs 81 days; p=.0007) as well as lateral (median 188 vs 84; p=.004) meniscal tears.

Conclusion: This study shows increased significant lateral meniscal tears, irrepairable tears, and lower preoperative Lysholm scores in patients with government versus commercial insurance. This may be related to the increased time between initial injury and surgery seen in the government insurance group.

Significance: Patient and healthcare factors contribute to irrepairable meniscal tears in adolescent ACL rupture patients, which deserve further examination, including long-term follow-up studies to document functional outcomes.

See pages 17 - 62 for financial disclosure information.

Asymmetric Knee Kinematics and Kinetics after ACL Reconstruction in Adolescent Athletes

Matthew D. Milewski, MD; *Erin J. Garibay, MS; Nicholas Giampetruzzi, PT, MS; Danielle Suprenant, DPT; Jessica R. Woods, BSBE; Carl W. Nissen, MD; Sylvia Õunpuu, MSc*
Connecticut Children's Medical Center, Hartford, CT; Elite Sports Medicine, Farmington, CT

†**LOE-Diagnostic - Level III**

Purpose: To compare the kinematics and kinetics between the reconstructed anterior cruciate ligament (ACLR) and healthy knee of adolescent athletes that have been returned to sport (RTS) following standard protocols.

Methods: Adolescent athletes completed our institution's RTS assessment which included the following tasks: running, drop vertical jump (DVJ), single leg long hop (SLLH) and cross-over triple hop (CTH), while simultaneous three-dimensional motion capture was performed. The sagittal knee kinematics, moments and powers of a patient's ACLR knee were compared to their uninjured knee during the landing phase of each task.

Results: Nine of 15 patients (three females and six males, mean age 14.7 ±1.9 years old) were allowed to RTS following RTS guidelines at this institution. All patients were at least 6 months post ACL reconstruction. The motion analysis results showed a greater than 10% deficit on the ACLR side for peak knee flexion in patients in running, SLLH and CTH for 5/9, 6/9 and 5/9 patients, respectively. A greater than 10% deficit on the ACLR side for peak knee extensor moment was found in running, DVJ, SLLH and CTH for 7/9, 8/9, 8/9and 7/9 patients, respectively. The ACLR knee also had a greater than 10% deficit in peak power absorption in running, DVJ, SLLH and CTH for 6/9, 7/9, 6/9 and 6/9 patients, respectively.

Conclusion: Athletes in this study showed asymmetry in knee kinematics and kinetics during running, jumping and hopping after RTS approval following standard assessments. Asymmetry was more commonly noted in peak joint moments and powers which consistently showed reduced loads on the ACLR side in comparison to the healthy knee. Evaluation of knee joint kinematics alone is not adequate to determine asymmetry in joint kinetics.

Significance: The reduced peak knee extensor moment and power absorption on the ACLR knee found during these functional tasks may predispose the healthy knee to injury due to continued higher loads or predispose the ACLR knee to increased weakness over time due to continued decreased loads. Long-term follow-up to evaluate whether these asymmetries continue to increase may help explain increased ACL re-rupture or contralateral ACL injury rates in this population.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

OCD and ADHD: Is There a Connection?

Kevin M Dale, MD; Andrew Livermore, MD; Susan Laham PAC; Tamara A. Scerpella, MD; Jeffery A. Cassidy, MD; Blaise A. Nemeth, MD; Kenneth J. Noonan, MD;
Matthew A. Halanski, MD
University of Wisconsin Hospitals and Clinics, Madison, WI

†**LOE-Prognostic - Level III**

Introduction: Attention Deficit Hyperactivity Disorder (ADHD) is increasingly encountered in the pediatric population. A review of the current literature, failed to demonstrate any published report linking ADHD or treatment medications as risk factors in developing Osteochondritis Dessicans (OCD) lesions or complicating its treatment.

Materials: A retrospective chart and radiographic review was performed at the American Family Children's Hospital and UW Hospital on patients treated between the years of 2000-2012. Inclusion criteria: males less than or equal to 16 years of age and females less than or equal to 14 years of age with the diagnosis of OCD of the distal femur and open physes. Data collected included patient age, sex, behavioral comorbidities, medications, treatment (conservative vs. operative), radiographic size of lesion, and radiographic grade of lesion based on plane radiographs or MRI.

Results: Eighty-two children met inclusion criteria for chart review. While the prevalence of ADHD is reported at 8% in the general population (2008 CDC), 19/82 OCD patients had a diagnosis of ADHD demonstrating a prevalence of 23% at our institution. Comparing children with and without ADHD there was no difference in age (13.6 v 13.4 yrs), height (64.7 v 63.6 inches), weight (131.5 v 124.8lbs), or BMI (21.4 v 21.2). There were 16 girls without ADHD group and no girls in the ADHD group. When females were removed, there were no differences in the male sub-population. With regards to the OCD lesions, there was no difference in the length, width, or area of the lesion at presentation or follow-up between cohorts. The average grade of lesions was the same in both groups at presentation (2.2 ADHD v 2.1 no ADHD). Of the patients initially offered non-operative treatments, 47% (8/17) kids with ADHD failed non-operative treatment compared with 33% (17/51) of kids without. At final follow-up (average 1 year in both groups), the average OCD grade was significantly worse for kids with ADHD (1.4 v 0.7 P=0.004)

Conclusion: In this study we found a three-fold increase in the prevalence of ADHD in children with OCD lesions compared with the general population. Nearly ½ of the children with ADHD failed initial non-operative therapy and these children demonstrated significantly worse healing than those without ADHD.

Significance: Nearly ½ of children with ADHD and OCD lesionsl failed non-operative management and those treated with surgery had worse radiographic healing at follow-up compared with children without ADHD.

See pages 17 - 62 for financial disclosure information.

The Progression to Surgery in Osteochondritis Dissecans in Children

Jennifer M. Weiss, MD; *Hooman Nikizad; Kevin G. Shea, MD; John C. Jacobs, Jr; Judith Bebchuk; Rita Ishkhanian; Jeffrey I. Kessler, MD*
Kaiser Permanente Southern California, Los Angeles, CA

†**LOE-Prognostic - Level III**

Purpose: To assess the frequency of pediatric osteochondritis dissecans (OCD) lesions that progress to surgery based on sex, joint involvement, and age.

Methods: A retrospective chart review was done on OCD between 2007 and 2011. Inclusion criteria included OCD of any joint and patients aged 2-19 at the time of diagnosis. Joint involvement/location, laterality, and all patient demographics were recorded. Progression to surgery was noted for each patient. Differences in surgical progression were assessed and multivariable logistic regression analysis performed to assess differences by gender, age and ethnicity.

Results: 317 patients with 334 OCD lesions were included. The majority of lesions (61.7%) were in the knee, with ankle, elbow, shoulder, and foot lesions representing 26.8%, 11.7%, 0.6%,and 0.3%, respectively. 35.3% of all OCD progressed to surgery; progression for knee, ankle, and elbow joints was 35%, 31.4%,and 55%, respectively. In logistic regression analysis, there was no significant difference in surgery risk for OCD by sex or ethnicity. As compared to 6-ll year olds, patients aged 12-19 were at significantly greater risk of progression to surgery for OCD of all locations (OR 8.25, $p<0.0001$) and for knee OCD (OR 7.4, $p<0.0001$); for ankle OCD they had a non-significant increased OR of 7.1 ($p =0.07$). Surgical progression of ankle OCD did not significantly differ based on location, while in the knee location in the trochlea or tibia correlated with greater progression to surgery.

Conclusions: 118 (35.3%) of OCD patients failed nonoperative treatment. Sex did not correlate with risk of surgical progression for any OCD lesions. Older patients were significantly more likely to progress to surgery than 6-11 year olds for all OCD and for knee OCD. Age was not a significant covariate in the logistic models for progression to surgery for the ankle or elbow locations.

Significance: This study is the first to assess the risk of failed nonoperative treatment of OCD in a stable, self-contained population of pediatric patients. The knowledge of progression to surgery by location, sex, and age is useful in counseling patients and in planning treatment. This study also confirms a higher risk of failed nonoperative treatment in older pediatric patients with OCD.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Stress Sonography of the Ulnar Collateral Ligament of the Elbow in Adolescent Baseball Pitchers

Alfred Atanda Jr, MD; *Lauren Averill, MD; Levon Nazarian, MD; Michael G. Ciccotti, MD*

†**LOE-Diagnostic - Level III**

Purpose: Stress ultrasound of the elbow has been used to evaluate the ulnar collateral ligament (UCL) in adult baseball pitchers. The dominant elbow has been shown to have increased anatomic changes, specifically in those requiring UCL reconstruction. It is not known if these UCL changes exist in adolescent pitchers as well. The purpose of this study was to use stress ultrasound to identify changes of the UCL in adolescent baseball pitchers and to examine how pitching history and physical characteristics correlate with these changes.

Methods: Stress ultrasound was used to evaluate both elbows of 31 asymptomatic baseball pitchers ages 12-18. UCL thickness at its midportion was recorded. The width of the ulnohumeral joint space at 30° of flexion was measured both at rest and with 150N of valgus stress using a Telos device. Any UCL heterogeneity and calcifications were documented. Age, BMI, and arm length measurements were also recorded. A pitching history was obtained at the time of the ultrasound. Correlation analysis was performed comparing age, BMI, arm length data, and pitching history to ultrasound findings.

Results: Mean UCL thickness (4.05 mm + / - .780 vs. (3.80 mm + / - .72), p=.02) and mean forearm circumference (25.5 mm + / - 2.6) vs. (25.1 + / - 2.6), p=.002) were greater in the dominant arms compared to the non-dominant arms. In high-school aged pitchers, UCL thickness was greater (4.59 mm +/- .70) than in younger pitchers (3.83 mm +/- .71), p=.011), and the joint space stressed was smaller (4.47 mm +/- 1.16) compared to the younger pitchers (7.40 mm +/ - 2.94), p=.007). Also, joint space stressed was lowest amongst "closers" and highest amongst those pitchers who received private pitching instruction, played catcher regularly, and pitched and caught in the same game. Age, BMI, years of pitching experience, number of career showcases, and maximum fastball velocity correlated positively with UCL thickness and negatively with joint space stressed.

Conclusions: In adolescent baseball pitchers, the dominant arms have increased UCL thickness that increases with age and size. In this population , the joint space stressed decreases with age and size, but actually increases in pitchers with higher pitch counts.

Significance: It appears that an increase in ligament thickness may help constrain the ulnohumeral joint to a certain extent, however; with continued overuse and increased pitching volumes, the ability of the UCL to constrain the joint decreases and becomes potentially more susceptible to injury.

See pages 17 - 62 for financial disclosure information.

Adolescent Multi-directional Shoulder Instability: Arthroscopic Treatment Outcomes

Michael T. Busch, MD; *Mackenzie Marie Herzog, BA; Drew E. Warnick, MD; Samuel C. Willimon, MD*
Children's Healthcare of Atlanta/Children's Orthopaedics of Atlanta

†**LOE-Therapeutic - Level IV**

Purpose: Activity modification and extensive rehabilitation are generally accepted as the mainstays of treatment for multidirectional instability (MDI) of the shoulder. Surgical stabilization is an option for patients who have failed judicious non-operative management. Outcomes following arthroscopic capsular plication have been reported, but few reports exist regarding surgical treatment in the adolescent population. The purpose of this study is to investigate the outcomes of arthroscopic treatment of MDI of the shoulder in adolescent patients.

Methods: Patients aged 12 to 21 years who underwent arthroscopic treatment of MDI of the shoulder were identified for this IRB-approved study. Between June 2004 and November 2011, a single surgeon using the same arthroscopic capsular plication technique and postoperative protocol treated all identified patients. Patients were excluded if they had previous shoulder surgery. Subjective questionnaires including DASH score, ASES score, and patient satisfaction were recorded. Failure was defined as revision shoulder surgery for instability.

Results: 38 patients (44 shoulders) met the inclusion criteria for this study. Mean age at time of surgery was 16.0 years (range: 12.2-20.6 years). There were 33 females (87%). Mean number of sutures used for the capsular plication was 5 (range: 2-8). 9 shoulders underwent concomitant procedures: 6 limited thermal capsulorraphies, 2 labral debridements, and 1 rotator cuff debridement. Average follow-up was 7.3 years (range: 1.3-8.5 years). 7 shoulders (14%) underwent revision surgery for shoulder instability at a mean of 20.5 months (range: 7.7-40.7 months). Patients who failed were younger than patients who did not (14.6 vs. 16.3, respectively; p=0.04). There was no difference between those who failed and those who did not fail in terms of gender (71% female vs. 89% female, respectively; p=0.14) or number of sutures (5.1 vs 5.0, respectively; p=0.79). Although improved, 11 of 37 patients (14 shoulders; 38%) reported some sensation of instability. The mean DASH score was 20.3 (range: 1.7-71.6), the mean ASES score was 70 (range: 30-100), and median patient satisfaction was 7 (range: 0-10).

Conclusion: In adolescent patients, arthroscopic capsular plication for the treatment of multidirectional instability of the shoulder can provide improved function and satisfaction. In the physiologically lax population some sensation of instability and failure are potential risks.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Trends in the Presentation, Management, and Outcomes of Little League Shoulder

Benton E. Heyworth, MD*; Daniel Martin, BS; Dennis Kramer, MD; Mininder S. Kocher, MD; Donald S. Bae, MD*
Boston Children's Hospital, Boston, MA

†LOE-Therapeutic - Level IV

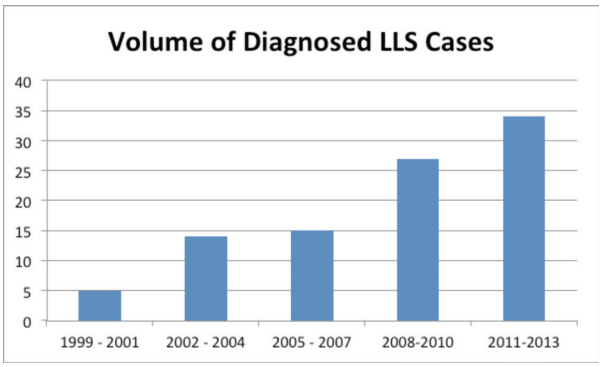
Purpose: With rising participation in youth sports such as baseball, proximal humeral epiphysiolysis ("Little league Shoulder," LLS), is being seen with increasing frequency. However, there remains a paucity of literature regarding the causes or outcomes of LLS. This study's purpose was to analyze the demographics, symptoms, diagnosis, and treatment of LLS, with an emphasis on identifying underlying risk factors for development and recurrence of LLS.

Methods: A departmental database at a single pediatric referral center was queried to identify cases of LLS between 1999 and 2013, which were reviewed to analyze age, sex, physical examination and radiologic findings, treatment details, and rates of recurrence.
Results: 95 patients (93 males; mean age 13.1 years, range 8-17 years) were diagnosed with LLS, with volumes increasing over the study period (Figure 1). In addition to the primary complaint of shoulder pain with overhead athletics seen in all patients, 13% reported elbow pain, 10% reported shoulder fatigue or weakness, and 8% reported mechanical symptoms. While the vast majority of patients (97%) were baseball players (86% pitchers, 8% catchers, 7% other positions), 3% were tennis players. On physical exam, 30% were reported to have glenohumeral internal rotation deficit (GIRD). Treatment recommendations included rest in 98% of cases, physical therapy in 79% (100% of patients with GIRD), and position change upon return to play in 25%. Average time to resolution of symptoms was 2.6 months, while average time to return to competition was 4.2 months. Recurrent symptoms were reported in 7.4% in the overall population at a mean of 8 months following symptom resolution. The odds ratio of recurrence between the group with diagnosed GIRD (14.3%) and those without GIRD (4.5%) was approximately 3:1.

Conclusion: Little league shoulder is being diagnosed with increasing frequency. While most common in male baseball pitchers, the condition can occur in females, youth catchers, other baseball positions players, and tennis players. Concomitant elbow pain may be seen in up to 13%. After rest and physical therapy, recurrent symptoms can occur, generally 6-12 months after return to sports. Almost one-third of LLS patients with had GIRD, and this group had three times higher probability of recurrence compared to those without GIRD.

Significance: GIRD and symptom recurrence are common in patients with LLS, which is being diagnosed with greater frequency. Patients should be followed for at least 1 year following initiation of treatment to insure resolution of risk factors and prevention of recurrence.

Figure 1:



See pages 17 - 62 for financial disclosure information.

POSNA

2014 SUBSPECIALTY DAY AGENDA

HAND SUBSPECIALTY DAY

Fri., May 2, 2014 • 1:00 PM–5:15 PM • Doheny/Beachwood

Co-Chairs: *Donald S. Bae, MD and Roger Cornwall, MD*

PERIOD 1 1:00 PM–2:15 PM

TRAUMA
Moderator: *Roger Cornwall, MD*

1:00 PM–1:25 PM **Elbow Cases**
Topics: Malunions/Nonunions, Elbow Contracture, Cubitus Varus, MCL Injury
Faculty Panel: *Andrea S. Bauer, MD; Robert B. Carrigan, MD; Lisa Lattanza, MD*

1:25 PM–1:35 PM **Technique Presentation on Cubitus Varus Correction**
Joshua M. Abzug, MD

1:40 PM–2:05 PM **Wrist & Hand Cases**
Topics: Radial Growth Arrest, Carpal Instability, Finger Fracture Malunions
Faculty Panel: *Nina R. Lightdale-Miric, MD; Michael J. Garcia, MD; Christopher Stutz, MD*

2:05 PM–2:15 PM **Technique Presentation on Ulnar Shortening and TFCC Repair**
Apurva Shah, MD, MBA

2:15 PM–2:30 PM BREAK

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

PERIOD 2

2:30 PM – 3:45 PM

CONGENITAL
Moderator: *Donald S. Bae, MD*

2:30 PM – 2:55 PM **Elbow & Forearm Cases**
Topics: Radioulnar Synostosis, Congenital Radial Head Dislocation, Madelung
Faculty Panel: *Terry R. Light, MD; Marybeth Ezaki, MD; Allan E. Peljovich, MD, MPH*

2:55 PM – 3:05 PM **Technique Presentation on Madelung Correction**
Marybeth Ezaki, MD

3:05 PM – 3:35 PM **Hand Cases**
Topics: Cleft Hand, Symbrachydactyly, Polysyndactyly
Faculty Panel: *Terry R. Light, MD; Peter M. Waters, MD; Scott A. Riley, MD*

3:35 PM – 3:45 PM **Technique Presentation on Cleft Hand Reconstruction**
Peter M. Waters, MD

3:45 PM – 4:00 PM BREAK

PERIOD 3

4:00 PM – 5:15 PM
Free Papers
Moderators: *Donald S. Bae, MD; Roger Cornwall, MD*

4:00 PM – 4:04 PM
1 *(page 273)* **Quantitative Assessment of Dynamic Control of Fingertip Forces after Pollicization**
Nina R. Lightdale-Miric, MD; *Nicole M. Mueske, MS; Jamie Berggren, OT; Jennifer Loiselle, OT; Francisco J. Valero-Cuevas, PhD; Sudarshan Dayanidhi, PhD; Tishya A. L. Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA; Viterbi School of Engineering, University of Southern California, Los Angeles, CA; University of San Diego, San Diego, CA

4:05 PM – 4:09 PM
2 *(page 274)* **Bilobed Flap for Radial Deficiency: A Safe and Effective Alternative for the Treatment of the Severely Affected Wrist**
Carley Vuillermin, MBBS, FRACS*; Lindley B. Wall, MD; Janith Mills, MPAS, PA-C; Lesley Wheeler, BA; Marybeth Ezaki, MD; Scott Oishi, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

See pages 17 - 62 for financial disclosure information.

4:10 PM–4:14 PM
3 *(page 275)*
Radial Polydactly: The Need for Reoperation Based on a New Classification System
Brian Evanson, MD; Pooya Hosseinzadeh, MD; Ronald Burgess, MD; ***Scott A. Riley, MD***
Shriners Hospital for Children at Lexington, KY

4:15 PM–4:24 PM DISCUSSION

4:25 PM–4:29 PM
4 *(page 276)*
Clavicle Fracture is Not Predictive of Need for Microsurgery in Brachial Plexus Birth Palsy
Holly B. Hale, MD; ***Andrea S. Bauer, MD;***
Nina R. Lightdale-Miric, MD; Peter M. Waters, MD
Children's Hospital, Los Angeles, CA

4:30 PM–4:34 PM
5 *(page 277)*
The Demographics and Epidemiology of Osteochondritis Dissecans of the Elbow in Children and Adolescents
Jeffrey I. Kessler, MD; *Hooman Nikizad; Kevin G. Shea; John C. Jacobs, Jr; Judith Bebchuk; Jennifer M. Weiss*
Kaiser Permanente Southern California, Los Angeles, CA

4:35 PM–4:39 PM
6 *(page 278)*
The Distal Humerus Axial View to Assess Displacement of Medial Epicondyle Fractures
Christopher D. Souder, MD; *Christine L. Farnsworth; Natalie McNeil; Eric W. Edmonds, MD*
Rady Children's Hospital San Diego, San Diego, California

4:40 PM–4:49 PM DISCUSSION

4:50 PM–4:54 PM
7 *(page 280)*
Use of Botulinum Toxin Type A in the Management of Neonatal Brachial Plexus Palsy
Charles T. Mehlman, DO, MPH; *Emily J. Louden, MPH; Allison J. Allgier, OTR/L; Linda J. Michaud, MD, PT*
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

4:55 PM–4:59 PM
8 *(page 281)*
Three Dimensional Magnetic Resonance Imaging of Glenohumeral Dysplasia in Neonatal Brachial Plexus Palsy
Emily A. Eismann, MS; Tal Laor, MD; ***Roger Cornwall, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

5:00 PM – 5:04 PM
9 *(page 282)*

Supraspinatus Slide to Treat Abduction Contracture in Brachial Plexopathy

Sonia Chaudhry, MD*; Alison Anthony BScPT;*
Sevan Hopyan, MD, PhD, FRCSC
Hospital for Sick Children, Toronto, ON, CANADA

5:05 PM – 5:14 PM DISCUSSION

See pages 17 - 62 for financial disclosure information.

Quantitative Assessment of Dynamic Control of Fingertip Forces after Pollicization

Nina R. Lightdale-Miric, MD; *Nicole M. Mueske, MS; Jamie Berggren, OT; Jennifer Loiselle, OT; Francisco J. Valero-Cuevas, PhD; Sudarshan Dayanidhi, PhD; Tishya A. L. Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA; Viterbi School of Engineering, University of Southern California, Los Angeles, CA; University of San Diego, San Diego, CA

†**LOE-Prognostic - Level III**

Purpose: This study used a novel Strength-Dexterity (S-D) test to isolate and quantify a specific aspect of dexterous manipulation, the dynamic control of fingertip forces, after finger pollicization in children.

Methods: The study included 10 pollicized and 5 non-pollicized hands from 8 participants ages 4-17 years. Participants attempted to compress and hold an instrumented spring between the thumb and next most radial finger to assess dynamic control of fingertip forces (S-D score). They also completed traditional functional tests including grip, lateral pinch, and tripod pinch strength, Box and Blocks Test, and 9-hole peg test and were graded using the Manual Ability Classification System and Total Active Motion measure. Retrospective chart and x-ray review provided clinical information. Pearson's correlation evaluated the relationship among age-normalized Z-scores from the S-D test and the other functional tests. Patient characteristics were compared between hands with good versus poor S-D outcome using Mann-Whitney rank sum tests.

Results: Six of 10 pollicized hands and all non-pollicized hands had S-D scores within the normal range. In contrast, almost all pollicized hands scored below the normal range for the traditional functional tests. S-D Z-scores were moderately correlated with Z-scores from all other functional tests ($r = 0.42$-0.61), but the correlations were generally weaker than the correlations amongst the other functional measures ($r = 0.59$-0.93), suggesting that the S-D test captures a different domain of function. The only clinical characteristic distinguishing hands with good vs. poor S-D outcome was a higher incidence of radial absence in the hands with poor S-D scores (3/4) compared with hands having normal S-D scores (0/6) ($p = 0.02$).

Conclusions: Manual dexterity is a key component in many activities of daily living, and it is an important outcome to evaluate after finger pollicization. The S-D results suggest that most pollicized hands achieved dynamic control of fingertip forces similar to age-matched norms. This may indicate that after pollicization children exhibit the necessary neuromuscular plasticity to acquire normal levels of control over dynamic fingertip forces, which may help them in performing tasks such as typing or holding a pencil. However, they may still lack the strength and/or gross motor coordination needed to achieve normal hand function.

Significance: Although children with pollicized hands have gross motion function deficits, they are still able to achieve near-normal control of fingertip forces.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Bilobed Flap for Radial Deficiency: A Safe and Effective Alternative for the Treatment of the Severely Affected Wrist

Carley Vuillermin, MBBS, FRACS*; Lindley B. Wall, MD; Janith Mills, MPAS, PA-C; Lesley Wheeler, BA; Marybeth Ezaki, MD; Scott Oishi, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level IV**

Purpose: The optimum treatment of the severe radially deviated wrist in radial longitudinal deficiency (RLD) has yet to be determined. Centralization or radialization, with or without distraction, is the procedure that is most commonly utilized, despite having risks of significant recurrence and ulnar physis injury resulting in shortening of the forearm. Because of these risks we instead utilize the technique of soft-tissue release and bilobed flap and report our results.

Methods: We retrospectively reviewed our patients who have undergone soft-tissue release and bi-lobed flap and have at least 3 year follow-up. The study group consisted of 19 patients and 21 wrists. All patients underwent follow-up examination and radiographs. Outcome measures utilizing PODCI, DASH, and VAS scores were recorded for each patient.

Results: Follow-up revealed all patients to have some active wrist motion. Average DASH score was 26.45 (4.31 – 53.57). PODCI Global was 86 (75 – 97), PODCI happiness was 87.27 (70 – 100), and VAS- overall satisfaction (0-10) was 1.38 (0 – 8). Average final resting wrist radial deviation angle was 58 degrees compared to 87.91 degrees pre-operatively. No physeal injuries were noted in follow-up radiographs, and no patients required subsequent arthrodesis.

Conclusions: We feel that the bilobed flap and soft-tissue release procedure should be considered in the treatment algorithm for patients with RLD. Outcome measures show that these patients use the extremity well after the procedure, and are very satisfied with both the appearance and function. As expected, some recurrence of radial deviation is the norm, but this is no different than in the centralization/ radialization procedures which also run the inherent risk of physeal injury to the ulna.

Significance: We present a safe, effective method for treatment of the severe wrist deformity in RLD which is distinctly different than procedures which are currently utilized but compares favorably with them without the inherent risks.

See pages 17 - 62 for financial disclosure information.

Radial Polydactly: The Need for Reoperation Based on a New Classification System

Brian Evanson, MD; Pooya Hosseinzadeh, MD; Ronald Burgess, MD; ***Scott A. Riley, MD***
Shriners Hospital for Children at Lexington, KY

†**LOE-Prognostic - Level III**

Purpose: Polydactyly is one of the more common congenital issues affecting the pediatric hand that is usually treated surgically. Chung et al, recently proposed a new classification system that categorizes radial polydactyly based on morphologic features that provides information that can be helpful in surgical decision-making. We reviewed all radial polydactyly cases that underwent operative treatment at a single institution over a 10 year period to see if this new classification system correlated with reoperation rates.

Methods: A total of 60 thumbs in 54 patients that were treated surgically from 2000 to 2010 were included in this study. Only patients with more than 2 year follow-up were included. The authors categorized all duplications based on the classification system proposed by Chung et al: Type I (Joint Type - each digit has its own joint at its origin), Type II (Single Epiphyseal Type - the origin of the duplicated digit arises from a common epiphysis), Type III (Osteochondroma-like Type - the origin of the duplicated digit resembles an osteochondroma), and Type IV (Hypoplastic Type - the duplicated digit is attached by soft tissue alone). Statistical analysis was then used to look at this classification system as it relates to sex, family history, syndrome related, and the need for reoperation.

Results: Of the 60 radial polydactyly cases, 37 (62%) were Type I; 6 (10%) were Type II; 6 (10%) were Type III; and 11 (18%) were Type IV. 6 thumbs underwent reoperation for residual deformity. From those 6, 3 were Type I, 3 Type II, and none of the Type III or IV. No statistical significance was found when comparing classification group to sex, family history, or relation to syndrome. Statistical significance was found ($p < .05$) between the groups and the need for reoperation with Type II having the highest rate of reoperation (30%).

Conclusion: The new classification proposed by Chung et al correlates with the need for reoperation after initial treatment.

Significance: The new classification for radial polydactlyly proposed by Chung et al is easy to use and can guide practitioners in their discussions with patients regarding surgical outcomes and the need for revision surgery.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Clavicle Fracture is Not Predictive of Need for Microsurgery in Brachial Plexus Birth Palsy

*Holly B. Hale, MD; **Andrea S. Bauer, MD;** Nina R. Lightdale-Miric, MD; Peter M. Waters, MD*
Children's Hospital, Los Angeles, CA

†**LOE-Prognostic - Level II**

Purpose: The relationship between brachial plexus birth palsy (BPBP) and birth fractures is not understood, although it has been postulated that concurrent clavicle fracture may spare nerve injury. We compared those children with brachial plexus birth palsy presenting to six tertiary care centers with and without concurrent fractures and assessed the utility of the presence of a birth fracture as a predictor of injury severity in children with BPBP.

Methods: Records of all patients belonging to a prospective multicenter cohort study of infants with BPBP from six regional medical centers were analyzed for demographic information and birth information including presence of birth fracture. We defined severe plexus injuries as those injuries requiring microsurgical intervention in infancy. Patients with missing data were excluded.

Results: The records of 639 children were reviewed. Thirteen patients were excluded for incomplete data. There were 96 children with concurrent birth fractures. Of those children 57 sustained clavicle fractures, 44 sustained humerus fractures, and 4 sustained other fractures. There was no difference between those children who sustained birth fractures and those that did not in terms of admission to NICU (p =0.08), gender (p=1.0), preeclampsia (p=0.40), breech delivery (0.11), level of complexity of the delivery (p=1.0), shoulder dystocia (p=0.62), respiratory complication (p=1.0), birth weight (p=0.76), Horner's syndrome (p=0.66) or age at first clinical visit (p=0.28). Only presence of gestational diabetes was found to be significantly higher in those children with fractures versus those without (p=0.003). The presence of birth fracture did not change incidence of microsurgical intervention (24.0% vs 23.4%, p=.98). Statistical analysis was repeated for clavicle fractures only, and the presence of a clavicle fracture specifically also did not change the incidence of microsurgery (22.8% vs 23.9%, p=0.98).

Conclusion: In this review of 626 children treated for BPBP at tertiary care centers, 15% also sustained a birth fracture. The severity of the brachial plexus injury, as defined as the need for microsurgery in infancy, was no different between children with or without birth fractures.

Significance: In this study population of children with severe enough BPBP to present to a tertiary care center, the presence of a clavicle fracture was not predictive of injury severity.

See pages 17 - 62 for financial disclosure information.

The Demographics and Epidemiology of Osteochondritis Dissecans of the Elbow in Children and Adolescents

Jeffrey I. Kessler, MD; *Hooman Nikizad; Kevin G. Shea; John C. Jacobs, Jr; Judith Bebchuk; Jennifer M. Weiss*
Kaiser Permanente Southern California, Los Angeles, CA

†**LOE-Prognostic - Level III**

Purpose: The purpose of this study is to assess the demographics and epidemiology of OCD of the elbow in children.

Methods: A retrospective chart review of an integrated health system was done on elbow OCD patients aged 2-19, with over 1 million patients in this cohort. Lesion location, laterality, and all patient demographics were recorded. OCD incidence was determined for the group as a whole and by sex and age group (divided into 2-5 years, 6-11 years, 12-19 years). Patient differences based on age, sex, and ethnicity were analyzed and, using multivariable logistic regression models, associations between age, sex, ethnicity and diagnosis of elbow OCD were evaluated.

Results: 37 patients with 40 OCD lesions fit the inclusion criteria. No lesion was found in 2-5 year-olds. 39 (97.5%) lesions were in the capitellum and 1 (2.5%) was in the trochlea. Twenty-five (67.5%) patients had right-sided lesions, 9 (24.3%) left-sided, and 3 (8.1%) had bilateral elbow OCD. The incidence of elbow OCD for patients aged 6-19 was 2.2 per 100,000 overall, and 3.8 and 0.6 per 100,000 for males and females, respectively. Those aged 12-19 years represented the vast majority of OCD, with an incidence of 3.4 per 100,000 versus 0.38 in ages 6-11. Based on race and ethnicity, non-Hispanic Whites had the highest incidence of elbow OCD compared to all other ethnic groups. Multivariable logistic regression analysis revealed a 21.7 times increased odds ratio (OR) of elbow OCD in patients 12-19 compared to 6-11 year-olds, and males had a 6.8 times greater OR of elbow OCD than females ($p<0.0001$ for both).

Conclusions: In this population-based cohort study of pediatric elbow OCD, males had almost 7 times the risk of elbow OCD compared to females. 12-19 year-olds had nearly 22 times the risk of elbow OCD as compared to 6-11 year-olds.

Significance: This is the first true population-based epidemiologic and incidence study of pediatric elbow OCD in a stable population. We must have a higher index of suspicion for elbow OCD in males, older teens, and in non-Hispanic Whites, and potentially target our treatment efforts toward these patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

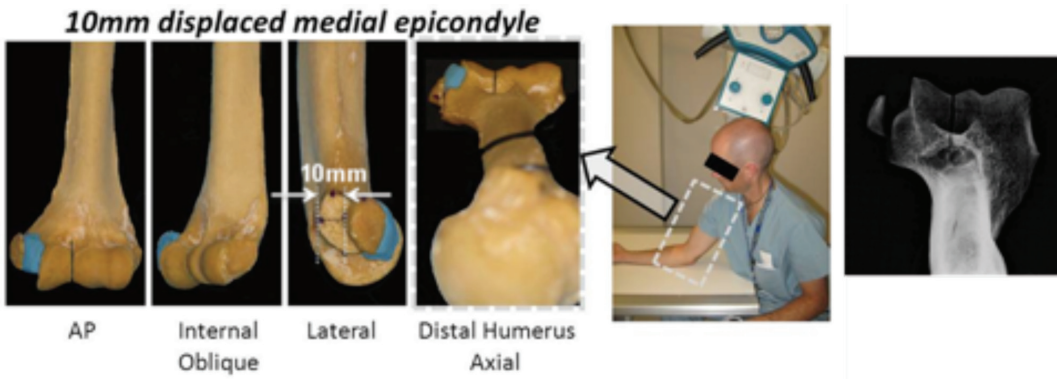
The Distal Humerus Axial View to Assess Displacement of Medial Epicondyle Fractures

Christopher D. Souder, MD; *Christine L. Farnsworth; Natalie McNeil; Eric W. Edmonds, MD*
Study performed at Rady Children's Hospital San Diego, San Diego, California

†LOE-Diagnostic - Level II

Purpose: The assessment and treatment of childhood medial epicondyle humerus fractures has been much debated. Several studies demonstrate that standard radiographic views are unable to accurately portray the true amount of displacement. This study describes a new distal humerus axial radiographic technique that improves the accuracy of measuring displacement in medial epicondyle fractures.

Methods: An osteotomy of the medial epicondyle of a cadaveric humerus was performed to simulate a medial epicondyle fracture that was then positioned using a radiolucent substance. Plain radiographs were obtained with the fracture fragment displaced anteriorly in 2mm increments between 0 and 18mm. Anteroposterior (AP), internal oblique (IR) and lateral (LAT) views were obtained in addition to a newly described distal humerus axial (AXIAL) view (FIGURE). Axial images were obtained by positioning the central ray above the shoulder at 10-15° from the long axis of the humerus, centering on the distal humerus. Displacement (mm) was measured by two pediatric orthopedic surgeons and an orthopedic resident on digital radiographs and compared to the true displacement.



Results: On LAT views, readers were not able to visualize fragments with <10mm displacement. Displacement ≥10mm from LAT views was overestimated by one surgeon (2.0 to 4.6mm) and underestimated by the other (0.1 to 3.3mm). At 10mm displacement, AP views underestimated displacement by a mean of 6.0±0.5mm and IR views underestimated by 3.2±1.3mm. Inter-observer correlation (ICC) was 0.612 for AP and IR measurements; whereas, ICC was 0.981 (lower/upper bound 95% confidence, 0.786 – 1.000) for the AXIAL view. AXIAL images more closely estimated the true amount of displacement, with a mean 1.3±1.0mm error in measurement for <10mm displacement and a mean 1.0±0.9mm error in measurement for displacements ≥10mm.

See pages 17 - 62 for financial disclosure information.

Conclusion: AP, IR and LAT imaging misrepresented displacement of medial epicondyle humerus fractures. The AXIAL projection more accurately and reliably demonstrated the true displacement with significant intra-observer correlation.

Significance: This distal humerus axial imaging technique allows the surgeon an enhanced evaluation of the medial epicondyle without exposing the child to the additional radiation of computed tomography.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Use of Botulinum Toxin Type A in the Management of Neonatal Brachial Plexus Palsy

Charles T. Mehlman, DO, MPH; *Emily J. Louden, MPH; Allison J. Allgier, OTR/L; Linda J. Michaud, MD, PT*
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

†**LOE-Therapeutic - Level III**

Purpose: Outcomes after the use of botulinum toxin type A (Botox) in the management of neonatal brachial plexus palsy (NBPP) population was studied.

Methods: After institutional review board approval, children with NBPP who received Botox at tertiary children's hospital charts were retrospectively reviewed. Indications for the procedure included muscle imbalance (shoulder, elbow, and forearm), co-contractions (triceps), and/or contracture (biceps). Post-injection therapy generally focused on stretching of the injected muscles and facilitation and strengthening of the antagonist muscle. Mallet and Toronto scores, Passive range of motion in shoulder external rotation and elbow extension were analyzed for patients at ≤ 6 months follow-up (Botox Active, BA) and at ³ 7 months follow-up (Botox Not Active, BNA).

Results: A total of 58 children (30 males) with NBPP had 74 Botox injection procedures between 2004 and 2010, 16 of which were to multiple sites. Fifty-one injection procedures were performed to shoulder internal rotators, resulting in significant improvements in total Mallet and abduction at BA (p=<0.0001, 0.0063) and BNA (n=32, p=<0.0001, 0.0009). Of 18 patients under consideration for shoulder surgery, 4 were averted, 4 were delayed, and 2 recommendations were modified following sustained improvements post-Botox. Fifteen Botox injections to the triceps for active elbow flexion were significant for Toronto scores and elbow flexion at BA (p=0.0039, 0.0039) and also at BNA (n=9, p=.0049, 0.0039). Two of the 7 patients under consideration for surgery for elbow flexion averted surgery due to sustained improvement. Fifteen Botox injections to the forearm were significant in active supination at BA (p=.0020) and also at BNA (n=8, p=.0156). Nine Botox injections to the biceps averaged a 49% gain in in passive elbow extension and were significant (p=0.0039) but was not at BNA (n=7, p=.5625). Following Botox, 80% (60/75) of caretakers expressed satisfaction and noted appreciable increases in and ease of range of motion and new or improved ability to perform age-appropriate activities.

Conclusion: Botox augmented with therapy is a safe and effective adjunct in the management of the shoulder, elbow, and forearm range of motion in patients with NBPP. The use of Botox is a favorable option for caregivers desiring for a less invasive approach prior to or in lieu of surgical treatment in appropriate cases.

Significance: Use of Botox can result in averting, modifying, or deferring surgical interventions in a significant number of affected children.

See pages 17 - 62 for financial disclosure information.

Three Dimensional Magnetic Resonance Imaging of Glenohumeral Dysplasia in Neonatal Brachial Plexus Palsy

Emily A. Eismann, MS; Tal Laor, MD; ***Roger Cornwall, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

†**LOE-Diagnostic - Level II**

Purpose: Glenohumeral dysplasia commonly occurs following unresolved neonatal brachial plexus palsy (NBPP). Assessment of this dysplasia is important in clinical decision-making and research, yet measures of this dysplasia have been limited to the axial plane. The current study describes the pathoanatomy of glenohumeral dysplasia using three-dimensional (3D) magnetic resonance imaging (MRI) and correlates it with existing two-dimensional (2D) MRI measures.

Methods: 3D reformations of the scapula, labrum, and proximal humerus were created from volume-acquisition proton density-weighted MRIs of the affected and unaffected shoulders of 12 children (age 5.8±5.2 years) with NBPP. 3D congruity of the humeral head, labrum, and glenoid was compared with glenohumeral alignment as assessed by 2D axial MRI measurement of the percentage of the humeral head anterior to the scapular line (PHHA). Glenoid retroversion was measured from 3D reformations and from 2D axial MR images. Coronal tilt of the glenoid relative to the medial border of the scapula, termed infraversion, was measured on the 3D reformations, controlling for glenoid retroversion. Wilcoxon signed ranks tests compared 3D measures between affected and unaffected sides; Spearman correlations assessed relationships between 2D and 3D measures.

Results: ***Glenohumeral alignment***: In all 4 shoulders with 2D PHHA=0%, suggesting complete posterior dislocation, the humeral head actually remained within the glenoid labrum, albeit eccentrically located in a posteriorly elongated labrum that encircled both a pseudoglenoid posteriorly and the empty native glenoid anteriorly. In 7 additional patients, with PHHA ranging from 19 to 48%, the humeral head was congruently aligned within the labrum. In one patient, with a PHHA of 40%, the humeral head was subluxated posteriorly out of the labrum. ***Glenoid version:*** 3D and 2D measurement of glenoid retroversion correlated significantly (GVA; r=0.86, p=0.014). However, 3D imaging also revealed consistent glenoid infraversion (p=0.018, median 14° on affected side vs. 0° on the unaffected side), even in the presence of normal retroversion.

Conclusion: Complete posterior translation of the humeral head is not a true dislocation, as the humeral head tends to remain within the misshapen labrum even when articulating with a severely dysplastic glenoid. Glenohumeral dysplasia is not limited to the axial plane, with glenoid infraversion present even with normal retroversion.

Significance: Treatment of severe posterior humeral head translation should not be considered as simple as reducing a 'dislocation'. Glenoid infraversion, a previously unrecognized coronal plane component of glenohumeral dysplasia, may have potential implications for the evaluation and treatment of shoulder weakness and contractures in NBPP.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Supraspinatus Slide to Treat Abduction Contracture in Brachial Plexopathy

Sonia Chaudhry, MD*; Alison Anthony BScPT; Sevan Hopyan, MD, PhD, FRCSC*
Hospital for Sick Children, Toronto, ON, CANADA

†**LOE-Therapeutic - Level III**

Purpose: Glenohumeral dysplasia associated with brachial plexus birth palsy can be managed with joint reduction and tendon transfers to restore active external rotation. Associated internal rotation contracture and correction with subscapularis lengthening or slide are well described. Abduction contracture is less appreciated, as preoperative range of motion is often assessed with the joint subluxed and treatment options are limited. Joint reduction often unmasks abduction contracture. Here we describe a technique to increase adduction range and reduce the Putti sign when present. We hypothesize that addition of a *supraspinatus* slide will decrease abduction contracture after glenohumeral reduction.

Methods: After ERB approval, retrospective review identified 55 brachial plexus birth palsy patients with Waters III-V glenohumeral dysplasia who underwent glenoid anteversion osteotomy with tendon transfers from 2006-2012. Intraoperative decision to add supraspinatus slide was incorporated in 2008 to address abduction contracture that *worsened* following operative joint reduction. Range of motion, Waters classification and Mallet scores were recorded pre- and post-operatively.

Results: Twenty-seven control patients were compared with 28 who had concomitant supraspinatus slide. A resection of the superomedial scapular border to treat residual intraoperative Putti sign was performed in 21 of the 28 slide patients. Control and slide groups had similar ages (7 and 10 years), Waters classification (Grade IV in both), and Mallet scores (11 and 12). Follow-up averaged 6.3 years. Preoperative abduction contracture was an average 27 degrees worse in the slide group compared to controls. Glenohumeral reduction worsened abduction contracture an average of 10 degrees in the control group (as measured postoperatively), while the slide group experienced a 1 degree improvement ($p=0.08$). Intraoperative findings in the slide group showed that glenohumeral reduction unmasked an additional 30 degrees of abduction contracture. Supraspinatus slide decreased the post-reduction abduction contracture noted intraoperatively by 35 degrees. Active abduction improved 21 degrees in the control group, while the slide group lost 3 degrees ($p=0.05$). Final Mallet score improved 4 and 3 points in control and slide groups, respectively ($p=0.08$). There were no surgical complications attributable to supraspinatus slide.

Conclusions: Abduction contracture is unmasked by glenohumeral reduction. Supraspinatus slide can be added to restore passive adduction closer to its apparent preoperative range at the cost of decreasing active abduction range. Further study is required to determine if there is functional consequence to this difference and how that compares with quantitatively evaluated cosmesis.

Significance: Apparent worsening of abduction contracture following glenohumeral reduction can be anticipated and minimized.

See pages 17 - 62 for financial disclosure information.

POSNA

2014 SUBSPECIALTY DAY AGENDA

NEUROMUSCULAR/LOWER EXTREMITY SUBSPECIALTY DAY

Fri., May 2, 2014 • 1:00 PM–5:00 PM • Hollywood AB

Co-Chairs: *Michelle S. Caird, MD and Jon R. Davids, MD*

PERIOD 1

1:00 PM–2:15 PM
Free Papers
Moderators: *Michelle S. Caird, MD; Jon R. Davids, MD*

1:00 PM–1:04 PM
1 *(page 287)*
The Importance of Active Follow-up in Growth Modulation Surgery
John W. Kemppainen, MD; *Kenneth A. Hood, MD; Joanna H. Roocroft, MA; John A. Schlechter, MD; Eric W. Edmonds, MD*
Rady Children's Hospital San Diego and Children's Hospital of Orange County, Orange, CA

1:05 PM–1:09 PM
2 *(page 288)*
Rectus Femoris Transfer Vs. Rectus Intramuscular Lengthening for the Treatment of Stiff Knee Gait in Children with Cerebral Palsy
Matthew D. Ellington, MD; Judi Linton, PT, MS; ***Allison C. Scott, MD****; Douglas Barnes, MD*
Shriners Hospital for Children, Houston, TX

1:10 PM–1:14 PM
3 *(page 289)*
The Effectiveness of Posterior Knee Capsulotomies and Knee Extension Osteotomies in Children with Cerebral Palsy
Daveda Taylor MSPT, DPT; ***Justin Connor, MD****; Chris Church, MPT; Manasa Sridhar, BA; John Henley, PhD; Tim Niiler, PhD; Freeman Miller, MD*
A.I. duPont Hospital for Children, Wilmington, DE

1:15 PM–1:22 PM DISCUSSION

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

1:23 PM–1:27 PM
4 *(page 290)*
The Effect of GMFCS Level and Neck Shaft Angle on Acetabular Remodeling after a Varus Derotational Osteotomy in Children with Cerebral Palsy
Frank M. Chang, MD*; Julie Ma, BA; Zhaoxing Pan, MB, PhD; Eduardo N. Novais, MD*
Children's Hospital Colorado – University of Colorado Anschutz Medical Campus, Aurora, CO

1:28 PM–1:32 PM
5 *(page 291)*
♦ **The Outcome of Botulinum Toxin A (Botox®) Injections for Painful Dislocated Hips in Patients with GMFCS IV and V Cerebral Palsy**
Henry (Hank) G. Chambers, MD*; Daniel Figueiredo*
Rady Children's Hospital and University of California at San Diego

1:33 PM–1:37 PM
6 *(page 292)*
Hip Dysplasia in Charcot-Marie-Tooth Type 1A: Evidence for Acquired Dysplasia
Marie Gdalevitch, MD*; Joshua Burns, MD; Paul J. Gibbons, MD*
Children's Hospital at Westmead, Sydney, AUSTRALIA

1:38 PM–1:42 PM
7 *(page 293)*
Anterior Tibialis Activity in Recurrent Clubfoot: Considerations for Supination Deformity
Kristan A. Pierz, MD*; Sylvia Ounpuu, MSc; Matthew J. Solomito, MS; Jessica R. Woods, BSBE*
The Center for Motion Analysis, Connecticut Children's Medical Center, Farmington, CT

1:43 PM–1:50 PM
DISCUSSION

1:51 PM–1:55 PM
8 *(page 294)*
Congenital Tibial Deficiency: A Thirty-seven-Year Experience at One Institution
John G. Birch, MD; ***Rebecca E. Clinton, MD***
Texas Scottish Rite Hospital for Children, Dallas, TX

1:56 PM–2:00 PM
9 *(page 295)*
Staged Double-level Limb Lengthening: Novel Technique Resulting in Decreased Healing Index
Matthew D. Abbott, MD; *Alexander M. Cherkashin, MD; Mikhail L. Samchukov, MD; John G. Birch, MD, FRCS(C)*
Texas Scottish Rite Hospital for Children, Dallas, TX

See pages 17 - 62 for financial disclosure information.

2:01 PM–2:05 PM **Obesity and Vitamin D Insufficiency in Idiopathic Genu Valgum**
10 *(page 296)*
***Pooya Hosseinzadeh, MD**; Kevin Murr, MD; Todd A. Milbrandt, MD, MS; Vishwas R. Talwalkar, MD; Henry J. Iwinski, MD; Ryan Muchow, MD; Janet L. Walker, MD*
Shriners Hospitals for Children and Univ. of Kentucky Dept. of Ortho. Surgery, Lexington KY

2:06 PM–2:13 PM DISCUSSION

2:17 PM–2:30 PM BREAK

PERIOD 2

2:30 PM–3:45 PM
Moderators: *Michelle S. Caird, MD; Jon R. Davids, MD*

Lectures

2:30 PM–2:45 PM **Assessment and Management of Transverse Plane Gait Deviations in Children with CP**
Jason Rhodes, MD

2:50 PM–3:00 PM **Use of Orthoses to Improve Gait in Children with CP**
Jon R. Davids, MD

3:05 PM–3:15 PM **Neuromuscular Hip Dysplasia: Role of Acetabular Osteotomy**
Robert M. Kay, MD

Master Techniques

3:20 PM–3:30 PM **Distal Femoral Extension Osteotomy with Patellar Tendon Advancement**
Tom F. Novacheck, MD

3:35 PM–3:45PM **Triple C Osteotomies**
Scott J. Mubarak, MD

3:45 PM–4:00 PM BREAK

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

PERIOD 3

4:00 PM–5:15 PM
Moderators: *Michelle S. Caird, MD; Jon R. Davids, MD*

Lectures

4:00 PM–4:15 PM **Duchenne Muscular Dystrophy: Change in Natural History and Implications for Orthopaedic Management**
Benjamin A. Alman, MD

4:20 PM–4:30 PM **Guided Growth for the Treatment of Infantile Tibia Vara**
Allison C. Scott, MD

4:35 PM–4:45 PM **Surgical Management for Mild Recurrence following Ponseti Management of TEV**
Matthew A. Halanski, MD

Master Techniques

4:50 PM–5:00 PM **Intramedullary Fixation in Osteogenesis Imperfecta**
Michelle S. Caird, MD

5:05 PM–5:15 PM **Correction of Rigid Cavus Foot Deformity Associated with Hereditary Sensory Motor Neuropathies**
Vincent S. Mosca, MD

See pages 17 - 62 for financial disclosure information.

The Importance of Active Follow-up in Growth Modulation Surgery

John W. Kemppainen, MD; *Kenneth A. Hood, MD; Joanna H. Roocroft, MA; John A. Schlechter, MD; Eric W. Edmonds, MD*
Rady Children's Hospital San Diego and Children's Hospital of Orange County, Orange, CA

†**LOE-Therapeutic - Level IV**

Purpose: Extraperiosteal tension plates have become the predominant method for angular deformity correction in skeletally immature patients, with many surgeons using them in very young patients intending to remove them when correction is complete. But, what if these patients do not follow up after placement of the plates? This study examines the incidence of incomplete follow-up after placement of tension plates for angular deformity correction, and reviews a series of patients who were lost to follow-up with retained implants.

Methods: Patients from two institutions treated with extraperiosteal tension plates around the knee were reviewed, and compliance with follow-up was noted. Skeletally immature patients with retained implants and incomplete follow-up were contacted to reestablish care. The effect of the retained plates in these patients was also reviewed.

Results: 200 patients treated with tension plates around the knee were identified between the two institutions (116 at institution one, 84 at institution two). The most common indication for surgery was genu valgum (54%), and the mean age at initial surgery was 11.7 years (range 3.1-16.8). A high rate of retained implants with incomplete follow-up was identified at both institutions, where a total of 23 patients (11.5%) were lost with their plates in place. At institution one, 4 of 11 missing patients were unreachable. Of the remaining seven patients, three had reached skeletal maturity with no significant complications, and the other four had overcorrection of their angular deformity. Two of those patients underwent osteotomies to remedy their overcorrection and the other two elected for plate removal only. In total, 29% of lost patients underwent additional surgery beyond simple plate removal after care was re-established. At institution two, only 2 patients have been reachable and have not yet returned.

Conclusion: The incidence of incomplete follow-up, after extraperiosteal plate placement for angular deformity correction around the knee, was significant at both institutions included in this study (11.5% combined incidence). Of those who were found for follow-up, 29% required surgery beyond plate removal. Incomplete follow-up among these patients was identified as a significant quality of care issue, and an EMR system has been established to actively follow patients receiving growth modulation surgery.

Significance: Surgeons who perform growth modulation surgery should have safeguards in place to avoid the potential complications that can accompany incomplete follow-up in patients who receive such procedures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Rectus Femoris Transfer Vs. Rectus Intramuscular Lengthening for the Treatment of Stiff Knee Gait in Children with Cerebral Palsy

Matthew D. Ellington, MD; Judi Linton, PT, MS; ***Allison C. Scott, MD****;*
Douglas Barnes, MD
Shriners Hospital for Children, Houston, TX

†**LOE-Therapeutic - Level III**

Purpose: To compare the short term outcomes of rectus femoris intramuscular lengthening to treat stiff knee gait with rectus femoris transfer in children with spastic cerebral palsy.

Methods: A retrospective chart review of 16 (31 limbs) patients with diplegic or triplegic spastic cerebral palsy who had undergone rectus femoris intramuscular lengthening for the diagnosis of a stiff knee gait with a Gross Motor Function Classification System (GMFCS) level I, II, or III was carried out. These patients were then matched with a cohort of 16 (32 limbs) patients who had undergone rectus femoris transfers for the same problem based on age, sex, GMFCS level, diagnosis, preoperative Gait Deviation Index (GDI), and the number and type of concomitant surgeries. Pre and one year postoperative motion analysis data as well as physical exam was then compared for both groups and the student T test used for statistical analysis.

Results: There were no significant differences in demographics between the two groups of patients. On physical exam, a positive postoperative Duncan Ely test was seen significantly less often in the transfer limbs (14 vs. 25). Average postoperative quad tone score also fell within the normal range (1.6) for the transfer group compared to mild (2.2) for the lengthening group. Motion analysis data showed no significant postoperative differences between groups with respect to stride length, walking speed, cadence, knee flexion at initial contact, peak knee flexion during loading response, mean knee flexion in stance, peak knee flexion in swing, time to peak knee flexion (% swing), time to peak knee flexion (% gait cycle), GDI or total knee range of motion. There was a difference in time to achieve 90 degrees passive knee flexion with the lengthening group reaching this in 5.9 days and transfer group in 14 days ($p < 0.0001$).

Conclusion: Motion analysis parameters showed short term postoperative results of rectus femoris transfers and rectus femoris intramuscular lengthenings were equivalent in these two matched cohorts. There were less positive Duncan Ely tests postoperatively with rectus transfers than lengthenings. 90 degrees passive knee flexion was achieved more quickly in the lengthenings compared to transfers.

Significance: The rectus femoris lengthening decreases surgical time and accelerates rehabilitation over a rectus femoris transfer. If outcome studies continue to confirm equivalent results, rectus femoris lengthening should be more cost effective.

See pages 17 - 62 for financial disclosure information.

The Effectiveness of Posterior Knee Capsulotomies and Knee Extension Osteotomies in Children with Cerebral Palsy

Daveda Taylor MSPT, DPT; ***Justin Connor, MD****; Chris Church, MPT; Manasa Sridhar, BA; John Henley, PhD; Tim Niiler, PhD; Freeman Miller, MD*
A.I. duPont Hospital for Children, Wilmington, DE

†**LOE-Therapeutic - Level III**

Purpose: Crouched gait is a common gait deviation in children with CP. There are a variety of treatment options. The purpose of this study is to determine the effectiveness of single event multi-level orthopedic surgeries, (SEMLS) specifically posterior knee capsulotomies (PKC) and distal femoral extension osteotomies (DFEO) to correct knee flexion contracture and improve crouched gait in children with CP using gait analysis.

Methods: In this retrospective study, the data from thirty-one children with spastic CP who walked with a crouched gait, had either a PKC or a DFEO, and had pre-operative gait analysis at age 13.5 ± 2.5 (GMFCS I (2) II (10) III (18) IV (1)) was evaluated. Post-operative evaluations were completed 1.83 years (± .97) (Range = 3.6 years) after surgery for the PKC group and 1.15 years (± .12) (Range = .3 years) after surgery for the DFEO group. Thirty-five limbs underwent a PKC and ten underwent a DFEO. Full gait analyses were completed including the collection of kinematic data using an eight-camera Motion Analysis System (Motion Analysis, Santa Rosa, CA).

Results: Significant improvements were seen in passive knee extension, popliteal angle, knee flexion at initial contact, maximum knee extension in stance and Gait Deviation Index (GDI) (*$p < 0.01$ for all*) in both the PKC and DFEO group. Gait velocity and function were not changed in the PKC group. Forward velocity of gait decreased in the DFEO group. The complication rate was 20% in the PKC group and 40% in the DFEO group.

Conclusions: Our study demonstrates that children with CP and crouched gait who develop knee flexion contractures can be treated effectively using SEMLS, specifically a PKC or DFEO with patellar tendon advancement for more severe contraction, yielding similar gait outcomes. With similar gait outcomes from the PKC and DFEO, the less invasive PKC has fewer complications that can be used to treat moderate knee flexion contractures.

Significance: Previous studies have looked at PKC's to improve knee flexion contracture and improve gait for children with CP, but have not used qualitative kinematic functional analysis to determine the effectiveness of the procedure.

Level of significance: Retrospective Type IV

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Effect of GMFCS Level and Neck Shaft Angle on Acetabular Remodeling after a Varus Derotational Osteotomy in Children with Cerebral Palsy

Frank M. Chang, MD*; Julie Ma, BA; Zhaoxing Pan, MB, PhD; Eduardo N. Novais, MD*
Children's Hospital Colorado – University of Colorado Anschutz Medical Campus, Aurora, CO

†**LOE-Therapeutic - Level IV**

Purpose: The optimal surgical intervention for hip dysplasia in cerebral palsy (CP) is controversial. The purpose of this study was to investigate the impact of Gross Motor Function Classification System (GMFCS) level, age at surgery, and corrected femoral neck shaft angle (NSA) on the rate of acetabular remodeling after a femoral varus derotational osteotomy (VDRO) for the treatment of CP hip dysplasia.

Methods: After IRB approval, a cohort of 100 consecutive patients with CP who received an isolated VDRO between 2003 and 2009 was retrospectively reviewed. Fifty-eight male and 31 female patients (178 hips) with a mean age of 4.6 years (range 2.4-10.6 years) at the time of procedure were included. Patients were followed for a minimum of one year (mean 5.0 years; range 1.1-9.5 years). The acetabular depth ratio (ADR) was used to quantify acetabular remodeling. The NSA set at the time of VDRO was measured from intraoperative radiographs. Linear mixed effects and logistic regression models analyzed pre-operative and post-operative changes in ADR and the association of NSA with changes in ADR. Patients of GMFCS levels 1, 2, and 3 were grouped together due to a small sample size for several analyses.

Results: There was a statistically significant increase in ADR postoperatively for the collective CP set (SD=4.5, $P<0.001$) and for each category of GMFCS (1/2/3, 4, 5: $P<0.001$). As GMFCS level increases, there is less increase (improvement) in ADR observed (1/2/3 vs. 5: $P<0.001$, 4 vs. 5: $P<0.05$). In addition, GMFCS levels 4 and 5 demonstrated a decrease in ADR *preoperatively* [slope of ADR relative to age: GMFCS 2=0.75/year (n=10 hips), 3=0.03 (n=26), 4=-0.10 (n=26), 5=-0.07 (n=52)] Age at surgery was found to be negatively associated with ADR increase postoperatively at 4.5 years of follow-up ($P<0.05$), but not at 5.0 years of follow-up ($P=0.07$). The mean NSA at surgery was 111° (range 91°-131°). A negative correlation was observed between NSA and the post-operative change in ADR (slope=-0.08/degree, n=165 hips, $P=0.046$).

Conclusion: Overall, isolated VDRO allowed for acetabular remodeling in CP hip dysplasia. Acetabular remodeling was more likely in patients with GMFCS levels 1, 2, and 3 compared to patients of GMFCS levels 4 or 5. Increase in varization at the time of VDRO improved acetabular remodeling.

Significance: Based on radiographic remodeling of the acetabulum, this study supports early and more aggressive VDRO in patients with CP hip dysplasia.

See pages 17 - 62 for financial disclosure information.

♦ The Outcome of Botulinum Toxin A (Botox®) Injections for Painful Dislocated Hips in Patients with GMFCS IV and V Cerebral Palsy

Henry (Hank) G. Chambers, MD*; Daniel Figueiredo*
Rady Children's Hospital and University of California at San Diego

†LOE-Therapeutic - Level IV

Purpose: To determine the outcome of pain relief in adolescents and adults who had a painful dislocated hip and severe total body involvement cerebral palsy using botulinum toxin A injections in the muscles about the hip.

Methods: Seventeen patients who had severe pain after paralytic hip dislocations had pre and postoperative evaluations of their pain after injecting botulinum toxin A (onabotulinumtoxin A , Botox®) into the quadriceps, hamstrings, adductor longus, gluteus maximus, gluteus medius, and tensor fascia femoris muscles. Each patient was classified by the Gross Motor Classification System (GMFCS) and the Functional Mobility Scale (FMS). The FLACC (Faces, Legs, Activity, Cry and Consolability) pain score was given pre and post injection in each patient.

Results: Nine patients were GMFCS IV and eight were GMFCS V. All of the patients were FMS 1,1,1. The age range was 14 to 57 years old. Each of the patients had previous pain relief therapy including nonsteroidal anti-inflammatory drugs. Six of the patients had also taken gabapentin and three of the patients had taken oral narcotics with little or no relief of their pain. Wheelchair modifications were attempted in all patients. The botulinum toxin A dose varied between 250 and 500 Units divided in 14 mls. The median preinjection FLACC score was 6 and the postinjection FLACC score was 2. The effect lasted from 2.5 months to 5 months. There were no complications from the injections. All but one of the patients returned for subsequent injections and are still receiving periodic injections depending on the severity of their pain (4-6 month intervals).

Conclusions: Botulinum toxin A (onabotulinumtoxin A, Botox) may decrease hip pain by decreasing the spasticity and dystonia of the muscles about the hip. It may also work via known direct nociceptive effects on the muscle.

Significance: Many patients with total body involvement cerebral palsy and dislocated hips have severe pain. The options include treatment with NSAID's , other pain relieving medication and various salvage orthopedic surgeries. Many patients choose not to have these procedures or are not candidates for other reasons. In addition, these surgeries often have significant postoperative pain and other morbidities. The use of botulinum toxin injections in the muscles about the painful hip is another option in the management of pain in these severely involved patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Hip Dysplasia in Charcot-Marie-Tooth Type 1A: Evidence for Acquired Dysplasia

Marie Gdalevitch, MD*; Joshua Burns, MD; Paul J. Gibbons, MD*
Children's Hospital at Westmead, Sydney, AUSTRALIA

†LOE-Prognostic - Level IV

Purpose: Charcot-Marie-Tooth type 1A (CMT1A) is one of the most common inherited peripheral neuropathies. The incidence of radiographic hip dysplasia in CMT1A is reported at 16% and directly correlated with a valgus neck shaft angle (NSA). The pathogenesis of dysplasia is unknown but may be due to weakness of proximal musculature. The purpose of this study is to retrospectively determine the incidence of radiographic hip dysplasia in children with CMT1A and assess the progression of their dysplasia.

Methods: Medical records of 66 children with a confirmed diagnosis of CMT1A between 2000 and 2011 were reviewed. Fifty-five children (110 hips) had at least one antero-posterior preoperative radiograph of the pelvis available. Radiographs were assessed for eight abnormalities: a center edge angle (CEA) less than 20°, a migration percentage greater than 20%, a break in Shenton's line, a wide tear drop, a medio-lateral joint space ratio greater than 2, a NSA greater than 147°, an acetabular index greater than 24° and an upward angulation of the sourcil. Twenty-two children had more than one radiograph available and their initial and final radiographs were assessed for progression to dysplasia. Radiographic dysplasia was defined as a CEA of less than 20.

Results: On initial radiographs 9 children (16%), 13 hips (11%), had dysplasia and each dysplastic hip had four or more radiographic abnormalities. All children with dysplasia had an abnormal CEA with an average of 1.85 (range -35 to 15), an abnormal migration percentage with an average of 44.65 (range 24 to 83) and at least two other radiographic abnormalities. Two children (3 hips) that initially did not meet radiographic criteria for dysplasia developed dysplasia on subsequent radiographs taken within less than 2 years. Two of those hips only had 1 radiographic abnormality when first assessed. At final assessment, 11 children (20%), 16 hips (15%), had dysplasia. Five of the dysplastic hips (31%) had a normal NSA. Average age at diagnosis of dysplasia was 9.7 years (range 7 to 15).

Conclusion: Incidence of hip dysplasia in CMT1A patients is 20% - higher than the previously published rate. Pathogenesis remains unclear since one third of children with dysplasia had a normal NSA. However, children that had four or more radiographic abnormalities all had hip dysplasia.

Significance: CMT1A patients with hip dysplasia should be treated aggressively since the dysplasia is severe and can progress quickly. A screening radiograph is recommended by age 4, then every 2 years.

See pages 17 - 62 for financial disclosure information.

Anterior Tibialis Activity in Recurrent Clubfoot: Considerations for Supination Deformity

Kristan A. Pierz, MD*; Sylvia Ounpuu, MSc; Matthew J. Solomito, MS; Jessica R. Woods, BSBE*
The Center for Motion Analysis, Connecticut Children's Medical Center, Farmington, CT

†**LOE-Therapeutic - Level IV**

Purpose: The purpose of this study was to evaluate stance phase anterior tibialis activity as a possible contributor to supination deformity for persons with recurrent clubfeet.

Methods: A retrospective review of all patients presenting to the Center for Motion Analysis with complaints of gait abnormalities following previously treated clubfeet was conducted. Three-dimensional gait analysis techniques, electromyography (EMG) and foot pressure data was collected on a subset of patients. Forefoot supination in stance was defined as reduced or missing pressure under the first metatarsal head and great toe. Supination was assessed through inspection of pedobarograph data. Electromyographic signals were evaluated during stance phase. EMG signals were analyzed to determine activity during the typically non-active phases of the gait cycle (15-56% of the gait cycle) and stratified into four groups based on activity: normal (< 15%) and three groups of increased muscle activity (15 to 19%, 20-45% and 45-100%).

Results: From a cohort of 76 patients, a subset of 34 (46 sides), aged 7.8±3.6 years, had EMG and motion data. Increased anterior tibialis EMG was noted in 34/46 sides (74%). Of the 33 sides with foot pressure data, a supination deformity was noted in 15 sides (38%). In those patients with supination deformity, 14/15 (93%) had increased EMG activity. However, in those patients without supination deformity, 13/19 (68%) also had increased EMG activity. Internal foot rotation (kinematic measurement of foot relative to distal tibia) during gait was found in 33/46 sides (72%). Of these 33 sides with internal foot rotation, 21 (63%) had increased anterior tibialis EMG in stance.

Conclusion: Increased anterior tibialis activity in mid stance is a common abnormal finding in recurrent clubfeet. Increased anterior tibialis activity in mid stance occurs in patients both with and without supination deformity. Increased internal foot rotation may be due in part to increased EMG activity in mid stance; however, other foot deformities need to be considered.

Significance: The causes of forefoot supination and internal rotation are likely multifactorial. Treatment that fails to address all causes of deformity may result in less than optimal outcomes.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Congenital Tibial Deficiency: A Thirty-seven-Year Experience at One Institution

John G. Birch, MD; ***Rebecca E. Clinton, MD***
Texas Scottish Rite Hospital for Children, Dallas, TX

†LOE-Prognostic - Level IV

Purpose: The purpose of this study was to evaluate all cases of tibial deficiency seen at a single institution from 1975-2012, to classify these cases by the Jones classification if possible, to evaluate for associated anomalies, and to review the surgical treatments provided to these patients.

Methods: Ninety-five patients (30 with bilateral tibial deficiency, resulting in 125 affected extremities) who were treated at our institution between 1975 and 2012 with tibial deficiency had complete records allowing for classification and review of treatment plan. These patients' records and imaging were retrospectively reviewed and limb deformity characterized by the Jones classification where possible. Records were reviewed for any associated anomalies and for surgical treatment performed.

Results: Seventy-three of 125 limbs (58%) were classified as Jones Type 1A, 6 (5 %) as Type 1B, 18 (14 %) as Type 2, and 12 (10%) as Type 4. Two limbs initially classified radiographically as Type 3 deformities subsequently developed a proximal tibia epiphyses and thus did not represent true absent proximal tibia deformities. Fourteen limbs (11%) were characterized by global tibial deficiency but with proximal and distal epiphyses, and as such could not be classified according to the Jones classification. Seventy-five of the 95 patients (79%) had associated anomalies. Other lower extremity anomalies were the most frequent associated anomaly; however, upper extremity, spine and visceral anomalies were also noted. None of 17 patients who had undergone a Brown reconstruction for Type I deficiency had a positive functional outcome.

Conclusions: True Type 3 deformity characterized by an absent proximal tibia was not seen in our patient population. Fourteen (11%) limbs, characterized by global tibia shortening relative to the fibula of variable degree, sometimes associated with great toe duplication and/or anterolateral bow of the affected tibia, could not be classified according to the Jones classification. Although this morphologic variation has been described previously, we propose this group is most easily incorporated as a new group within the Jones classification.

Significance: In our experience with this group of patients, radiographic Type 3 tibial dysplasia developed a proximal epiphysis, and knee disarticulation may not be appropriate treatment for this group. Adding a fifth type of tibial dysplasia characterized by global tibial shortening to the Jones classification provided us a more all-encompassing classification system. Finally, in this patient population, the Brown procedure for Type 1 tibial deficiency universally failed, confirming results noted in other studies.

See pages 17 - 62 for financial disclosure information.

Staged Double-level Limb Lengthening: Novel Technique Resulting in Decreased Healing Index

Matthew D. Abbott, MD; *Alexander M. Cherkashin, MD; Mikhail L. Samchukov, MD; John G. Birch, MD, FRCS(C)*
Texas Scottish Rite Hospital for Children, Dallas, TX

†**LOE-Therapeutic - Level III**

Purpose: Single-level limb lengthening has known problems in terms of quality of bone regenerate, long consolidation time and complications including regenerate fracture and stiffness. Attempts have been made to speed up the lengthening process using simultaneous double-level limb lengthening; however this technique has resulted in increased complications due to overstretching of soft tissues. As a result, we have proposed a technique of staged double-level limb lengthening. The purpose of this study was to compare a novel technique of staged double-level limb lengthening to standard single-level limb lengthening.

Methods: We retrospectively reviewed 10 patients treated since 2006 that completed staged double-level lower extremity lengthening using circular external fixation (CEF). All patients initially underwent a single level limb lengthening of an average of 4 cm, at which point the distraction was stopped and allowed to consolidate for 6 to 8 weeks. This was followed by second osteotomy and lengthening was progressed until the desired total amount was achieved. A control group of 10 patients lengthened using CEF with single-level osteotomy was matched primarily by diagnosis, sex, and leg length discrepancy, and the treatment and control groups were compared in terms healing index (total frame time per centimeter lengthened) and complications.

Results: Among our outcome measures, the healing index was significantly lower in the staged double-level lengthening group compared to the matched control group (1.0 month/cm vs. 1.3 month/cm; p=0.037). There was no difference in complications between the two groups.

Conclusion: In this study, staged double-level limb lengthening using CEF resulted in lower healing index while not increasing the risk of complication when compared to single-level lengthening. On average, staged double-level lengthening resulted in 2.4 months less time in the frame per patient than if the patient underwent single-level limb lengthening.

Significance: Staged double-level limb lengthening offers a comparably safe technique that may result in decreased total frame time in limb lengthening patients.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Obesity and Vitamin D Insufficiency in Idiopathic Genu Valgum

Pooya Hosseinzadeh, MD*; Kevin Murr, MD; Todd A. Milbrandt, MD, MS;*
Vishwas R. Talwalkar, MD; Henry J. Iwinski, MD; Ryan Muchow, MD; Janet L. Walker, MD
Shriners Hospitals for Children and Univ. of Kentucky Dept. of Ortho.Surgery, Lexington KY

†**LOE-Diagnostic - Level IV**

Purpose: Obesity as a cause of lower extremity deformity has been well established. This deformity is usually described as tibia vara, however, at our institution we have noticed a large number of obese children and adolescents with idiopathic genu valgum (IGV). As valgus deformity is seen in other osteopenic conditions (renal failure etc), we began to investigate the Vitamin D (VitD) levels in these children. Our hypothesis is that children with IGV have high rates of obesity and VitD insufficiency which impacts the severity of their disease.

Methods: Retrospective review of existing data was performed on 28 children/46 limbs over age7yrs with IGV, seen between 2010 and 2013. Children with known metabolic or skeletal disease were excluded. Genu valgum was assessed by mechanical axis zone, mechanical tibiofemoral angle (mTF) and mechanical axis deviation (MAD) measured from standing AP radiograph of the lower extremities. Genu valgum was defined as mechanical axis in zone II or III and mTF >3 degrees. 25-OH VitD was measured using immunochemiluminometric assay and considered as sufficient (≥30ng/ml), insufficient (21-29ng/ml) or deficient (≥20ng/ml). BMI % was calculated from height and weight and classified by CDC percentiles.

Results: Mean patient age was 11.8±2.4 years. Males in this study were significantly older than the females (p=0.024). Mean VitD level was 24.3±8.4 ng/ml. VitD deficiency was found in 43% and insufficiency in 32%. Only 25% had normal VitD. VitD was abnormal in 83% of unilateral cases and 60% of bilateral cases. 50% of patients had BMI≥30 and 79% were categorized as obese (≥95th%tile). VitD level was not associated with amount of deformity (MAD, mTF). Patients with BMI≥30 were more likely to have a higher MAD and mTF than those with BMI<30 ($p<0.02$ and 0.05, respectively). There was no correlation with BMI%tile. 68% of patients had surgery. Older patients and those with more severe deformity were likely to be treated operatively ($p<0.05$).

Conclusion: VitD insufficiency and obesity are found in 75% and 79% of patients with idiopathic genu valgum, respectively. The severity of valgus deformity is positively associated with obesity but not associated with VitD level.

Significance: This study may suggest an etiological role for obesity in idiopathic genu valgum. Although we are not able to prove an etiologic role of VitD insufficiency in genu valgum, we believe clinicians should be aware of this association and consider screening this population as it impacts recovery from surgical treatment.

See pages 17 - 62 for financial disclosure information.

POSNA

2014 POSTER PROGRAM

Paper Poster #1 *(page 301)*
Variation in Health Care Cost: Quality, Utilization, and Efficiency Review for ACL Surgery Cost Varience Within A Health Care System
Kevin G. Shea, MD*; Noah Archibald-Seiffer; John C. Jacobs Jr, BS; Lahoma Hooft; Rebecca Humphreys, RN, BSN, ONC*
St. Luke's Regional Medical Center, Boise, ID

Paper Poster #2 *(page 302)*
Hemiepiphysiodesis Implants for Late-Onset Tibia Vara: An Analysis of Cost, Surgical Failure, and Implant Failure
Shawn S. Funk, MD; Megan E. Mignemi, MD; Jonathan G. Schoenecker, MD, PhD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD, MS***
Vanderbilt Children's Hospital, Nashville, TN

Paper Poster #3 *(page 304)*
Angiographic Documentation of Restoration of Blood Flow to an Ischemic Proximal Femoral Epiphyisis by Modified Dunn Procedure for Unstable Slipped Capital Femoral Epiphysis
J. Benjamin Jackson, III, MD; Steven L. Frick, MD; Brian K. Brighton, MD; ***Virginia F. Casey, MD***
Carolinas Medical Center, Charlotte, NC

Paper Poster #4 *(page 306)*
Developmental Morphology in Childhood Patellar Instability: Age-Dependent Differences on Magnetic Resonance Imaging
Katarina A.E. Düppe, BA; Nicole A. Gustavsson; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

Paper Poster #5 *(page 308)*
Anatomic and Clinical Predictors of Inability to Obtain Intra-Operative Neuromonitoring During Cerebral Palsy Scoliosis Correction
Andrew Mo, BS*; Anthony O. Asemota, MBBS, MPH; Arun Venkatesan, MD; Eva K. Ritzl, MD; Dolores B. Njoku, MD; Emmanuel N. Menga, MD; Paul D. Sponseller, MD, MBA*
Johns Hopkins School of Medicine, Baltimore, MD

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Paper Poster #6 *(page 309)*
The Importance of Starting Antiresorptive therapies in Young Children with Osteogenesis Imperfecta: A Study in the *oim/oim* Mouse
Josephine Marino, MPH; Nancy Pleshko, PhD; Erin M. Carter, MS; Stephen Doty, PhD; Karl J Jepsen, PhD; Adele L. Boskey, PhD; ***Cathleen L. Raggio, MD***
Hospital for Special Surgery, New York, NY

Paper Poster #7 *(page 311)*
Temperature Change When Drilling Near the Distal Femoral Physis in a Skeletally Immature Ovine Model
Allison Tenfelde, MD*; Amanda Esquivel, PhD; Allison M. Andre, BS; Stephen E. Lemos, MD, PhD*
Detroit Medical Center Sports Medicine, Detroit, MI

Paper Poster #8 *(page 313)*
Hemoglobin to Hematocrit Ratio: The Strongest Predictor of Femoral Head Osteonecrosis in Children with Sickle Cell Disease
Douglas M. Worrall, BS; ***Anish G. Potty, MD****; Lawrence Wells, MD; Kimberly Smith-Whitley, MD*
The Children's Hospital of Philadelphia, Philadelphia, PA

Paper Poster #9 *(page 314)*
Musculoskeletal Medicine: An Assessment of Knowledge of Pediatric Residents and Faculty
Emily Stuart, MD; Kristina Wilson, MD, MPH; ***M. Wade Shrader, MD****; Lee S. Segal, MD*
Phoenix Children's Hospital, Phoenix, AZ

Paper Poster #10 *(page 315)*
Validation of A Distal Radius Fracture Closed Reduction and Casting Model
M. Lucas Murnaghan, MD, Med, FRCSC*; Ian P. Mayne, MD; Ryan Brydges, PhD*
The Hospital for Sick Children, Toronto, ON, CANADA

Paper Poster #11 *(page 316)*
Utility and Indications for Use of Ponte Osteotomies in the Correction of Adolescent Idiopathic Scoliosis
Matthew E. Oetgen, MD*; Ian S. Patten, BS, MPH; Laurel C. Blakemore, MD*
Children's National Medical Center, Washington, DC

See pages 17 - 62 for financial disclosure information.

Paper Poster #12 *(page 318)*
Do We Need to Remove the Biopsy Tract in Patients Undergoing Surgery Following Neo-Adjuvant Chemotherapy?
***Venkatesan Sampath Kumar**; Rishi Ram Poudel; Shah Alam Khan, MD; Asit Ranjan Mridha, MD; Sameer Bakhshi, MD; Shishir Rastogi, MD*
All India Institute of Medical Sciences, New Dehli, INDIA

Paper Poster #13 *(page 319)*
Vitamin D Insufficiency and Fracture Risk in Children
Rachel E. Mednick, MD; Daniel M. Dean, BS; ***Joseph A. Janicki, MD***
Anne & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

Paper Poster #14 *(page 320)*
Anterior Dislocation of the Shoulder in Skeletally Immature Patients: Comparison Between Non-Operative Treatment versus Open Latarjet's Procedure
Federico Canavese, MD, PhD
Department of Pediatric Surgery, CHU Estaing, Clermont Ferrand, FRANCE

Paper Poster #15 *(page 322)*
C Sign: Talocalcaneal Coalition or Flatfoot Deformity?
Luis Moraleda, MD, PhD; George D. Gantsoudes, MD; ***Scott J. Mubarak, MD***
Rady Children's Hospital, San Diego, San Diego, California

Paper Poster #16 *(page 323)*
Concomitant Modified Kidner Procedure and Calcaneo-Cuboid-Cuneiform Osteotomies for Severe Flatfoot Associated with Symptomatic Accessory Navicular in Children and Adolescents
Jung-Ryul Kim, MD, PhD
Chonbuk National University, Medical School, Jeonju, REPUBLIC OF KOREA

Paper Poster #17 *(page 324)*
Bone, Muscle and Adipose Tissue Volume in Children and Adolescents with Myelomeningocele
***Deirdre D. Ryan, MD**; Daniel J. Lorenzana, BA; Nicole M. Mueske, MS; Tishya A.L. Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA

Paper Poster #18 *(page 325)*
The Evolution of Lower Extremity Deformity Management in MPS IVA, Morquio-Brailsford Syndrome
***Tom Southorn, MBBS, BSc, FRCS**; George Cooper; Deborah Eastwood, FRCS; Christopher Edward Bache, FRCS (Ortho)*
Great Ormond Street Hospital for Children, London, UNITED KINGDOM

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Paper Poster #19 *(page 326)*
Prevalence of Autism Spectrum Disorder in Children That Present with Toe Walking
Glen O. Baird, MD*; Mark L. McMulkin, PhD; Andi B. Gordon, MPT; Bryan J. Tompkins, MD; Paul M. Caskey, MD*
Shriners Hospitals for Children, Spokane, WA

Paper Poster #20 *(page 327)*
Inking of Paediatric Orthopaedic Oncologic Surgical Resections and the Potential for False Positive Margins
Christine R. McClelland, MSc; Natalie Fioratos; Dr. Bob Fraser; ***Karl J. Logan, MbChB, FRCS***
IWK Health Centre, Halifax, NS, CANADA

See pages 17 - 62 for financial disclosure information.

Variation in Health Care Cost: Quality, Utilization, and Efficiency Review for ACL Surgery Cost Varience Within A Health Care System

Kevin G. Shea, MD*; Noah Archibald-Seiffer; John C. Jacobs Jr, BS; Lahoma Hooft; Rebecca Humphreys, RN, BSN, ONC*
St. Luke's Regional Medical Center, Boise, ID

Purpose: Variation in health care costs is an area of focus amongst national policy experts. While cost variation between facilities is an important area of investigation, cost variation within the same institution is recognized as an opportunity for rapid process change to provide better value to patients. The purpose of this study was to perform a Quality, Utilization, Efficiency (QUE) review for ACL surgery.

Methods: This project was reviewed by an IRB and approved for performance improvement. Using models developed by Intermountain Health Care, a QUE review was done for ACL procedures within a 22 surgeon, 7 hospital system. Cost data from January through June 2013 was reviewed. Four consistent cost categories were identified, and analyzed for cost variation among surgeons: tibial fixation, femoral fixation, graft choice, and tools/disposable instruments.

Results: The range in costs for these 4 categories to perform an ACL reconstruction ranged from $392.80 to $7,838.73, a difference of $7,445.93 and a mean of $2,128.93. Tibial fixation costs ranged from $42.43 to $580.00 (average $171.78). Femoral fixation ranged from $95.00 to $865.00 (average $287.33). The graft cost ranged from $1,275.00 to $2,545.75 (average $1,976.43). Suture prices for each individual suture, varied from $1.19 to $130.82, a range of $129.63 and mean $28.00. Tools and disposable supplies ranged from $184.00 to $896.00 (average of $346.00).

Conclusions: The cost difference in ACL reconstructive surgeries showed a twenty-fold increase from minimum to maximum for different cost categories. In some cases, higher costs may be necessary for more complex and revision cases. As health systems and physicians collaborate to improve health care quality and value for patients, accurate information on cost will be important for providers.

Significance: Rational variation in health care costs, which arise from patient-centered care, is appropriate. Irrational variations in care and procedural costs are not justified, and these variations offer opportunities to provide better care and value to patients. Providing high quality and timely information about costs is critical for engaging physicians in improving quality.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Hemiepiphysiodesis Implants for Late-Onset Tibia Vara: An Analysis of Cost, Surgical Failure, and Implant Failure

Shawn S. Funk, MD; Megan E. Mignemi, MD; Jonathan G. Schoenecker, MD, PhD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD, MS***
Vanderbilt Children's Hospital, Nashville, TN

Purpose: Hemiepiphysiodesis for late-onset tibia vara has evolved from staples to physeal plates. This study analyzes implant options and patient characteristics that may predict surgical failure.

Methods: Review of late-onset tibia vara treated with hemiepiphysiodesis from 1998-2012. Mechanical axis deviation (MAD) and medial proximal tibial angle (MPTA) were measured. Surgical failure was defined as residual deformity requiring osteotomy, revision surgery, or MAD > 40 mm at final follow-up. Implant failure was noted. Costs include implants and disposables. Staple constructs: three staples. Plate constructs: plate, screws, guide wires, and drill bits.

Results: 25 patients with 38 temporary lateral proximal tibia hemiepiphysiodeses met the inclusion criteria. The mean BMI was 39.1 kg/m^2 with mean follow-up of 3 years and minimum one year follow-up. Surgical failure occurred in 57.9% of procedures. Greater BMI ($p=0.05$) and more severe deformity (MAD & MPTA, $p<0.01$) predicted surgical failure whereas younger age predicted implant failure ($p<0.01$) There were no differences in the rates of surgical or implant failure between staple and plate systems. Hospital costs of plate constructs ($781 – $1,244) were 1.5 to 2.5 times greater than the staple constructs ($498). The mean fully allocated hospital costs were $5,612 for hemiepiphysiodesis and $34,072 for osteotomy.

Conclusions: Greater BMI, more severe deformity, and younger age were predictive of surgical or implant failure. There was no difference in success rates between implant types. If hemiepiphysiodesis was only performed for patients with BMI < 35 and MAD > 60 mm, the surgical failure rate would diminish to 22%; the failure rate outside these parameters was 83%.

Significance: With health care reform, further research will be required to validate implant choices and patient selection. The rate of surgical failure is high; consideration should be given to reserving hemiepiphysiodesis for patients with lower BMI and less severe deformity.

See pages 17 - 62 for financial disclosure information.

	Surgical Outcome			Implant Results		
	Success (n=16)	**Failure (n=22)**	**p-value**	**Intact (n=23)**	**Failed (n=15)**	**p-value**
Age (years)	12.0	11.1	0.19	12.6	9.8	<0.01*
BMI (kg/m^2)	34.3	42.4	0.05*	36.6	43.4	0.19
MAD (mm)	48.5	79.8	<0.01*	67.8	66.4	0.98
MPTA (deg)	81.7	74.1	<0.01*	78.2	75.9	0.30
Staples	4 (50%)	4 (50%)	0.61	6 (75%)	2 (25%)	0.35
Plates	12 (40%)	18 (60%)		17 (43%)	13 (57%)	

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

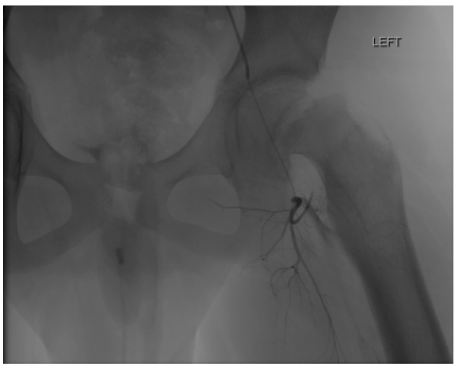
Angiographic Documentation of Restoration of Blood Flow to an Ischemic Proximal Femoral Epiphyisis by Modified Dunn Procedure for Unstable Slipped Capital Femoral Epiphysis

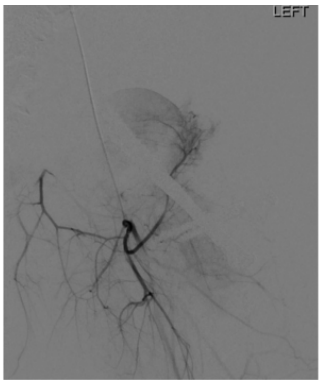
J. Benjamin Jackson, III, MD; Steven L. Frick, MD; Brian K. Brighton, MD;
Virginia F. Casey, MD
Carolinas Medical Center, Charlotte, NC

Purpose: To document by superselective angiography the preoperative and postoperative blood supply to the proximal femoral epiphysis following an unstable slipped capital femoral epiphysis (SCFE). A specific aim was to determine if blood flow could be restored by a surgical procedure to an ischemic epiphysis. A secondary aim was to determine the efficacy of a widely used blood flow monitor to assess blood flow within the femoral head intraoperatively.

Methods: This was an IRB approved prospective cohort pilot study. Ten patients with an unstable SCFE underwent superselective catheterization and angiogram of the medial circumflex femoral artery preoperatively, and then underwent operative fixation with an open reduction via a modified Dunn approach (9 patients) or closed reduction and pinning (1). For those treated with open reduction, femoral head blood flow was evaluated with an intracranial pressure (ICP) monitor. Angiography was repeated immediately after surgery in all patients. Patients were followed radiographically to assess for osteonecrosis (ON).

Results: Follow-up ranged from blank to blank months and averaged 17 months. One patient developed ON. This patient had no arterial flow to the femoral head pre or postoperatively on angiogram. Complete tearing of the periosteum was noted and no waveform was present on the ICP monitor intraoperatively. Four patients did not have flow to the femoral head on the preoperative angiogram. Blood flow was restored postoperatively on angiogram in three of the four. However, all four patients showed a pulsatile waveform on the ICP monitor after reduction of the SCFE. In one patient, there was no waveform on the ICP monitor after the initial reduction. After removal of more callous, the waveform returned. The presence or absence of a waveform after reduction was predictive of development of ON in all patients.





See pages 17 - 62 for financial disclosure information.

Conclusions: This study showed that some patients with unstable SCFE have reduced afterblood supply to the femoral head secondary to the SCFE. It also documented restoration of blood flow to the femoral head in three patients by angiogram and four by ICP monitor. The ICP monitor correlated 100% with the presence or absence of development of ON.

Significance: Pre and postoperative angiograms demonstrate maintenance of the blood flow to the femoral head after open reduction via modified Dunn approach. Perhaps more importantly, the modified Dunn procedure can restore perfusion to an ischemic epiphysis. ICP monitoring is an excellent intraoperative tool for real time assessment of blood flow to the femoral head.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Developmental Morphology in Childhood Patellar Instability: Age-Dependent Differences on Magnetic Resonance Imaging

Katarina A.E. Düppe, BA; Nicole A. Gustavsson; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

Purpose: Magnetic resonance imaging (MRI) has been used to define pathologic morphology of patellar instability primarily in adults, but few studies have evaluated skeletally immature patients. The purpose of this study was to delineate differences in morphological parameters between normal children and children with patellar instability.

Methods: A retrospective review of knee MRIs, ages 8 to 18 years, using a "normal" cohort without evidence of patella instability (NG) and a cohort with unstable patella (UG). 34 measurements were made on patellar characteristics, trochlear morphology, limb alignment and the medial patellofemoral ligament (MPFL). Spearman's rho correlations were calculated between age and MRI measures.

Results: There were 132 NG and 66 UG children included. A new measure, MPFL insertion site to the physis distance, was also significantly different (NG -1.8±3.5mm vs UG 0±3.4mm). More importantly, some measurements demonstrated both a difference between the two groups and an age correlation: osseous sulcus angle (groups NG 133.4°±12.4° vs UG 145.2°±11.2°, age correlation p=0.01) and cartilaginous sulcus angle (NG 138.2°±9.5° vs UG 152.5°±11.7°, age correlation p=0.03).

Measurement	NG mean ± SD	UG mean ± SD	P value
MPFL insertion site (above +/below -)	-1.77 ± 3.54	-0.02 ± 3.42	0.006
Insall-Salvati Ratio	1.03 ± 0.18	1.22 ± 0.22	<0.001
Caton-Deschamps Ratio	0.9 ± 0.14	1.12 ± 0.21	<0.001
Angle of Fulkerson (lateral +/medial -)	21.07 ± 6.37	10.14 ± 11.86	<0.001
Patellar Inclination Angle (lateral+/ medial-)	-3.55 ± 6.44	-12.88 ± 10.00	<0.001
Sulcus angle	138.19 ± 9.53	152.47 ± 11.69	<0.001
Medial portion	75.97 ± 6.89	81.55 ± 9.35	0.002
Lateral portion	62.22 ± 6.15	70.62 ± 6.34	<0.001
Sulcus depth	4.7 ± 1.3	2.54 ± 1.33	<0.001
ETIT	1.42 ± 0.3	2 ± 0.81	<0.001
TT-TG	10.68 ± 4.01	18.01 ± 5.97	<0.001
Trochlear groove	5.04 ± 1.56	4.2 ± 1.14	0.001
Lateral condyle	4.12 ± 1.64	2.9 ± 1.07	<0.001
Medial angle % sulcus angle	0.55 ± 0.33	0.54 ± 0.04	0.005
Lateral angle % sulcus angle	0.45 ± 0.33	0.46 ± 0.04	0.005

See pages 17 - 62 for financial disclosure information.

Conclusion: The majority of parameters considered diagnostically relevant in adults, also appear to be statistically relevant for children. Yet, the pathologic cut-off values that have been previously described in adults cannot be fully utilized for children as a whole because of the correlation with skeletal maturity. Several end-stage adult parameters are significant as good predictors of patellar instability when seen on a child's MRI; but, some parameters, such as sulcus angle, are dependent on age of the child. Moreover, there is a significant change in the location of the MPFL attachment on the femur as it relates to the physis with age, as well as stability.

Significance: This study supplies the comparison measurments between normal parameters and abnormal parameters of patella instabilty for knee morphology in the growing child, demonstrating that many adult parameters are valuable in children; but, highlighting that some parameters correlate with age and require an understanding of normal development with skeletal maturity to fully function in predicting risk for patella instability.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Anatomic and Clinical Predictors of Inability to Obtain Intra-Operative Neuromonitoring During Cerebral Palsy Scoliosis Correction

Andrew Mo, BS*; Anthony O. Asemota, MBBS, MPH; Arun Venkatesan, MD; Eva K. Ritzl, MD; Dolores B. Njoku, MD; Emmanuel N. Menga, MD; Paul D. Sponseller, MD, MBA*
Johns Hopkins School of Medicine, Baltimore, MD

Purpose: To understand factors limiting the utilizable transcranial electric motor evoked potentials (TcMEP) and posterior tibial nerve somatosensory-evoked potentials (SSEP) during the surgical correction of cerebral palsy (CP) related scoliosis.

Methods: Patients with cerebral palsy and surgically corrected neuromuscular scoliosis at a single institution between 2002 and 2013 were reviewed. 150 patients with intraoperative neuromonitoring (IONM) data were identified. IONM data was categorized into 'attainable' if consistent, useful TcMEP could be obtained, 'unattainable' if no utilizable TcMEP or SSEP could be obtained, and 'limited' if only SSEP could be obtained. We studied existing neuroimaging and past medical information and analyzed against the obtainability of neuromonitoring signals using univariate analysis. Odds ratios were calculated with appropriate significance levels set at $p<0.05$.

Results: From our study, 80 patients had 'attainable' TcMEP signals, 47 had completely 'unattainable' signals, and 23 patients had 'limited' signals. Neuroimaging, available for 99 patients, revealed the following findings: periventricular leukomalacia (24.2%), abnormalities demonstrable in the corpus callosum (27.3%), generalized cerebral atrophy (31.3%), encephalomalacia (29.3%), hydrocephalus (46.5%), lissencephaly (5.1%), and Dandy-Walker malformation (2.0%). Univariate analysis of neuroimaging findings revealed odds ratios for not obtaining 'attainable' IONM signals to presence of encephalomalacia (OR=2.96, p=0.020) and findings of hydrocephalus (OR=3.70, p=0.002) (Figure 1). Univariate analysis of clinical findings in the full patient population revealed the following odds ratios for not attaining 'attainable' IONM signals: profound mental retardation (OR 3.70, p=0.039), history of seizures (OR=2.62, p=0.036), those with impaired communication status (OR=3.79, p=0.020).

Conclusion: The obtainability of intraoperative TcMEP and SSEP is sub-optimal in one-third of patients with CP. It is negatively correlated to profound mental retardation, a history of seizures, impaired communication status, a finding of hydrocephalus, and presence of encephalomalacia.

Significance: IONM is an indispensable technique in reducing post-surgical neurologic deficits in the surgical treatment of scoliosis. Patients who have findings of hydrocephalus and encephalomalacia, or who have clinical findings of profound mental retardation, or a history of seizures, are less likely to have obtainable TcMEP or SSEP.

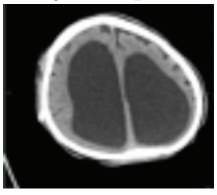


Figure 1. Hydrocephalus in patient with no 'attainable' signals (no TcMEP).

See pages 17 - 62 for financial disclosure information.

The Importance of Starting Antiresorptive therapies in Young Children with Osteogenesis Imperfecta: A Study in the *oim/oim* Mouse

Josephine Marino, MPH; Nancy Pleshko, PhD; Erin M. Carter, MS; Stephen Doty, PhD; Karl J Jepsen, PhD; Adele L. Boskey, PhD; ***Cathleen L. Raggio, MD***
Hospital for Special Surgery, New York, NY

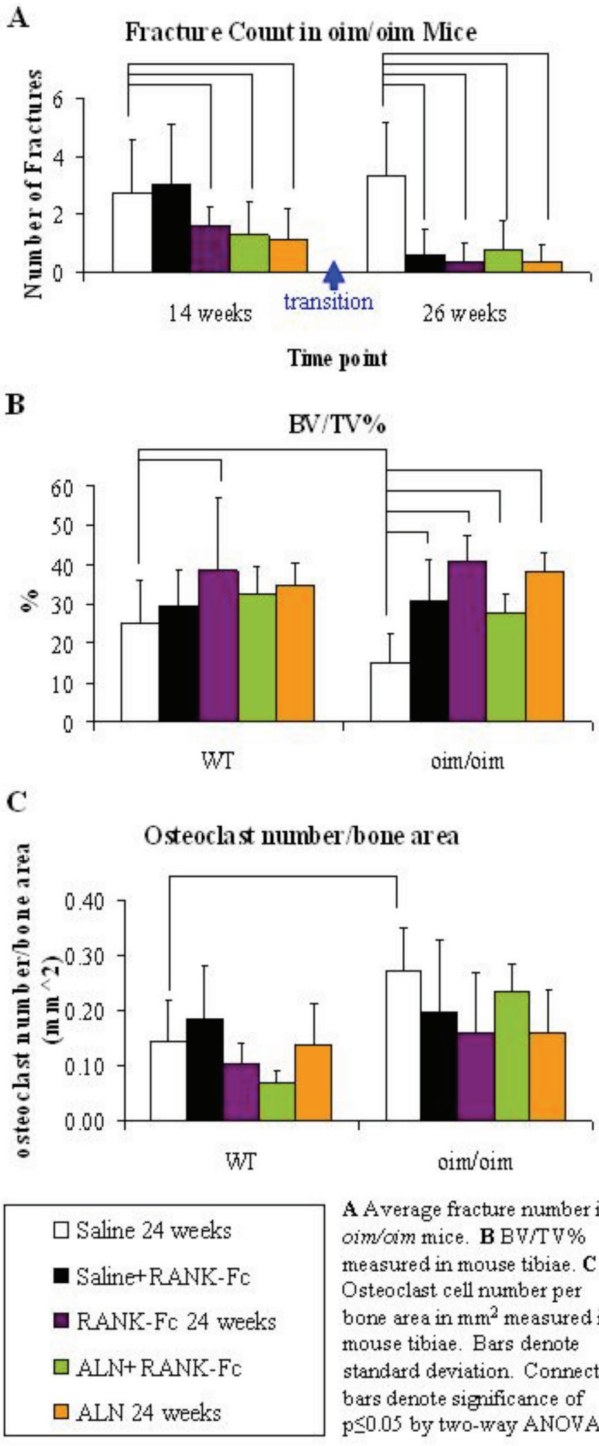
Purpose: Osteogenesis Imperfecta (OI) is a type I collagen disorder that manifests as increased bone fragility with subsequent fractures. The *oim/oim* mouse models a moderate-to-severe OI phenotype (Type 3) caused by a naturally occurring mutation resulting in an α1-homotrimer. We used *oim/oim* to ask if (1) RANK-Fc is as efficacious as alendronate (ALN) in reducing fracture number? (2) RANK-Fc is safe to administer to children? (3) post-adolescence RANK-Fc treatment is advantageous following no or ALN treatment from infancy through adolescence?

Methods: Under IACUC approval, wild type (WT) or *oim/oim* mice (both sexes) were treated from 2-26 weeks (sacrifice). There were 20 mice/treatment group (n=200): (1) saline 24 weeks (baseline) (2) ALN (0.21 mg/kg/dose weekly) 24 weeks (3)RANK-Fc (1.5 mg/kg/dose biweekly) 24 weeks (4) saline 12 weeks transitioned to RANK-Fc 12 weeks, and (5) ALN for 12 weeks transitioned to RANK-Fc for 12 weeks. Fracture counts (blinded): radiographs (AP/ML) at treatment transition (14 weeks) and sacrifice (26 weeks). μCT: femora and humeri (n=8-10/group). Histomorphometry: tibiae (n=8-12/group). Significance was set at $p>0.05$ by two-way ANOVA with post-hoc tests.

Results: At 14 weeks, all treatments reduced *oim/oim* fracture number. From 14 weeks to sacrifice, saline oim/oim averaged 0.9 new fractures, and Saline+RANK-Fc averaged 0.3 new fractures, whereas RANK-Fc, ALN+RANK-Fc, and ALN had zero fractures. Delayed fracture remodeling occurred in all groups. At baseline, compared to WT, *oim/oim* had higher osteoclast number/bone area mm^2, and lower BV/TV%. RANK-Fc increased BV/TV in WT. *Oim/oim* femora had reduced cortical BVF and cortical thickness compared to WT. *Oim/oim* RANK-Fc, ALN+RANK-Fc, and ALN increased cortical BVF compared to baseline. WT trabecular parameter changes mirrored those in the *oim/oim* femur. RANK-Fc, ALN+RANK-Fc, and ALN increased trabecular number and BVF and decreased trabecular separation, without changing trabecular thickness. In *oim/oim*, saline+RANK-Fc reduced trabecular separation compared to baseline.

Conclusion: Early treatment with ALN or RANK-Fc is more effective at reducing fractures than saline+RANK-Fc. Discrepancies between histological and μCT parameters are attributed to differences in resolution. Based on μCT, early treatment with ALN attenuates RANK-Fc efficacy in adult mice: the *oim/oim* cortical bone is responsive only if exposed to early antiresorptive treatment. ALN, RANK-Fc, and ALN+RANK-Fc comparably reduced fractures and increased BVF in *oim/oim*. As expected, when antiresorptive treatment starts after adolescence there is lesser effect although fracture risk is reduced and bone parameters improve. The data suggests that early intervention with antiresorptive agents yields significant reductions in fracture incidence and sustained increased BVF.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.



A Average fracture number in *oim/oim* mice. **B** BV/TV% measured in mouse tibiae. **C** Osteoclast cell number per bone area in mm^2 measured in mouse tibiae. Bars denote standard deviation. Connected bars denote significance of $p \leq 0.05$ by two-way ANOVA.

See pages 17 - 62 for financial disclosure information.

Temperature Change When Drilling Near the Distal Femoral Physis in a Skeletally Immature Ovine Model

***Allison Tenfelde, MD**; Amanda Esquivel, PhD; Allison M. Andre, BS;*
Stephen E. Lemos, MD, PhD
Detroit Medical Center Sports Medicine, Detroit, MI

Purpose: The purpose of this study was to determine whether drilling at or near the physis caused a temperature increase that could trigger chondrolysis.

Methods: Ten skeletally immature lamb femoral condyle specimens were randomly placed in each of six groups.
1) 8 mm acorn tipped; 3 mm distance (n=10)
2) 8 mm acorn tipped; 0.5 mm distance (n=10)
3) 10 mm acorn tipped; 3 mm distance (n=10)
4) 10 mm acorn tipped; 0.5 mm distance (n=10)
5) 8 mm FlipCutter; 0.5 mm distance (n=10)
6) 10 mm FlipCutter 0.5 mm distance (n=10)
A temperature probe was placed in the physis. The condyles were drilled with 8 mm or 10 mm acorn tipped reamer or FlipCutter at 0.5 and 3mm away from the physis. Each condyle was secured in a saline bath at 37° C $\pm$0.1°. Temperatures in the physis were monitored.

Results: The temperature increased to 42.6° C using the 8 mm FlipCutter in one specimen (Table 1). The temperature did not increase above 39.5° C in any specimen at any time for the acorn tipped reamers. There was a significant difference among the four groups at 0.5 mm from the physis (p=0.001). Pairwise Mann-Whitney post-hoc tests were performed to evaluate the differences among the groups. The 8 mm FlipCutter had a significantly higher maximum temperature (39.8° +/- 1.4°) compared with the 10 mm FlipCutter (38.0° +/- 0.6°, p=0.001), 8 mm acorn tipped reamer (38.1° +/-0.9°, p=0.007) and 10 mm acorn tipped reamer (37.5° +/- 0.3°, p<0.001). The maximum temperature was significantly higher for the 8 mm acorn reamer at 0.5 mm from the physis compared with 3 mm (37.3° +/- 0.3°, p=0.02). There was no significant difference in maximum temperature for the 10 mm acorn reamer when drilling 0.5 mm from the physis compared with 3 mm (p=0.301) (Table 1).

Conclusion: To our knowledge, this is the first study evaluating the temperature at the physis when drilling in its proximity. Our findings suggest the risk of thermal induced injury to the physis is very low with an all epiphyseal drilling technique using an acorn tipped reamer even if the drilling occurs very close to the physis. The FlipCutter device may have a slightly higher risk for thermal injury, however, only when drilling 0.5 mm from the physis.

Significance: Drilling near the femoral physis when performing an all epiphyseal ACL reconstruction should not cause thermal injury to this area when using an acorn tipped reamer. There may be a slight risk when using other devices.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

References:

1. **Lawrence, J. T.; Bowers, A. L.; Belding, J.; Cody, S. R.; and Ganley, T. J.:** All-epiphyseal anterior cruciate ligament reconstruction in skeletally immature patients. *Clin Orthop Relat Res,* 468(7): 1971-7, 2010.

2. **Edwards, R. B., 3rd; Lu, Y.; and Markel, M. D.:** The basic science of thermally assisted chondroplasty. *Clin Sports Med,* 21(4): 619-47, viii, 2002.

3. **Benton, H. P.; Cheng, T. C.; and MacDonald, M. H.:** Use of adverse conditions to stimulate a cellular stress response by equine articular chondrocytes. *Am J Vet Res,* 57(6): 860-5, 1996.

4. **Zuger, B. J.; Ott, B.; Mainil-Varlet, P.; Schaffner, T.; Clemence, J. F.; Weber, H. P.; and Frenz, M.:** Laser solder welding of articular cartilage: tensile strength and chondrocyte viability. *Lasers Surg Med,* 28(5): 427-34, 2001

See pages 17 - 62 for financial disclosure information.

Hemoglobin to Hematocrit Ratio: The Strongest Predictor of Femoral Head Osteonecrosis in Children with Sickle Cell Disease

*Douglas M. Worrall, BS; **Anish G. Potty, MD**; Lawrence Wells, MD; Kimberly Smith-Whitley, MD*
The Children's Hospital of Philadelphia, Philadelphia, PA

Purpose: Femoral head osteonecrosis (ON) secondary to sickle cell disease (SCD) can progress to femoral head collapse, and require total hip arthroplasty (THA). However, this treatment has a limited durability and patients with SCD have a higher rate of complication, necessitating multiple reoperations and revisions. Identifying risk factors linked to osteonecrosis in SCD, can facilitate earlier, more effective diagnosis and intervention.

Methods: Fifty-nine children treated at our institution between 2001 and April 2012 with SCD and ON, as diagnosed by magnetic resonance imaging (MRI) or radiographic imaging (XR), were compared to age- and sickle cell type-matched (SS, SC, $S\beta^0$, $S\beta^+$) controls with no evidence of osteonecrosis. Two sided t-tests assuming unequal variances and threshold values were used to determine statistically significant differences in clinical variables and calculate odds ratios, respectively.

Results: Systolic blood pressure ($p=1.2x10^{-4}$, OR=3.68), diastolic blood pressure (p=0.0084, OR=1.41), weight in the SCD-SS population (p=0.04, OR = 1.85), and hemoglobin (Hb) in the SCD-SS population (p=0.036, OR=2.56) were elevated in cases. Curiously, dividing the Hb by the hematocrit (hct) to serve as a clinical proxy for the concentration of Hb within the red blood cell (RBC) and account for recent transfusions, produced an excellent predictor of ON ($p=2.06x10^{-6}$, OR=5.17), that was especially pronounced in the SCD-SS subpopulation ($p=2.28x10^{-7}$, OR = 8.65). Among active children at our institution with SCD, the overall prevalence of ON was 9% (59/658) and the great risk subtype was SBeta0 with an ON prevalence of 11.1%. There was no observed correlation between AVN and height, BMI, prothrombin INR, cholesterol, MCV, hematocrit, or glucocorticoid use.

Conclusion: This data supports a novel clinical marker: the hemoglobin to hematocrit ratio, as the strongest predictor of ON in children with SCD. High-risk children should receive hip MRIs to diagnose early ON and facilitate earlier, more effective intervention than THA.

Significance: This study contributes immensely to the decision making process in orthopaedic surgical intervention. The predictors could be used to time the surgical intervention and cause a change in the natural history of the disease. The findings from this study will also help to understand the disease progression and be an useful marker to assess prognosis.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Musculoskeletal Medicine: An Assessment of Knowledge of Pediatric Residents and Faculty

Emily Stuart, MD; Kristina Wilson, MD, MPH; ***M. Wade Shrader, MD****; Lee S. Segal, MD*
Phoenix Children's Hospital, Phoenix, AZ

Purpose: There is a growing body of literature that has demonstrated the inadequacy of musculoskeletal (MSK) education during medical school, and conversely the high proportion of patients seen in practice who present with MSK related problems. The goal of this study was to evaluate the adequacy of MSK training and education in a pediatric residency training program located at a children's hospital.

Methods: A twenty-item musculoskeletal survey was developed. The survey was sent anonymously to 93 pediatric residents and 180 faculty (pediatric hospitalists, outpatient pediatricians, and subspecialists) at a children's hospital. The number of correct responses was evaluated and compared for each level of residency training and for faculty. In addition, respondents were asked to rate their confidence in the examination, diagnosis, and treatment of patients with MSK, respiratory, gastrointestinal (GI), and neurological complaints.

Results: 60 residents (63.8%) and 45 faculty (21.7%) completed the survey. The mean percentage of correct scores on the MSK survey by resident year of training (PGY1, 2, 3) were 58.1%, 63.8%, and 72.2% respectively. The increase in knowledge scores over the three years of residency was statistically significant ($p < 0.001$). The hospitalists and outpatient faculty mean percentage of correct scores compared to subspecialists were 69.8% and 62.1% respectively, which was not statistically different ($p = 0.18$). No statistical difference was found between the overall MSK knowledge scores between the residents and faculty ($p = 0.46$). For the entire group, the residents were less confident in MSK examinations than respiratory, GI, and neurologic exams ($p<0.01$). PGY 2/3 residents were less confident in both the diagnosis and treatment of MSK complaints compared to respiratory, GI, or neurologic complaints ($P< 0.01$).

Conclusion: The lack of confidence of both residents and faculty in the examination, diagnosis, and treatment of MSK complaints at a large pediatric hospital indicates that there is a need for increased education in MSK topics in pediatric residency training. The pediatric faculty had similar scores on the knowledge-based exam compared to residents, which suggests the need for continued MSK education among pediatric faculty. The next step of our research is to distribute the MSK survey to community pediatricians.

Significance: The lack of confidence of both residents and faculty in the examination, diagnosis, and treatment of MSK complaints at a large pediatric hospital indicates that there is a need for increased education in MSK topics in pediatric residency training.

See pages 17 - 62 for financial disclosure information.

Validation of A Distal Radius Fracture Closed Reduction and Casting Model

M. Lucas Murnaghan, MD, Med, FRCSC*; Ian P. Mayne, MD; Ryan Brydges, PhD*
The Hospital for Sick Children, Toronto, ON, CANADA

Purpose: Simulation-based education has become a field of rapidly progressing research and integration into orthopaedic curricula due to a concern that residents are not obtaining technical competency in specific orthopaedic procedures. The objectives of our study were to develop a distal radius fracture closed reduction (CR) and casting model and to examine its construct validity using validated objective performance scales and radiographic criteria to assess orthopaedic residents.

Methods: A distal radius fracture model with radiopaque markers was developed using a modified Sawbones® forearm model. Ten junior and ten senior orthopaedic residents were videotaped performing a CR and casting on the model. After each procedure, standard radiographs were performed. Two blinded orthopaedic fellows then rated each resident using a previously validated OSATS (Objective Structured Assessment of Technical Skills) and GRS (Global Rating Scale) scoring tools specific to this procedure and the radiographic objective measures of dorsal angulation and Three-Point Index. Construct validity was assessed using an independent samples t-test to examine the difference between junior and senior residents. Pearson correlation statistics were used to estimate the relationship between performance scales and radiographic criteria. Inter-rater reliability for each assessment tool was calculated using the intraclass coefficient.

Results: The senior residents had significantly higher OSATS and GRS scores ($p<0.002$). The groups did not differ significantly with respect to radiographic angulation ($p=0.858$) and three-point index ($p=0.426$). However, all residents were able to restore anatomical alignment with a mean volar angulation of 9.1° (Range -2.0 - 19.0°). In addition, the mean three-point index of all residents was low (0.8, Range 0.3 – 1.4). All senior residents and nine out of ten junior residents were able to adequately reduce the distal radius fracture, which was confirmed radiographically. There was a strong correlation between OSATS and GRS scores ($r>0.87$, $p<0.001$) within the residents. The inter-rater reliability was high for the OSATS (0.88), GRS (0.87), X-Rays (0.88), and 3-point index (0.84).

Conclusion: We have successfully developed a novel distal radius fracture CR and casting model with high construct validity and inter-rater reliability using two validated scoring tools. The radiographic aspect of the study allowed for confirmation of fracture reduction and that the residents were able to successfully restore anatomical alignment and had low three-point index scores signifying a well-molded cast.

Significance: We developed a novel distal radius fracture CR and casting model and validated it with orthopaedic residents using objective performance scales and radiographs.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Utility and Indications for Use of Ponte Osteotomies in the Correction of Adolescent Idiopathic Scoliosis

Matthew E. Oetgen, MD*; Ian S. Patten, BS, MPH; Laurel C. Blakemore, MD*
Children's National Medical Center, Washington, DC

Purpose: Ponte osteotomies (PO) have been recommended to improve deformity correction during posterior spinal fusion for adolescent idiopathic scoliosis (AIS); however, limited data exist documenting the effectiveness of this technique. The purposes of this study were to assess the clinical utility of PO in the correction of AIS deformities and determine indications for their use.

Methods: We performed a retrospective review on 176 patients who underwent posterior spinal fusion for AIS at a tertiary care pediatric hospital. Radiographic and operative outcomes were compared between the patients who were treated without PO (n=166) and those who were treated with PO (n=10). Correction of deformity was measured using the correction index (CI), defined as (pre-op Cobb– postop Cobb / pre-op Cobb) / (Pre-op Cobb– pre-op bending Cobb / pre-op Cobb).

Results: We found no difference in absolute coronal or sagittal curve correction between the groups. In curves > 65° we found an improved CI with the use of PO, without a significant increase in blood loss (EBL), while in curves < 65°, PO did not improve the CI, but did lead to more significant blood loss. In stiff curves (flexibility rate < 0.55), PO led to a significantly larger CI and blood loss. Finally, when PO were used in curves > 65° with a flexibility index < 0.55, the CI was significantly improved without a significant increase in blood loss, as compared to deformities in which PO were not used.

	Osteotomy Group	**No Osteotomy Group**	**p-value**
All Patients			
Absolute Correction (º)	40.2 ± 9.9	36.4 ± 10.2	0.27
Correction Index	2.21 ± 0.81	1.57 ± 2	**0.003**
Estimated Blood Loss (ml)	1340 ± 657	774 ± 501	**0.0009**
Curves >65 degrees			
Absolute Correction (º)	50.5 ± 8.2	48.4 ± 9.2	0.67
Correction Index	2.94 ± 0.7	1.74 ± 0.7	**0.003**
Estimated Blood Loss (ml)	1400 ± 735	960 ± 655	0.23

Conclusion: Our data suggest that PO allow improved correction of deformity in AIS but at the cost of higher EBL. In larger (>65°) and stiffer (flexibility index < 0.55) curves however, the EBL is not significantly elevated by the addition of PO's. We therefore feel that PO's are best indicated in curves >65° with a flexibility index of flexibility index < 0.55, leading to maximal deformity correction without a significant increase in intra-operative blood loss.

See pages 17 - 62 for financial disclosure information.

Significance: Ponte osteotomies improve deformity correction in adolescent idiopathic scoliosis at the cost of increased blood loss, except in curves > 65°. Judicious use of osteotomies for appropriately selected patients is likely indicated to maximize both safety and clinical outcome.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Do We Need to Remove the Biopsy Tract in Patients Undergoing Surgery Following Neo-Adjuvant Chemotherapy?

***Venkatesan Sampath Kumar**; Rishi Ram Poudel; Shah Alam Khan, MD; Asit Ranjan Mridha, MD; Sameer Bakhshi, MD; Shishir Rastogi, MD*
All India Institute of Medical Sciences, New Dehli, INDIA

Purpose: During limb salvage surgery for malignant bone tumours, it is not infrequent to encounter a poorly placed biopsy scar. Whether this biopsy scar needs to be removed in patients receiving neo adjuvant chemotherapy is yet to be established. Our aim was to study the excised specimens of patients who underwent surgery (limb salvage or amputation) for osteosarcoma and Ewing's sarcoma of the bone to see for tumour seeding in the biopsy scar.

Methods: Retrospective analysis of excised tumour specimens was done for patients operated between July, 2006 and June, 2011 at our tertiary care centre. Patients who did not receive neo-adjuvant chemotherapy from our institute and those in whom biopsy was performed outside our institute were excluded. We also excluded patients who underwent incisional biopsy and multiple biopsy procedures. Demographic data was collected from hospital records. Available histopathological slides/blocks of the excised tumour specimens were carefully examined by a senior pathologist (specialist in bone tumours) for tumor seeding along/in the biopsy scar.

Results: Of the remaining 60 patients who qualified for the study, 50 (83.3%) were diagnosed with Osteosarcoma and 10 (16.6%) with Ewing's sarcoma. Limb salvage was done in 42 patients while 18 went for amputation as the primary procedure. The average age of patients at the time of performing biopsy was 16.4 years and the male: female ratio was 1.3:1. The most frequent site to be biopsied was distal end femur (50%), followed by proximal end tibia (16.7%) and humerus (10%). The mean delay between biopsy and definitive surgery was 16 weeks. On examination of the histopathology blocks/slides, it was seen that tumour seeding was present in only one specimen. On retrospective analysis it was seen that this patient was a diagnosed case of Osteosarcoma of the distal femur and had undergone upfront amputation following failure of response to neo-adjuvant chemotherapy. Eleven patients (18.3%) did not have any viable tumour tissue in the whole of the biopsy specimen. Nine patients (15%) who underwent limb salvage surgery had local recurrence but none of them had tumour seeding in the biopsy tract of the specimen received after the index procedure.

Conclusion and Significance: Response to neo- adjuvant chemotherapy is the most important predictive factor for skin involvement by Osteosaracoma and Ewings sarcoma of the bone. The main drawback of the study is its retrospective nature and the presence of a small number of cases. We strongly feel that in patients who respond to neo-adjuvant chemotherapy, need to remove the biopsy tract in the primary procedure is questionable.

See pages 17 - 62 for financial disclosure information.

Vitamin D Insufficiency and Fracture Risk in Children

Rachel E. Mednick, MD; Daniel M. Dean, BS; ***Joseph A. Janicki, MD***
Anne & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

Purpose: There is evidence from multiple sources linking vitamin D deficiency and fracture risk in the elderly population. Investigation into vitamin D's role in fractures in the pediatric population has been limited despite nearly 70% of American children having insufficient or deficient vitamin D serum levels. The purpose of this study was to evaluate vitamin D's role in pediatric fracture risk by comparing vitamin D levels between fractured and non-fractured cohorts.

Method: A case control study was completed in children 2-14 years of age. Sixty children with a fracture requiring conscious sedation or general anesthesia for management were compared to 60 healthy children undergoing non-fracture orthopaedic procedures. Fractured children were excluded if their injury was from a high-energy mechanism, if they had a history of any chronic medical condition or if the fracture involved the hands or feet. Information obtained included race, sex, characteristics of the fracture, family history of fractures, medical problems, dietary intake of calcium, sun exposure and BMI. Serum vitamin D and calcium levels were collected.

Results: The mean age of the fractured and control patients was 5.8(SD:2.8) and 7.5(SD:4.4), respectively (p=0.012). There was no statistically significant difference in BMI, race, sex, calcium intake, sun exposure, sunscreen usage, previous fracture history, family history of fractures, or medical comorbidities between the two groups. Calcium levels between the fractured (9.4,SD:0.5) and control populations (9.5,SD:0.5) were comparable (p=0.116) The mean serum vitamin D was 28.5 ± 6.9 (insufficient) in the fractured cohort and 31.6 ±10.3 (sufficient) in the control population (p=0.055). After controlling for patient age and daily sun exposure, lower serum Vitamin D was associated with higher fracture risk (OR 1.06; CI 1.01-1.05; p=0.023). In the fractured cohort, 6(10%) patients were deficient (vitamin D<20) and 33(55%) were insufficient (20-30). Of the control population, 8(13%) patients were deficient and 19(32%) were insufficient. There were more insufficient patients in the fractured cohort than in the control group (OR = 2.99; CI 1.27- 7.0; p=0.037) and likely too few deficient patients in either group to show a statistically significant difference between the study populations.

Conclusion: Children in the fractured cohort showed a greater trend toward vitamin D deficiency and insufficiency as compared to the non-fractured control population. Further, after controlling for age, lower vitamin D levels were associated with a higher incidence of fracture. Lower vitamin D level seems to place the otherwise healthy pediatric population at increased risk for fracture.

Significance: Vitamin D deficiency likely plays a role in pediatric fractures from low energy mechanisms. Consideration must be given to routine vitamin D testing in children with fractures. Further research is needed to determine whether there is a role for routine Vitamin D supplementation in children post-fracture.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Anterior Dislocation of the Shoulder in Skeletally Immature Patients: Comparison Between Non-Operative Treatment versus Open Latarjet's Procedure

Federico Canavese, MD, PhD
Department of Pediatric Surgery, CHU Estaing, Clermont Ferrand, FRANCE

Purpose: Most of the studies published to date on shoulder instability have focused on skeletally mature patients. It is unclear whether it is possible to apply the proposed decision-making algorithm to skeletally immature patients. The aim of the study is to evaluate functional outcome of surgical and non-surgical techniques within the skeletally immature group, using QuickDASH scale, as well as to investigate whether the Latarjet's technique is applicable in skeletally immature patients. Long-term functional/radiological outcomes and arthritic glenohumeral changes after surgery were investigated as well.

Methods: Skeletally immature patients ≤16 years old with growth plate visible on plain radiographs, and radiologically proven anterior shoulder dislocation without concomitant fracture, nor neurovascular injuries followed at two institutions (1993-2010), were included. Patients from one institution had never been operated on (Group I), while patients from the other institution were submitted to Latarjet's procedure if they had ISIS ≥5 and a frequency of dislocation ≥3 episodes (Group II).

Statistical analysis: χ^2 or Fisher's exact test for categorical variables; Student's t-test or Mann-Whitney test for quantitative variables (normality verified by the Shapiro-Wilk test and homoscedasticity by the Fisher-Snedecor test). Intra-group paired comparisons: paired t-test or Wilcoxon tests for quantitative parameters and McNemar test for binary outcomes.

Results: Groups were homogenous (Table 1). All patients showed reduction of external rotation ($p<0.001$). Although Group II patients showed loss of external rotation with means of 62.1° versus 77.6° of Group I ($p=0.001$), they could return to the same level of sport activities in 92% of patients versus 52% of Group I patients.

Group II patients showed a less painful shoulder and better scoring of the QuickDASH questionnaire (5.8±11.2 versus 11.7±21.1 in Group I) ($p=0.41$). Apprehension tests were positive in 60% of shoulders in Group I and 25% in Group II ($p=0.01$). Eight shoulders (32%) of Group I had Hill-Sachs lesion and 1 (4%) shoulder had bony Bankart lesion. Four shoulders (14.2%) of Group II had partial to complete coracoid bone block resorption. There were no gleno-humeral arthritic changes, according to Samilson classification, in either Group I or II. High ISIS scores were associated with increased rate of recurrence.

Conclusions: Mid- to long-term results are good to excellent in post-surgical patients and fair in non-surgically treated patients. Post-surgical patients showed better signs of shoulder stability than others who have more rate of recurrence. The first episode of dislocation in skeletally immature patients should be treated conservatively regardless of age of onset. After one or more recurrences, Latarjet's stabilization can be performed.

See pages 17 - 62 for financial disclosure information.

Significance: We found no contraindications to operate on the skeletally immature patient, especially if they engage in high-energy physical activities, nor in those with existence of Hill-Sachs lesion, as well as hyperlax patients.

Table 1. Patient Demographic.

Variables	Total N=53^{S}/49^{P}	Group I N=25^{S}/23^{P}	Group II N=28^{S}/26^{P}	*P* value
Gender, male, no (%)	35 (71.4)	14 (60.9)	21 (80.8)	0.12
Age (ys) at follow-up, mean (sd*)	23.8 (4.4)	22.0 (3.9)	25.3 (4.3)	0.02
Side, right, no (%)	27 (50.9)	10 (40.0)	17 (60.7)	0.13
Dominant side, right, no (%)	44 (89.8)	22 (95.6)	22 (84.6)	0.35
Age (years) at surgery, mean (sd*)	15.9 (0.7)	-	15.9 (0.7)	NA
ISIS, mean (sd*)	6.7 (2.6)	4.6 (1.9)	8.7 (1.4)	<0.001
Mean interval dislocation/surgery	19.5 (12.3)	-	19.5 (12.3)	NA

* SD: standard deviation, S: number of shoulder, P: number of patients

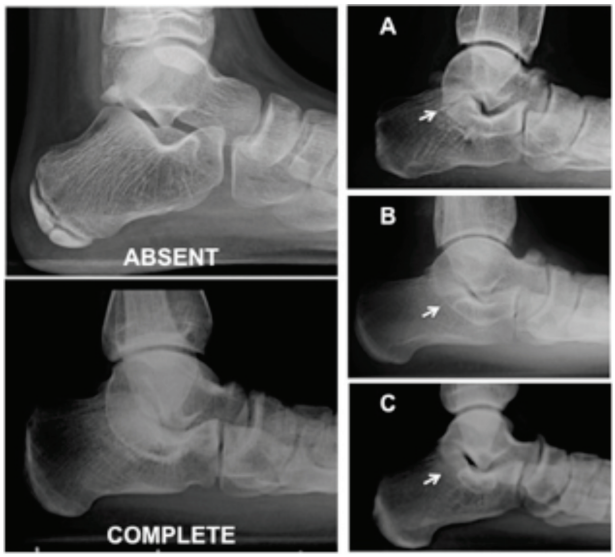
♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

C Sign: Talocalcaneal Coalition or Flatfoot Deformity?

Luis Moraleda, MD, PhD; George D. Gantsoudes, MD; ***Scott J. Mubarak, MD***
Rady Children's Hospital, San Diego, San Diego, California

Purpose: *C sign* is used to alert the physician of the possible presence of talocalcaneal coalition (TCC) so advanced imaging can be ordered The purpose of this study is to know the prevalence of the *C sign* among patients with TCC and its relationship to the presence of a TCC or to hindfoot alignment.

Methods: Retrospective reviews of the presence of C sign in radiographs of 88 feet with TCC (proved by CT scan or surgical findings) and 260 flexible flatfeet. *C sign* was classified as complete or interrupted (types A, B and C). The interobserver variability of the *C sign* was studied. Seven radiographic parameters were measured in order to analyze the relationship of these measurements with the presence or absence of the *C sign*.



Results: *C sign* was present in 68 feet (77%) with TCC: 14,5% complete and 62.5% interrupted (26% type A, 19.5% type B and 17% type C). *C sign* was present in 116 flatfeet (45%), all of them interrupted (0.4% type A, 5.5% type B and 39% type C). We considered a true *C sign* the complete sign and the interrupted type A sign. The true *C sign* was present in 36 (41%) and 1(0.8%) feet of the TCC and flatfoot group, respectively. On the other hand, the false *C sign* (an interrupted *C sign* type B or C) was present in 32 (36%) and 115 (44%) feet of the TCC and flatfoot group, respectively. The talo-first metatarsal angle, the talohorizontal angle, the calcaneal pitch, the calcaneo-fifth metatarsal angle and the naviculocuboid overlap presented a more pathological value when a *C sign* was present. The kappa value for the presence/absence of a *C sign* was 0.663.

Conclusions: The so-called *true C sign* (complete or interrupted type A) indicates the presence of a TCC and it is not related to flatfoot deformity. However, it is only present in 41% of the cases. The interrupted C sign is much more likely to be related to flatfoot deformity than to the presence of a TCC, specifically when a type C is found.

Significance: The suspicion of the presence of talocalcaneal coalition should be based on the symptoms and physical examination, fundamentally when not seeing an interrupted type C-sign.

See pages 17 - 62 for financial disclosure information.

Concomitant Modified Kidner Procedure and Calcaneo-Cuboid-Cuneiform Osteotomies for Severe Flatfoot Associated with Symptomatic Accessory Navicular in Children and Adolescents

Jung-Ryul Kim, MD, PhD
Chonbuk National University, Medical School, Jeonju, REPUBLIC OF KOREA

Purpose: The relationship of the accessory navicular (AN) to the development of the flatfoot remains controversial. However, some severe flatfoot deformities are associated with AN. The results of concomitant modified Kidner procedure and calcaneo-cuboid-cuneiform osteotomies (3C) for severe flatfeet associated with symptomatic AN in children and adolescents were investigated in this study.

Methods: Twenty one feet of thirteen patients (9 boys, 4 girls; mean age 12.7 y) with severe flatfeet associated with symptomatic AN treated with concomitant modified Kidner procedure and 3C were evaluated retrospectively based on clinical and radiographic examinations preoperatively, and at a latest follow-up investigation. We measured and compared 12 parameters on the anteroposterior (AP) and lateral weight-bearing radiographs. We used the American College of Foot and Ankle Surgeons (ACFAS) score for clinical assessment. Paired t-tests were used for statistical analysis.

Results: In terms of the inter-observer reliability, all of the radiographic measurements but one parameter (medial-lateral column ratio), showed good to excellent reliability for clinical use. We found significant improvements ($p<0.001$) in 8 of the 11 radiographic measurements: AP talo-first metatarsal (MTT) angle, AP talo-navicular coverage angle, lateral talo-1st MTT angle, calcaneal pitch, lateral talo-calcaneal angle, lateral talo-horizontal angle, and naviculocuboid overlap. We also found marginally significant improvements in 3 of the 11 radiographic measurements: AP talo-fifth MTT ($p=0.095$), lateral calcaneo-fifth MTT angle ($p=0.105$), and lateral first-fifth MTT angle ($p=0.057$). Average ACFAS scores were significantly improved at the time of the last follow-up ($p<0.001$). There was no complication in all cases.

Conclusion: Our results have demonstrated that combined the modified Kidner procedure with 3C could obtain favorable radiographic and clinical outcomes in the treatment of severe flatfeet associated with symptomatic accessory navicular in children and adolescents.

Significance: Combined modified Kidner procedure and 3C were attributed to the otherwise healthy posterior tibial tendon establishing an appropriate length after healing with osteotomies and posterior tibial tendon was able to support the arch on its own.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Bone, Muscle and Adipose Tissue Volume in Children and Adolescents with Myelomeningocele

Deirdre D. Ryan, MD*; Daniel J. Lorenzana, BA; Nicole M. Mueske, MS; Tishya A.L. Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA

Purpose: The purpose of this study was to investigate the relationship between disease severity and distal lower extremity body composition in children with myelomeningocele (MM).

Methods: The study included 85 subjects with MM and 121 healthy controls between the ages of 6 and 14 years old. Tissue volumes were computed along the entire length of both tibias from bilateral lower leg computed tomography (CT) scans. Tissue volumes were computed by a semi-automated threshold-based method using fixed attenuation ranges of [-190, -30] Hounsfield units (HU) for adipose tissue, [-29, 150] HU for skeletal muscle and [151, 1000] HU for bone. Clinical data gathered included height, weight, body mass index (BMI), Tanner stage of sexual maturity, International Myelodysplasia Study Group (IMSG) category and preferred method of ambulation in the settings of home, school and community. For the purpose of analysis, patients were categorized as controls, sacral level and lumbar level and above. Tissue volumes were compared between groups using multivariate linear regression models built in a step-down fashion to adjust for the effects of clinical data.

Results: After adjusting for height, there was no significant difference between bone volume in control compared to sacral groups ($p = 0.11$). Adipose volume also did not differ between the control and sacral groups after adjusting for height and weight ($p = 0.08$). Muscle volume in the control group, however, was significantly greater than the sacral group after adjusting for height ($p < 0.001$). Using the same models, adipose volume was higher, and both muscle and bone volumes were lower in the lumbar group compared to both the sacral and control groups ($p < 0.05$).

Conclusions: The results of this study suggest that children with sacral level MM do not have significantly different bone or adipose volume compared to healthy controls, despite significantly lower muscle volume in children with sacral level MM. These results may indicate that children with sacral level MM may not suffer the same incidence of adverse outcomes associated with pathological changes in bone and adipose volume.

Significance: Children with sacral level MM may not have an elevated risk of long bone fractures associated with decreased bone volume or adverse effects associated with subcutaneous and intramuscular adipose deposits.

See pages 17 - 62 for financial disclosure information.

The Evolution of Lower Extremity Deformity Management in MPS IVA, Morquio-Brailsford Syndrome

Tom Southorn, MBBS, BSc, FRCS*; George Cooper; Deborah Eastwood, FRCS; Christopher Edward Bache, FRCS (Ortho)*
Great Ormond Street Hospital for Children, London, UNITED KINGDOM

Purpose: Surgical interventions in children with Morquio-Brailsford syndrome type A (MPS-IVA) were historically performed only for symptom relief. With advances in management these children are surviving longer and functioning at a higher level. The aim of this study is to describe the evolution of surgical intervention for deformity management of the lower extremity with particular reference to genu valgum.

Methods: A retrospective review from two UK institutions of MPS-IVA patients who underwent surgery for lower extremity deformity correction was performed. Demographic details, surgical details, clinical measurements, outcomes and complications were recorded as well as data for mobility pre and post intervention.

Results: 46 patients with MPS-IVA were identified. Of these, 24 patients had 8 plates and 2 had staples inserted for correction of genu valgum. 2 patients had surgery for hip subluxation. Male to female ratio was 1:1. Indication for surgery in all patients was progressive genu valgum. Average age at insertion was 8 years 6 months (4 years 7 months-15 years 11 months). Average duration of insertion was 22 months (7 to 60 months). Mean intermalleolar distance pre-operatively was 12.5cm (5.3-24) and post operatively was 7.8cm (0-23). Alignment was improved in all patients when inserted at fewer than 7 years of age. Removal of plates in patients under the age of 6 was associated with higher risk and severity of recurrence. 3 patients have had 8 plates re-inserted for recurrence but with no success in further reduction of deformity. 20 patients had hip radiographs analysed. All hips were radiographically abnormal, with 17 out of 26 hips dislocated. Average migration percentage was 67%, with only one hip centred in the acetabulum. Of the 2 hips treated surgically, neither had remained reduced at most recent follow up.

Conclusion: Progressive deformity is a well-recognised feature of MPS-IVA. Early intervention with guided growth is effective at correcting deformity but care needs to be taken to watch for recurrent deformity over time. Due to early closure of physes associated with MPS-IVA we would suggest intervention under the age of 7 years but plates may need to be revised/ retained until after closure of physes to prevent recurrence of deformity.

Significance: The existing evidence for the use of 8 plates in a normal physis may not be generalisable to the pathological physis in MPS-IVA in terms of age at insertion and duration of insertion as well as predicted correction of deformity.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Prevalence of Autism Spectrum Disorder in Children That Present with Toe Walking

Glen O. Baird, MD*; Mark L. McMulkin, PhD; Andi B. Gordon, MPT; Bryan J. Tompkins, MD; Paul M. Caskey, MD*
Shriners Hospitals for Children, Spokane, WA

Purpose: When a child has an established diagnosis of autism spectrum disorder (ASD), the prevalence of toe walking is 20%. Conversely, a child can present with a primary complaint of toe walking due to underlying diagnoses such as cerebral palsy, muscular dystrophy, spinal dysraphism, congenital achilles contracture, myopathies, neuropathies, or ASD. The term idiopathic toe walking may be used when no known cause has been identified. If a child presents with a primary complaint of toe walking, the prevalence of an associated diagnosis is not clear. The purpose of this study was to describe the prevalence of diagnoses (in particular ASD) associated with children that present to an orthopedic clinic with a complaint of toe walking.

Methods: IRB approved retrospective cohort study. The medical records database at a children's orthopedic hospital was queried for all patients since 2004 coded for a primary gait abnormality. These 426 charts were reviewed to identify those children with documented toe walking during examination or as a final diagnosis. For the 191 participants identified as toe walkers, concomitant diagnosis such as cerebral palsy and ASD were recorded. The diagnosis of ASD was based on physician and/or caretaker report, or recorded characteristics of children based on interactions during examinations that were noted by providers (eg. 'autistic-like'). Prevalence of each diagnosis was calculated along with 95% confidence intervals (CI) of each percentage.

Results: The disorders associated with toe walking along with percentage and CI were as follows:

Disorder	#	%	CI %
Idiopathic (no known cause)	136	71.2	64.7-77.7
Cerebral palsy	27	14.1	9.2-19.1
Autism Spectrum disorders	16	8.4	4.4-12.3
Neuropathies	5	2.6	0.3-4.9
Muscular dystrophy	4	2.1	0.1-4.1
Genetic Disorders	2	1.0	0.0-2.5
Spinal dysraphisms	1	0.5	0.0-1.6

The incidence of ASD in those diagnosed with non-neurologic toe walking was 10.5% (16/152), CI 5.6-15.4%.

Conclusions: The results of this study found that for all children presenting with toe walking, 8.4% have ASD. However, when a child presents with toe walking and no neurologic findings on exam, 10.5% will have ASD.

Significance: Understanding the prevalence of ASD for children that toe walk has the potential to guide treatment. In the future, the use of computerized three dimensional gait analysis may be able to further differentiate those children with idiopathic toe walking versus children with ASD and other diagnoses.

See pages 17 - 62 for financial disclosure information.

Inking of Paediatric Orthopaedic Oncologic Surgical Resections and the Potential for False Positive Margins

Christine R. McClelland, MSc; Natalie Fioratos; Dr. Bob Fraser; ***Karl J. Logan, MbChB, FRCS***
IWK Health Centre, Halifax, NS, CANADA

Purpose: Following resection of musculoskeletal malignant tumours, ink is applied to surgical margins and processed to assess the proximity of tumorous tissue to the inked margins. We have observed that ink can leak along tissue planes in orthopedic resection specimens, potentially leading to an interpretation of a false positive margin. Using surgical resections of porcine hindlimbs, the **purpose of this study was to document and evaluate ink leaks beyond true margins of resection in orthopedic specimens.**

Materials and methods: Resection specimens were obtained from the proximal part of porcine hind limbs (n=5) by an orthopaedic surgeon in order to represent human diaphyseal bone tumour resections. Specimens were inked with tissue marking dye and pathologically processed to evaluate margins of resection. Depths of penetration were documented for a total of 279 cut sections from 5 specimens and compared among types of tissue to determine areas of greatest concern when interpreting inked orthopaedic resection margins.

Results: While the majority of each section was adequately inked, areas of concern were identified in most sections (288 areas in 279 sections). Incidences of ink tracking to areas other than true resection margins commonly occurred in 6 areas: 1) between adipose globules, 2) down plane in adipose globule, 3) between muscle fascicles, 4) down plane in muscle, 5) between muscle and adipose tissue, and 6) in areas of tissue where source of ink leak is unapparent. Ink was found to most commonly penetrate down muscle planes (32%) and between muscle fascicles (36%). Ink penetrated down planes in adipose tissue in 14% of ink leaks observed and 8% were found between adipose globules. Notably, only 5% of documented ink leaks occurred between muscle and fat tissues; however, this area posed the greatest propensity for ink to travel with a significantly greater distance of penetration ($p<0.05$).

Conclusion: Based on our results, inking of pediatric oncologic orthopaedic specimens needs to be carefully applied, documented thoroughly, and interpreted with caution. Effective communication between the surgeon and pathologist is absolutely paramount as is careful interpretation of inked margins when performed on orthopaedic specimens in particular.

Significance: This study highlights the potential pitfalls of inking large orthopedic specimens and may help to avoid false positive margin reports. Future work should aim to optimize pathological handling procedures of orthopedic specimens in order to minimize false positive margins reports.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

POSNA

2014 e-POSTER PROGRAM

See pages 17 - 62 for financial disclosure information.

e-Poster #7 *(page 350)*
Periosteal Incarceration versus Interposition Adipose Grafting in Physeal Fractures: A Laprine Model
Eric W. Edmonds, MD*; Josh Doan, MEng; Diana A. Glaser, PhD; Christine L. Farnsworth, MS*
Rady Children's Hospital, San Diego, California

e-Poster #8 *(page 351)*
Leptin Enhances Bone Regeneration in Ischemic Femoral Head of Diet-Induced Obese Rats
Jung-Ryul Kim, MD, PhD
Chonbuk National University, Medical School, Jeonju, REPUBLIC OF KOREA

e-Poster #9 *(page 352)*
Transplantation of a Scaffold-Free Cartilage Tissue Equivalent (CTE) Generated in Suspension Chondrocyte Culture to Physeal Cartilage Injury of the Proximal Tibia in Rabbit
Changhoon Jeong, MD
Bucheon St. Mary's Hospital, The Catholic University of Korea, KOREA

e-Poster #10 *(page 353)*
Bilateral Oblique Anterior Pelvic Osteotomy in Classic Bladder Exstrophy
Emmanouil Morakis; ***Mohan V. Belthur, MD****; Farhan Ali, MD; Raimondo M. Cervellione; Tahir Khan, FRCS*
Royal Manchester Children's Hospital, Manchester, UNITED KINGDOM

e-Poster #11 *(page 354)*
Utilization of the Dystrophic Index Predicts Outcome and Complications in Patients with NF-1 and Operative Spinal Deformity
Yavuz Saglam, MD; Anna McClung, BSN, RN; ***Daniel J. Sucato, MD, MS***
Texas Scottish Rite Hospital for Children, Dallas, TX

e-Poster #12 *(page 356)*
Characterisation of Hip Morphology in Children with Mucopolysaccharidosis Type I
Markus P. Baker, MRCS*; Elizabeth Ashby, FRCS; Deborah M. Eastwood, FRCS*
Great Ormond Street Hospital for Children, Eastwood, London, UNITED KINGDOM

e-Poster #13 *(page 357)*
Spinal Cord Injury Following Extremity Surgery in Children with Thoracic Kyphosis: Case Series
Blazej A. Pruszczynski, MD; ***William G. Mackenzie, MD, FRCS****; Kenneth J. Rogers, PhD, ATC; Amir Ahmadian, MD; Klane K. White, MD, MSc*
Department of Orthopedics, Nemours Alfred I. DuPont Hospital for Children, Wilmington, DE

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #14 *(page 358)*
Early Open Reduction of Dislocated Hips in Arthrogryposis. Short Term Results.
***Hakan Senaran, MD**; Guney Yilmaz, MD; Fatih Durgut; Omer Faruk Erkocak, MD; Bahattin Kerem Aydin; Mehmet Ali Acar, MD*
Selcuk University Medical Faculty, Konya, TURKEY

e-Poster #15 *(page 359)*
Sandwich Allografts for Long Bone Non-Unions in Patients with Osteogenesis Imperfecta
*Varun Puvanesarajah, BS; Jay R. Shapiro, MD; **Paul D. Sponseller, MD, MBA***
Johns Hopkins Hospital, Baltimore, MD

e-Poster #16 *(page 361)*
The Diagnostic Utility of Muscle Biopsy for Suspected Myopathy: A Primer for Orthopedists
***Brian J. Deignan, MD**; Corrine Link; Kenneth J. Rogers, PhD, ATC; William G. Mackenzie, MD; Mihir M. Thacker, MD*
Nemours Alfred I DuPont Hospital for Children, Wilmington, DE

e-Poster #17 *(page 362)*
Characterization of Lower Limb Deformity in Children with Mucopolysaccharidosis Type I and Treatment with Guided Growth
***Elizabeth Ashby, FRCS**; Markus P. Baker, MRCS; Deborah Eastwood, FRCS*
Great Ormond Street Hospital for Children, London, UK

e-Poster #18 *(page 363)*
Medial Malleolar Screw Hemiepiphysiodesis for Ankle Valgus Revisited
*Sean M. Caskey; David J. Wilson, MD; Glen O. Baird, MD; Bryan J. Tompkins, MD; **Paul M. Caskey, MD***
Shriners Hospital for Children, Spokane, WA

e-Poster #19 *(page 364)*
Can Radiographs Predict Outcome in Patients with Idiopathic Clubfoot Treated with the Ponseti Method?
*Conor Patrick O'Halloran, BS; Blaise A. Nemeth, MD; Matthew A. Halanski, MD; Catherine Carlyle Zimmerman, MD; **Kenneth J. Noonan, MD***
University of Wisconsin-Madison School of Medicine & Public Health, Madison, WI

e-Poster #20 *(page 365)*
Predicting the Need for Surgical Intervention in Patients with Idiopathic Clubfoot
***Rachel Y. Goldstein, MD, MPH**; Derek A. Seehausen, BA; Alice Chu, MD; Debra A. Sala, MS, PT; Wallace B. Lehman, MD*
NYU Hospital for Joint Diseases, New York, NY

See pages 17 - 62 for financial disclosure information.

e-Poster #21 *(page 366)*
Painful Flatfoot in Clubfeet Treated By Ponseti Casting
Pooya Hosseinzadeh, MD*; Christopher B. Hayes, MD; Kevin A. Murr, MD; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet Walker, MD; Vishwas R. Talwalkar, MD; Todd A. Milbrandt, MD, MS*
Lexington Shriners Hospital for Children, Lexington, KY

e-Poster #22 *(page 367)*
Success of Non-Operative Treatment of Proximal Fifth Metatarsal Fractures in Children
Melissa J. Wilcox, BA; Joanna H. Roocroft, MA; Tracey P. Bastrom, MA; ***Eric W. Edmonds, MD***
Rady Children's Hospital, San Diego, CA

e-Poster #23 *(page 368)*
The Demographics and Epidemiology of Osteochondritis Dissecans of the Ankle in Children and Adolescents
Jeffrey I. Kessler, MD*; Hooman Nikizad; Kevin G. Shea, MD; John C. Jacobs, Jr., BS; Judith D. Bebchuk, PhD; Jennifer M. Weiss, MD*
Kaiser Permanente Southern California, Los Angeles, CA

e-Poster #24 *(page 369)*
Ponseti Casting for Infants with Idiopathic Clubfoot: Does onset of Treatment Matter?
Conor P. O'Halloran, BS; ***Blaise A. Nemeth, MD, MS****; Matthew A. Halanski, MD; Catherine Carlyle Zimmerman, MD; Kenneth J. Noonan, MD*
University of Wisconsin School of Medicine and Public Health, Madison, WI

e-Poster #25 *(page 370)*
Do Surgeons and Third Party Payors Agree on the Criteria to Diagnose Femoroacetabular Impingement?
John C. Clohisy, MD*; Ira Zaltz, MD; Geneva Baca, BA; David A. Podeszwa, MD; Perry L. Schoenecker, MD; Daniel J. Sucato, MD, MS; Robert T. Trousdale, MD; Christopher M. Larson, MD; James Ross, MD*
Washington University, St. Louis, MO

e-Poster #26 *(page 371)*
Staphylococcus Aureus Musculoskeletal Infections and Methicillin-Resistance Over the Past Decade
Eric J. Sarkissian, BS; Itai Gans, BS; Melissa Gunderson, BA; ***John (Jack) M. Flynn, MD***
The Children's Hospital of Philadelphia, Philadelphia

e-Poster #27 *(page 372)*
Does Tranexamic Acid Reduce Blood Loss and Transfusion Requirements Associated with the Periacetabular Osteotomy?
Scott A. Wingerter, MD, PhD; Angela D. Keith, MS; Perry L. Schoenecker, MD; Geneva Baca, BA; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #28 *(page 373)*
Impact of Obesity on Risk of Complications Following Periacetabular Osteotomy for the Treatment of Symptomatic Hip Dysplasia in Children and Adolescents
Eduardo N. Novais, MD; *Young Jo Kim, MD, PhD; Perry L. Schoenecker, MD; John C. Clohisy, MD; Rafael Jose Sierra, MD; Robert T. Trousdale, MD; Gorden D. Potter, III, MD; Patrick Carry, MA; Michael B. Millis, MD*
Boston Children's Hospital, Mayo Clinic Rochester, Shriners Hospital St. Louis

e-Poster #29 *(page 374)*
Accuracy of Acetabular Correction in Periacetabular Osteotomy
Stephen T. Duncan, MD; Gail Pashos, BS; Angela D. Keith, MS; Geneva Baca, BA; Perry L. Schoenecker, MD; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

e-Poster #30 *(page 375)*
Idiopathic Cam Morphology Is Not Caused By Subclinical Slipped Capital Femoral Epiphysis: A MRI and CT Study
Shafagh Monazzam, MD; James D. Bomar, MPH; ***Andrew T. Pennock, MD***
Rady Children's Hospital, San Diego, CA

e-Poster #31 *(page 376)*
What Is "Acetabular Retroversion" and How Should We Measure Femoral Head Coverage: Evaluation of Acetabular Morphology By Volume-Rendered Ct
John R. Faust, MD; *Stephen Little, MD; Tim Schrader, MD*
Children's Healthcare of Atlanta at Scottish Rite, Atlanta, GA

e-Poster #32 *(page 378)*
Does Pain Chronicity in Patients with Symptomatic Acetabular Dysplasia Correlate with Intra-Articular Disease?
Geneva Baca, BA; ***John C. Clohisy, MD***; *Ira Zaltz, MD; Perry L. Schoenecker, MD; Daniel J. Sucato, MD, MS; Young Jo Kim, MD, PhD; Paul E. Beaule, MD; Michael B. Millis, MD; Christopher L. Peters, MD*
Washington University, St. Louis, MO

e-Poster #33 *(page 379)*
Femoroacetabular Impingement in Adolescents: Characteristics and Intraoperative Pathology of a Prospective, Multicenter Cohort
Jeffrey Nepple, MD; Mark Leland Miller, MD; Geneva Baca, BA; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

See pages 17 - 62 for financial disclosure information.

e-Poster #34 *(page 380)*
Descriptive Epidemiology of Symptomatic Acetabular Dysplasia in Adolescents: A North American Cohort
John C. Clohisy, MD*; Geneva Baca, BA; Stephen T. Duncan, MD; Ira Zaltz, MD; Michael B. Millis, MD; Ernest L. Sink, MD; Robert T. Trousdale, MD; Young Jo Kim, MD, PhD; David A. Podeszwa, MD; Perry L. Schoenecker, MD*
Washington University, St. Louis, MO

e-Poster #35 *(page 381)*
What Is the Relationship Between Childhood Obesity and Femoral Retroversion?
Benjamin J. Shore, MD, FRCSC*; Patricia Miller, MS; Benjamin Allar, MS; Travis H. Matheney, MD; Young Jo Kim, MD, PhD*
Department of Orthopaedic Surgery, Boston Children's Hospital, Harvard Medical School, Boston, MA

e-Poster #36 *(page 382)*
Interleukin-6 in Pediatric Musculoskeletal Infection: A Pilot Study
Byron F. Stephens, II, MD; Jeffrey R. Sawyer, MD; William C. Warner, Jr., MD; James H. Beaty, MD; David D. Spence, MD; Alice A. Moisan, BSN, RN, CCRP; ***Derek M. Kelly, MD***
Le Bonheur Children's Hospital, Memphis, Tennessee

e-Poster #37 *(page 383)*
A Clinical Algorithm or Hip Joint Aspiration: Which Is Better for the Diagnosis of Septic Arthritis of the Hip?
Uri Givon, MD*; Amir Herman, MD, PhD; Amos Schindler, MD; Boaz Liberman, MD*
Edmond and Lilly Safra Hospital for Children, Sheba Medical Center, Tel Hashomer, ISRAEL

e-Poster #38 *(page 384)*
Acute Rheumatic Fever and Septic Arthritis in Children: The Diagnostic Value of Serological Inflammatory Markers
Matthew J. Boyle, MD; Raakhi M. Mistry, MBBS; Diana Lennon; Wesley P. Bevan, MD; Chris Frampton; ***Haemish A. Crawford, MD***
Starship Children's Hospital, Auckland, NEW ZEALAND

e-Poster #39 *(page 386)*
Are there Disparities in Community-Acquired Pediatric Musculoskeletal *S. Aureus* Infections?
Jorge L. Rocha, BA; Sheldon L. Kaplan, MD; Edward O. Mason, PhD; Danielle Guffey, MS; Charles G. Minard, PhD; ***Howard R. Epps, MD***
Texas Children's Hospital, Houston, TX

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #40 *(page 387)*
Arthroscopic Irrigation of the Hip Joint with a Simplified Technique
***Prasad Gourineni, MD**; Summer Watkins, APN; James E. Ho, MD*
Advocate Children's Hospital, Oak Lawn, IL

e-Poster #41 *(page 388)*
Can Glucose Level of Joint Fluid Predict Diagnosis of Septic Arthritis? A Preliminary Report
***Maki Kinugasa, MD**; Daisuke Kobayashi, MD; Shinichi Satsuma, MD; Yoshiyuki Shinada, MD*
Kobe Children's Hospital, Kobe, JAPAN

e-Poster #42 *(page 389)*
Leg Length Discrepancy in the Digital Age: Transitioning Management to the EOS Machine
Michael T. Milone, MD; Victor M. Ho-Fung, MD; B. David Horn, MD;
Richard S. Davidson, MD
Children's Hospital of Philadelphia, Philadelphia, PA

e-Poster #43 *(page 391)*
Pseudarthrosis of the Fibula After Lower Limb Lengthening - The Risk of Developmental Ankle Valgus Deformity
***Daisuke Kobayashi, MD**; Shinichi Satsuma, MD; Maki Kinugasa, MD*
Kobe Children's Hospital, Kobe, JAPAN

e-Poster #44 *(page 392)*
Percutaneous Epiphysiodesis Using Transphyseal Screws (PETS) for Limb Length Discrepancies (Outcome and Accuracy of Growth Prediction Models)
*Bryan Monier, MD; **David D. Aronsson, MD**; Jennifer Lisle, MD; Michael Sun, BS*
Fletcher Allen Hospital, University of Vermont, Burlington, VT

e-Poster #45 *(page 393)*
Lengthening for Congenital Limb Length Discrepancy Using the Precice™
*Kevin Debiparshad, MD; David Chong, MD; **Dror Paley, MD***
Paley Advanced Limb Lengthening Institute, West Palm Beach, FL

e-Poster #46 *(page 394)*
Early and Late Fracture Following Lower Limb Lengthening
***Hiroshi Kitoh, MD, PhD**; Hiroshi Kaneko, MD, PhD; Kenichi Mishima, MD; Masaki Matsushita, MD; Naoki Ishiguro, MD, PhD*
Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine, Nagoya, Aichi, JAPAN

See pages 17 - 62 for financial disclosure information.

e-Poster #47 *(page 395)*
Core Decompression and Bone Marrow Aspirate Concentrate for Femoral Head AVN Secondary to Sickle Cell Disease
***Karen Bovid, MD**; Tim Schrader, MD*
Children's Healthcare of Atlanta at Scottish Rite/Children's Orthopaedics of Atlanta, Atlanta, GA

e-Poster #48 *(page 396)*
In-Toeing: A Primary Care Problem Referred to Pediatric Orthopaedic Clinic?
*John Sielatycki, MD; **William L. Hennrikus Jr, MD***
Orthopaedics, Penn State College of Medicine, Hershey, PA

e-Poster #49 *(page 397)*
Comparison of Bovine Xenograft and Allograft in Calcaneal Lengthening Osteotomy for Correction of Pes Planus Foot in Children with Cerebral Palsy
*Alfred A. Mansour, III MD; Jason T. Rhodes, MD; Zhaoxing Pan, MB, PhD; Nancy H. Miller, MD; Breanna M. Pritchard, BA; **Frank M. Chang, MD***
Children's Hospital Colorado and University of Colorado, Aurora, CO

e-Poster #50 *(page 399)*
Retrospective Comparison of Age At Surgery and Rate of Remodeling of Distal Femoral Extension Osteotomies in Children with Cerebral Palsy
*David Roy, MSIV; Breanna Pritchard, BA; Zhaoxing Pan, MB, PhD; Jason T. Rhodes, MD; **Frank M. Chang, MD***
Children's Hospital Colorado and University of Colorado, Aurora, CO

e-Poster #51 *(page 400)*
Solving the Pediatric Lower Extremity Vascular Trauma Dilemma: Improved Care with a Vascular Trauma Protocol
*Itai Gans, BS; **Keith D. Baldwin, MD, MPH, MSPT**; Michael L. Nance, MD, FACS; John (Jack) M. Flynn, MD; Joseph M. Serletti, MD; Stephen J. Kovach, III, MD; L. Scott Levin, MD, FACS*
The Children's Hospital of Philadelphia, Philadelphia, PA

e-Poster #52 *(page 401)*
First Assist in Pediatric Orthopaedics: Implications for Financing Graduate Medical Education
*Jeffrey Abildgaard, MD; M. Wade Shrader, MD; Alexander C. McLaren, MD; **Lee S. Segal, MD***
Phoenix Children's Hospital, Phoenix, AZ

e-Poster #53 *(page 402)*
Radiation Exposure for Spinal Fusion in Children Using O-Arm and C-Arm
***G. Ying Li, MD**; Alejandro Dabaghi Richerand, MD; Michelle S. Caird, MD; Frances A. Farley, MD*
University of Michigan, Ann Arbor, MI

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #54 *(page 404)*
Switching to A Pediatric Dose O-Arm Protocol in Spine Surgery Significantly Reduced Patient Radiation Exposure
A. Noelle Larson, MD; *Tianyi David Luo, BS; Amy L. McIntosh, MD; Anthony A. Stans, MD; Jennifer A. Winkler; Beth Schueler*
Mayo Clinic, Rochester, MN

e-Poster #55 *(page 406)*
Pre-Operative Fears in Pediatric Patients Scheduled for Orthopaedic Surgery
Lauren Rife; Michelle Peterson, BA, CCLS; Amy Krahe, MPT; Melanie A. Morscher, BS; ***Kenneth T. Bono, MD***
Akron Children's Hospital, Akron, OH

e-Poster #56 *(page 407)*
Institutional Variation in the Perioperative Care of Scoliosis in Cerebral Palsy: A Multi-Center Comparison of the Drivers of Cost and Outcome
Brian Scannell, MD; *Peter O. Newton, MD; Burt Yaszay, MD; Suken A. Shah, MD; Paul D. Sponseller, MD; Firoz Miyanji, MD; Mark F. Abel, MD; Harry L. Shufflebarger, MD; Harms Study Group*
Rady Children's Hospital, San Diego, CA

e-Poster #57 *(page 408)*
Variation in Documentation of Pediatric Supracondylar Fractures
Carissa L. Meyer, MD; Ebrahim Paryavi, MD, MPH; ***Joshua M. Abzug, MD***
University of Maryland School of Medicine, Baltimore, MD

e-Poster #58 *(page 409)*
Anterior Cruciate Ligament Reconstruction in Main Hospital vs. Hospital Owned Ambulatory Surgery Facility: Comparison of Surgical Time and Operation Room Efficiency
Muayad Kadhim, MD; *Itai Gans, MD; Keith D. Baldwin, MD; John (Jack) M. Flynn, MD; Theodore J. Ganley, MD*
Children's Hospital of Philadelphia, Philadelphia, PA

e-Poster #59 *(page 410)*
Does Simulation Training Improve Residents' Performance When Placing Short Arm Casts?
Joshua M. Abzug, MD; *Ebrahim Paryavi, MD, MPH; Robert V. O'Toole, MD; Robert S. Sterling, MD*
University of Maryland School of Medicine, Baltimore, MD

See pages 17 - 62 for financial disclosure information.

e-Poster #60 *(page 411)*
Simulation Training and Objective Structured Clinical Examinations: The Residents' Perspectives
***Joshua M. Abzug, MD**; Robert V. O'Toole, MD; Robert S. Sterling, MD*
University of Maryland School of Medicine, Baltimore, MD

e-Poster #61 *(page 412)*
Intraoperative Neuromonitoring for AIS: Multimodal Motor Evoked Potential Monitoring Utilizing Simultaneous Transcranial MEP and Neurogenic MEP
***Daniel J. Sucato, MD, MS**; Anna McClung, BSN, RN*
Texas Scottish Rite Hospital for Children, Dallas, TX

e-Poster #62 *(page 413)*
Adolescent Idiopathic Scoliosis Patients Are At Increased Risk for Pulmonary Hypertension
Rachel E. Borlack, BS; Michael P. DiLorenzo, MD; Vishal Sarwahi, MD; Aviva G. Dworkin, BS; Terry D. Amaral, MD; ***Sarika Kalantre, MD***
Children's Hospital at Montefiore Medical Center and Albert Einstein College of Medicine, Bronx, NY

e-Poster #63 *(page 414)*
At What Levels Are Free Hand Pedicle Screws More Frequently Malpositioned?
Mark Heidenreich, BS; Yaser M.K. Baghdadi, MD; Anthony A. Stans, MD; Amy L. McIntosh, MD; William J. Shaughnessy, MD; ***A. Noelle Larson, MD***
Mayo Clinic, Rochester, MN

e-Poster #64 *(page 416)*
Validation and Reliability of the Simplified Skeletal Maturity Scoring System
Prakash Sitoula, MD; Kushagra Verma, MD; Laurens Holmes, Jr., PhD; Peter G. Gabos, MD; Kerry L. Loveland, MD; Petya Yorgova, MS; Geraldine Neiss, PhD; Kenneth J. Rogers, PhD; Satyendra Verma, PhD; James O. Sanders, MD; ***Suken A. Shah, MD***
Nemours/Alfred I. duPont Hospital for Children, Wilmington DE

e-Poster #65 *(page 418)*
Does Apical Vertebral Body Derotation Result in Equal Improvement in Thoracic and Lumbar Scoliometer Readings? - A 3D Analysis of Axial Trunk Deformity in AIS
***John W. Kemppainen, MD**; Burt Yaszay, MD; Krishna Ravi Cidambi, MD; Fredrick G. Reighard, MPH; Tracey Bastrom, MA; Peter O. Newton, MD*
Rady Children's Hospital, San Diego, CA

e-Poster #66 *(page 420)*
The Effect of Vertebral Body Stapling on Sagittal Profile
Elias Dakwar, MD; Amer F. Samdani, MD; Giuseppe Orlando, MD; Michael Auriemma, MD; Joshua M. Pahys, MD; Randal R. Betz, MD; ***Patrick J. Cahill, MD***
Shriners Hospitals for Children, Philadelphia, PA

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #67 *(page 421)*
72% of Spine Fusions Have Postoperative Fevers, But This Does Not Correlate to Surgical Site Infection
Gideon W. Blumstein, MS; Derek A. Seehausen, BS; Liam Harris, BS; Lindsay Andras, MD; Patrick Ross, MD; ***David L. Skaggs, MD, MMM***
Children's Hospital Los Angeles, Los Angeles, CA

e-Poster #68 *(page 422)*
Sub-Axial Cervical Spine Injuries in Children and Adolescents
Robert Francis Murphy, MD*; Austin R. Davidson, BS; William C. Warner Jr., MD; Derek Michael Kelly, MD; David D. Spence, MD; Jeffrey R. Sawyer, MD*
University of Tennessee - Campbell Clinic Lebonheur Childrens' Hospital, Memphis, TN

e-Poster #69 *(page 423)*
Safety of Pedicle Screws for Pediatric Patients Younger Than 10 Years Old: Analysis of 5024 Pedicle Screws
Takahito Fujimori, MD, MSc; Burt Yaszay, MD; Carrie Bartley, MA; Tracey Bastrom, MA; ***Peter O. Newton, MD***
Rady Children's Hospital, San Diego, CA

e-Poster #70 *(page 424)*
Evolution of the Surgical Correction of Scoliosis in Patients with Duchenne Muscular Dystrophy
Brian Scannell, MD*; Burt Yaszay, MD; Carrie Bartley, MA; Peter O. Newton, MD; Scott J. Mubarak, MD*
Rady Children's Hospital, San Diego, CA

e-Poster #71 *(page 425)*
Picc Lines Inserted the Day Before Surgery Decrease Time from Induction of Anesthesia to Incision for Spinal Deformity Surgery and Safely Provides Central Venous Access During Surgery: A Pilot Study
Anne Stuedemann, RN, MSN, CPNP*; Vikram N. Chakravarthy, MSIII; Richard M. Schwend, MD, FAAP; Valorie K. Thomas, RN, PNP-BC; Tammy Sue Lightner, MHA, RN, CPN*
Children's Mercy Hospitals & Clinics, Kansas City, MO

e-Poster #72 *(page 426)*
Perioperative Use of Adjunctive Medication for Pain Management Improves Outcomes After Posterior Spinal Fusion for AIS
Suken A. Shah, MD*; Karen Sacks, CRNP; Dinesh K. Choudhry, MD; Kenneth J. Rogers, PhD, ATC*
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

See pages 17 - 62 for financial disclosure information.

e-Poster #73 *(page 427)*
A Multicenter Retrospective Cohort Analysis of Infection Characteristics and Rates with VEPTR Surgery: 2007 to Present
***Sumeet Garg, MD**; Micaela Cyr, BA; Michael P. Glotzbecker, MD; Patrick Carry; John Taylor Smith, MD; Jeffrey R. Sawyer, MD; Joshua Pahys, MD; Scott J. Luhmann, MD; John (Jack) M. Flynn, MD; Ron El-Hawary, MD; Michael G. Vitale, MD, MPH; Tricia St. Hilaire, MPH; The Children's Spine Study Group*
University of Colorado, Children's Hospital Colorado Orthopedics Institute, Aurora, CO

e-Poster #74 *(page 428)*
No Advantage by Regional Anesthetic Technique for Pain Control After Anterior Cruciate Ligament Reconstruction in Youth: A Randomized Controlled Trial
Sean Flack, MBChB; Viviana Bompadre, PhD; ***Gregory A. Schmale, MD***
University of Washington School of Medicine and Seattle Children's Hospital, Seattle, WA

e-Poster #75 *(page 429)*
High Satisfaction Yet Decreased Activity Four Years After Transphyseal ACL Reconstruction
***Gregory A. Schmale, MD**; Christopher Y. Kweon, MD; Viviana Bompadre, PhD*
University of Washington School of Medicine and Seattle Children's Hospital, Seattle, WA

e-Poster #76 *(page 430)*
Validation of a Dedicated Pediatric Shoulder Outcome Questionnaire
***Eric W. Edmonds, MD**; Tracey P. Bastrom, MA; Joanna H. Roocroft, MA; Valerie A. Young-Calandra, RN; Andrew T. Pennock, MD*
Rady Children's Hospital, San Diego, CA

e-Poster #77 *(page 431)*
Return to Play and Clinical Outcomes after All-Inside, Anterior Cruciate Ligament Reconstruction in Skeletally Immature Athletes
Danyal H. Nawabi, MD, FRCS (Orth); Moira M. McCarthy, MD; ***Daniel W. Green, MD**; Frank A. Cordasco, MD*
Hospital for Special Surgery, New York, NY

e-Poster #78 *(page 432)*
Status of the Patellofemoral Articular Cartilage in Recurrent Patellar Instability
Nandan Prasad, BA; June C. O'Donnell; ***Scott J. Luhmann, MD***
Washington University School of Medicine, St. Louis, MO

e-Poster #79 *(page 433)*
Arthroscopic Lateral Retinacular Release in Adolescents with Medial Patellofemoral Ligament-Centered Pain
Andrew J. Blackman, MD; June C. O'Donnell; ***Scott J. Luhmann, MD***
Washington University School of Medicine, St. Louis, MO

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #80 *(page 434)*
Increased Posterior Tibial Slope and Its Association with Acl Rupture in the Pediatric Population
Michael P. O'Malley, MD; ***Matthew D. Milewski, MD****; Matthew J. Solomito, MS; Andrew S. Erwteman, MD; Carl W. Nissen, MD*
Elite Sports Medicine, Connecticut Children's Medical Center, Framington, CT

e-Poster #81 *(page 435)*
Outcomes of Dynamic Splinting in Patients with Stiffness After Knee Surgery
J. Lee Pace, MD; Adam Y. Nasreddine, BS, MA; David Zurakowski PhD; Michael Kalani Simoni, BA; Mininder S. Kocher, MD, MPH
Boston Children's Hospital, Boston, MA

e-Poster #82 *(page 436)*
Adolescent Supracondylar Humerus Fractures: Multi-Center Study of Management and Outcomes
Brian P. Scannell, MD*; Kelly L. Vanderhave, MD; Bryan J. Loeffler, MD; Steven L. Frick, MD; Brian K. Brighton, MD; R. Glenn Gaston, MD; Virginia F. Casey, MD; Kyle J. Jeray, MD; Lisa K. Cannada, MD; Robert Hymes, MD*
Carolinas Medical Center, Charlotte, NC

e-Poster #83 *(page 437)*
Iatrogenic Nerve Injuries in the Treatment of Supracondylar Humerus Fractures: Are We Really Just Missing Nerve Injuries on Preoperative Examination?
Elizabeth Joiner, BS; ***David L. Skaggs, MD****; Alexandre Arkader, MD; Lindsay M. Andras, MD; Nina R. Lightdale-Miric, MD; J. Lee Pace, MD; Deirdre D. Ryan, MD*
Children's Hospital Los Angeles, Los Angeles, CA

e-Poster #84 *(page 438)*
It's Always Sunny in the Operating Room: Weather Affects Operative Pediatric Orthopaedic Volume
Christina J. Gutowski, MD, MPH; Kushagra Verma, MD; Eleanor Lewin, MD; Peter G. Gabos, MD; ***Suken A. Shah, MD***
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

e-Poster #85 *(page 439)*
Exposed versus Buried Intramedullary Implants for Pediatric Forearm Fractures: A Comparison of Complications
Brian A. Kelly, MD; Patricia Miller, MS; Benjamin J. Shore, MD, MPH, FRCSC; Peter M. Waters, MD; ***Donald S. Bae, MD***
Boston Children's Hospital, Boston, MA

See pages 17 - 62 for financial disclosure information.

e-Poster #86 *(page 440)*
Short Leg Casting for Isolated Tibial Shaft Fractures in Children
Megan H.M. Kuba, MD; Drew Brown, IV, MD; Nicholas Scarcella, MD; ***Byron Hideo Izuka, MD***
Kapi'olani Medical Center for Women and Children, Honolulu, HI

e-Poster #87 *(page 441)*
Displaced Medial Epicondyle Fractures in Children: Comparative Effectiveness of Operative versus Non-Operative Treatment
Emily Mayer, BS; Emily A. Eismann, MS; ***Charles T. Mehlman, DO***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

e-Poster #88 *(page 442)*
Functional Outcomes Following Operative Treatment of Tibial Tubercle Fractures
Grant D. Hogue, MD; ***Anthony I. Riccio, MD****; Corey S. Gill, MD; DeRaan Collins, BS; Lori A. Karol, MD; Robert L. Wimberly, MD*
Children's Medical Center-Texas Scottish Rite Hospital for Children, Dallas, TX

e-Poster #89 *(page 443)*
The Outcome of Surgical Treatment of Multidirectionally Unstable (Type IV) Pediatric Supracondylar Humerus Fractures
Mauricio Silva, MD*; Shannon Cooper, BS; Angela Cha, CPNP*
Orthopaedic Institute for Children, Los Angeles, CA

e-Poster #90 *(page 444)*
The Effectiveness of Cast Wedging for the Treatment of Pediatric Fractures
Jaffer M. Kattan, BA; Michael P. Leathers, MD; Justin H. Barad, MD; ***Mauricio Silva, MD***
Orthopaedic Institute for Children, Los Angeles, CA

e-Poster #91 *(page 445)*
Prevalence and Remodeling of Reversed Radial Bowing Following Radial Shaft Fractures in Children
Erik Olsen; Emily A. Eismann, MS; ***Kevin J. Little, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

e-Poster #92 *(page 446)*
Increased Fracture Risk in Children with Attention Deficit Hyperactivity Disorder: A Nationwide Matched Cohort Study
Chii Jeng Lin, MD*; Nai-Wen Guo; Ming-Tung Huang, MD; Cheng-Li Lin, MD; Tsung-Hsueh Lu, PhD; Fu-Wen Liang, PhD; Min-Fnag Tsai; Shi-Liang Wu, MD*
National Cheng Kung University, TAIWAN

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #93 *(page 447)*
The Epidemiology of Pediatric Supracondylar Fracture Fixation: A Population-Based Study
Amir Khoshbin, MD; Timothy S. Leroux, MD; David Wasserstein, MD, MSc; Jesse I. Wolfstadt, MD; Peggy W. Law, MSc; Nizar Mahomed, MD; ***James G. Wright, MD, MPH, FRCSC***
Hospital for Sick Children, Toronto, Ontario, CANADA

e-Poster #94 *(page 448)*
Outcomes of Rigid Intramedullary Nail Fixation in Paediatric Femoral Fractures
Timothy P. Carey, MD, FRCSC*; Christopher Del Balso, BSc, MSc, MBBS; Debra Bartley, MD, FRCSC; Megan S. Cashin, MD, FRCSC; Abdel-Rahman Lawendy, MD, MSc, FRCSC*
Children's Hospital, London Health Sciences Centre, London, Ontario, CANADA

e-Poster #95 *(page 449)*
The High Risk of Infection with Delayed Treatment of Pediatric Seymour's Fractures
Bryan A. Reyes, MD; ***Christine Ann Ho, MD***
Children's Medical Center-Texas Scottish Rite Hospital for Children, Dallas, TX

e-Poster #96 *(page 450)*
Indirect Shoulder Magnetic Resonance Arthrography: A Technique for Identifying Labral Pathology in Young Patients
Andrew J. Razzano, Jr., DO; Melanie A. Morscher; Richard P. Steiner, PhD; Azam A. Eghbal, MD; ***Kerwyn C. Jones, MD***
Akron Children's Hospital, Akron, OH

e-Poster #97 *(page 451)*
Developmental Anatomy of the Distal Radial Epiphysis in Children
Pooya Hosseinzadeh, MD*; Douglas Olson, MD; Ashley Jaglowicz; Ryan Eads, BS; Scott A. Riley, MD*
Lexington Shriners Hospital for Children, Lexington, KY

e-Poster #98 *(page 452)*
Significance of the Lateral Humeral Line for Evaluating Radiocapitellar Alignment in Children
Christopher D. Souder, MD*; Joanna H. Roocroft, MA; Eric W. Edmonds, MD*
Rady Children's Hospital, San Diego, CA

e-Poster #99 *(page 453)*
Lower Extremity Anomalies in Patients with Ulnar Longitudinal Deficiency
Pooya Hosseinzadeh, MD; Stanford T. Israelsen, MD; Scott A. Riley, MD; ***Janet Walker, MD***
Lexington Shriners Hospital for Children, Lexington, KY

See pages 17 - 62 for financial disclosure information.

Legg-Calvé-Perthes Disease (LCPD) Produces Chronic Synovial Effusion and Significantly Elevated Pro-Inflammatory Cytokine Interleukin-6 (IL-6) in the Synovial Fluid

***Nobuhiro Kamiya, MD, PhD**; Elena Chen; Harry Kwang-Woo Kim, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

Purpose: Hip synovitis is a consistent feature of LCPD which produce joint irritability and stiffness. The mechanisms causing the synovitis and how it affects the disease process are unknown. Purposes of this study were 1) to assess the synovitis in LCPD patients using serial MRIs, 2) to measure inflammatory cytokines from their synovial fluids (SFs), and 3) to investigate the mechanisms causing inflammation following ischemic osteonecrosis using a piglet model and in-vitro studies.

Methods: This is an IRB/ IACUC approved study. Serial MRIs were performed in 34 patients (40 hips) to assess synovitis by quantifying the synovial effusion on all T2 images using an image analysis software. Two independent observers performed the measurements. SFs were obtained at the time of hip arthrogram from 10 patients with LCPD and 6 patients with DDH as controls and cytokine levels were measured using ELISA. In a screen study, 12 cytokines including TNF and IL-1 were assayed and IL-6 was found to be highly elevated. Since IL-6 is a potent inflammatory cytokine which activates osteoclasts, we focused on studying IL-6. To investigate the mechanisms causing inflammation, a piglet model of ischemic osteonecrosis was used and SFs were assessed for IL-6. IL-6 expression in the femoral head was also assessed using immunostaining. To study mechanisms, chondrocytes were cultured under hypoxia (1% O_2) and normoxia (21% O_2). Inflammatory cytokine expression and 2 key pathways, hypoxia inducible factor-1 (HIF-1) and reactive oxygen species (ROS), were investigated.

Results: Initial MRI showed significantly greater SF volume in the affected hip compared to the normal hip ($p<0.05$). Over time, 31 affected hips (77.5%) showed a decrease but persistent synovial effusion whereas 9 hips (22.5%) stayed at a similar level. IL-6 was significantly elevated in the SFs of LCPD patients vs. DDH patients ($p<0.05$). In the piglet model, IL-6 was dramatically increased in the SFs of affected vs. normal side. IL-6 immunostaining was increased in the affected femoral head cartilage. In-vitro studies showed significantly increased IL-6 expression in chondrocytes cultured under hypoxia vs. normoxia. Activation of HIF-1 and addition of ROS significantly increased IL-6 expression levels.

Conclusion: LCPD produces chronic synovial effusion with significantly elevated IL6 in the SFs. Piglet model and in-vitro hypoxia studies suggest that HIF-1 and ROS are possible mechanisms that activate IL-6.

Significance: This study is the first to identify the possible mechanisms of synovitis and IL-6 activation following ischemic osteonecrosis.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Proximal Femoral Growth Modification: Effect of Screw, Plate, and Drill on Asymmetric Growth of the Hip

Albert D'Heurle, MD; David Klimaski, MD; Keith Stringer, MD; David L. Glos, BSE; Donita I. Bylski-Austrow, PhD; ***James J. McCarthy, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

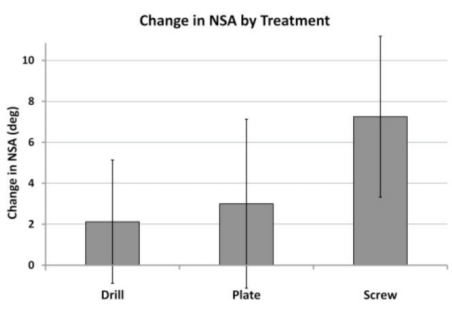
Purpose: Guided growth has long been used in the lower extremities but has not been applied to varus or valgus deformity in the hip, as may occur in children with CP or DDH. The purpose of this study was to determine if screw, plate, or drilling techniques decreased the femoral neck-shaft angle. A second goal was to determine growth plate structural changes with each method.

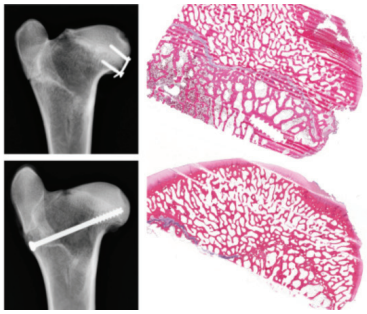
Methods: Twelve 8-wk-old lambs underwent proximal femoral hemiepiphysiodesis (IACUC approved) using either a screw (n=4), plate (n=4), or drilling procedure (n=4). Contralateral hips underwent a sham procedure. Post-operative time was 8 months. Radiographs taken after limb harvest were used to measure neck-shaft angle (NSA) and articular trochanteric distance (ATD). Differences between treated and control sides were determined by one-tailed paired t-tests and Bonferroni ($\alpha=0.05/3$). Histology was obtained for one limb pair per group. Proximal femurs were cut in mid-coronal plane and the longitudinal growth plates were examined for structural changes.

Results: NSA for control limbs for screw, plate, and drill groups respectively, were, 117° (±1), 119° (±3), 119° (±3), and for experimental sides, 110° (±5), 116° (±7), 116° (±1). Differences in NSA between control and experimental were greatest for the screw ($p<0.0172$). Differences in ATD were not significant. Histologically, physeal changes were observed on the operative sides in screw and plate specimens, but not drill, compared to contralateral sham control. The screw specimen exhibited the most severe changes, with growth plate closure over half the section. The plate specimen showed focal loss of the physis across the section, but with no evidence of closure.

Conclusion: The decrease in angle of the proximal femur was greater with the screw than with plate or drill. Plate and screw methods altered the histologic structure of the proximal femoral growth plate. Small numbers and variations in technique limit comparisons between groups. However, the study suggests that, if consistently applied, screws may be effective in decreasing the neck-shaft angle in skeletally immature hips.

Significance: Guided growth may become viable for treatment or prevention of hip deformity.





See pages 17 - 62 for financial disclosure information.

Afferent Muscle Denervation and Contracture Formation Following Neonatal Brachial Plexus Injury

Athanasia Nikolaou, PhD; Liangjun Hu, MS, MD; ***Roger Cornwall, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose: Unresolved upper trunk (C5-6) neonatal brachial plexus injury (NBPI) frequently causes secondary contractures, in part through functional shortening of neonatally denervated muscles. One notable exception is the clinically rare C5-6 rootlet avulsion injury, where contractures do not occur despite complete motor denervation of affected muscles, possibly due to preserved muscle afferent innervation in this pre-ganglionic injury with maintained axonal connection to the dorsal root ganglia. The current study uses a mouse model of NBPI-induced elbow flexion contractures to test the hypothesis that preservation of muscle afferent innervation prevents contractures.

Methods: Sixteen 5-day-old CD-1 mice underwent unilateral pre- or post-ganglionic C5-6 nerve root(let) transection. Four weeks postoperatively, passive range of motion was measured immediately post-sacrifice, blinded to surgical group. Elbow flexion contractures were defined as the difference in passive extension between the operated and control sides. The musculocutaneous nerve (MCN) was removed from both limbs for immunohistochemical analysis of axon count using anti-neurofilament-H (NF-H) to stain total axons and anti-parvalbumin (PV) to stain muscle-specific afferent axons. Operated and control forelimbs were then harvested and formalin fixed at 0° shoulder abduction and 90° elbow flexion. Biceps and brachialis muscles were then removed, stained with 25% Lugol's solution, and imaged by microCT at 20mm resolution to determine muscle volume and cross-sectional area (CSA).

Results: Total anti-NF-H stained MCN axon counts did not differ between the two groups, confirming a similar level of denervation. However, anti-PV staining revealed a 2.8-fold higher number of afferent axons in the pre-ganglionic group than the post-ganglionic group ($P=0.03$, unpaired t-test), indicating successful preservation of elbow flexor muscle afferent innervation following pre-ganglionic NBPI. Significantly worse elbow flexion contractures occurred in the post-ganglionic than pre-ganglionic group (10.9° ± 8.7° vs. 3.5° ± 4.1°, respectively, $p=0.05$, unpaired t-test), with no contractures >10° occurring following pre-ganglionic NBPI. The denervated biceps and brachialis muscles had significantly smaller volume and CSA than contralateral controls in both groups ($P<0.0001$, paired t-tests), although no difference existed between the two groups, consistent with similar efferent denervation.

Conclusion: The current study's findings support the hypothesis that preservation of afferent innervation despite motor denervation protects against contractures following NBPI.

Significance: Understanding the cellular and molecular basis of contracture formation following NBPI will allow novel strategies to prevent and treat contractures and improve muscle functional recovery. The current study supports further investigation of the role of afferent innervation in postnatal muscle development and contracture pathophysiology.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Skeletal Maturation of the Pelvis, Hand and Elbow Compared to Growth Completion – Results of a Longitudinal Study

James O. Sanders, MD*; Debbie Yen-Dao Dang, MD; Xing Qiu, PhD;*
Mariano E. Menendez, BS; P. Christopher Cook, MD; Daniel Roy Cooperman, MD
University of Rochester, Rochester, NY

Purpose: Determining growth termination is important for many pediatric orthopedic disorders but particularly for scoliosis where the end of growth presumably indicates cessation of rapid progression. While various skeletal maturity assessments have been suggested to indicate growth termination, the relationship has not been formally longitudinally studied.

Methods: A longitudinal series of children were followed throughout their growth with annual stadiometric height measurements and concurrent radiographs of their left hand, elbow, and hemipelvis. We identified those subjects who clearly completed their growth and compared their terminal growth to skeletal maturity using the Risser sign, DiMeglio elbow scale, and the Sanders hand method. The measures were compared to the percentage of final height. Peak height velocity (PHV) time was identified and compared to the timing of growth completion for each subject.

Results: 36 females and 24 males had completed their growth. The PHV occurred at age 11.3 yrs in girls (range 9.2-14.2) and 13.0 yrs in boys (range 11.5-14.4). Measurement variability was found up to 1.5cm. 99% of final height occurred at 2.5 years after the PHV and 99.5% at 3.0 years for both boys and girls with 0.5% corresponding to 8-9mm respectively. The elbow matured (DiMeglio 5) before the hand or pelvis reached their final stages. The earliest elbow maturation occurred at 95.3% final growth. The earliest Risser 4 occurred at 98.4% final growth in both girls and boys. For the hand, Sanders stage 7 occurred at a minimum of 98.4% in girls and 98.3% in boys. Both Risser 5 and Sanders 8 occurred at a minimum of 99% final growth. One girl was an exception and grew 2.7cm after Risser 4, Sanders 7 and 1.7cm after Risser 5, Sanders 8.

Conclusions: Girls and boys both grow 2.5 to 3 years after their PHV and have similar growth and skeletal maturity at the end of growth. The olecranon matures before growth is completed and its closure does not represent growth completion. Risser 4 and Sanders 7 both indicate growth is within 1.6% or 13mm of completion. Both Risser 5 and Sanders 8 are reliable indicators of growth cessation.

Significance: Skeletal maturation using the pelvis or hand closely reflects the end of growth and boys and girls have similar final skeletal maturation.

See pages 17 - 62 for financial disclosure information.

Bisphosphonates Inhibit Osteosarcoma Mediated Osteolysis via Attenuation of Tumor Expression of MCP-1 and RANKL

Tetsuro Ohba, MD, PhD; Heather Cole; ***Jonathan G. Schoenecker, MD***
Vanderbilt University Medical Center, Nashville, TN

Purpose: Osteosarcoma is the most common primary malignant tumor of bone, and accounts for around 50% of all primary skeletal malignancies. In addition to novel chemotherapies, there is a need for adjuvant therapies designed to inhibit osteosarcoma proliferation and tumor-induced osteolysis to attenuate tumor expansion and metastasis. As such, studies on the efficacy of bisphosphonates on human osteosarcoma are planned following feasibility studies which determined that the bisphosphonate zoledronic-acid (ZOL) can be safely combined with conventional chemotherapy (1). However, the molecular mechanisms responsible for, and means of inhibiting, osteosarcoma-induced osteolysis are largely unknown.

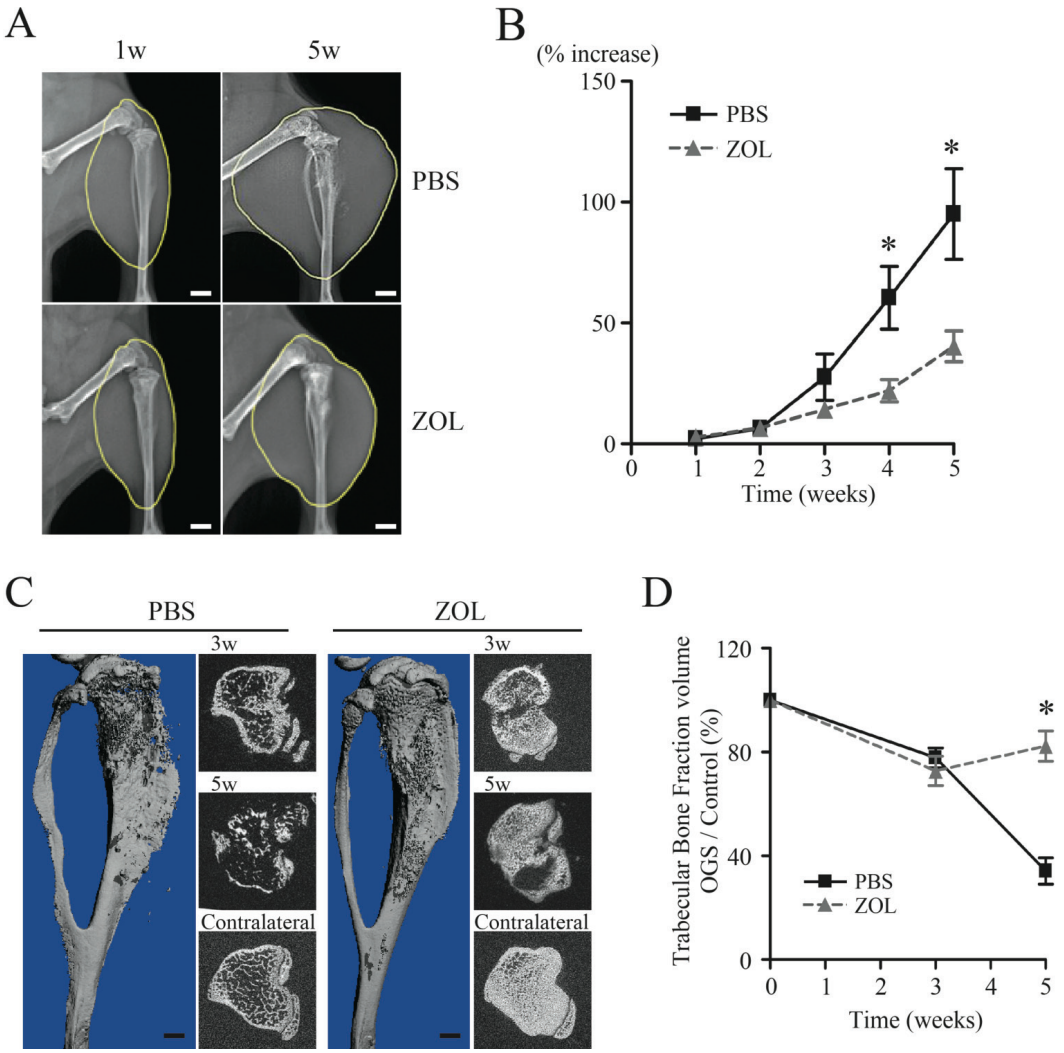
Methods: Here we tested the hypotheses that i) osteosarcoma-associated osteolysis is mediated by tumor-induced osteoclastogenesis through expression of RANKL and MCP-1 and ii) that bisphosphonates directly reduce osteosarcoma expression of osteoclast activators, functional recruitment of osteoclast precursors and osteoclastogenesis. The rate of osteosarcoma growth, RANKL/MCP-1 expression, and degree of bone resorption were also determined *in vivo* in a previously validated model of syngeneic-orthotopic osteosarcoma. Finally, we determined the capacity of the bisphosphonate ZOL to inhibit osteosarcoma-associated osteolysis and tumor growth.

Results: We establish that osteosarcoma growth directly correlates with tumor-induced osteolysis and activation of osteoclasts *in-vivo*. *In-vitro*, tumor cells were determined to expresses surface, but not soluble, RANKL and stimulated osteoclastogenesis in a manner directly proportional to their malignant potential. In addition, osteosarcoma cell line was determined to secrete monocyte chemo-attractant protein-1 (MCP-1) resulting in robust monocyte migration. Since MCP-1 is a key cytokine for monocyte recruitment and surface bound RANKL strongly supports local osteoclastogenesis, we suggest that high levels of these signaling molecules are associated with the aggressive potential of osteosarcoma. Consistent with these findings, abundant expression of RANKL/MCP-1 was observed in tumor *in-vivo*, and MCP-1 plasma levels strongly correlated with tumor progression and osteolysis. ZOL administration directly attenuates osteosarcoma production of RANKL/MCP-1, reducing tumor-induced bone destruction (Figure C,D). *In vivo*, these findings also correlated with significant reduction in osteosarcoma growth (Figure A,B).

Conclusions: ZOL attenuates tumor-induced osteolysis, not only through direct inhibition of osteoclasts, but also through direct actions on tumor expression of osteoclast activators.

Significance: Together we believe that these data provide valuable, previously unrealized insights regarding the effect of ZOL on osteosarcoma essential for designing the planned upcoming prospective randomized trials to determine the efficacy of bisphosphonates on osteosarcoma in humans.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.



ZOL attenuates osteosarcoma growth and osteosarcoma-initiated osteolysis *in vivo*. A, Single-cell suspensions (1×10^5) of murine osteosarcoma (K7M3) cells were injected into the tibia of PBS (n=15) and ZOL (n=30) treated mice. Weekly radiographic evaluations were performed. Scale bar indicates 1mm. B, Quantification of tumor expanding into the soft tissue surrounding the injected tibia compared to the contralateral, tumor free, tibia was performed by radiographic analysis (n=15 PBS-treated; n=30 ZOL-treated). Y-axis indicates % increase in relative size from 0%. *, $P < 0.01$ compared with ZOL-treated group. C, Bone lesions 21 or 35 days after tumor cell inoculation were analyzed by micro-CT and compared to the bones of PBS and ZOL-treated tumor bearing mice. Scale bar indicates 1mm. D, Bone fraction volume of the tumor laden tibial metaphysis normalized by contralateral, tumor free, tibial metaphysis illustrates decreased tumor-induced osteolysis in the ZOL-treated mice group compared with PBS-treated mice group (n=5 for each group at 3W; n =10 for each group at 5W). *, $P < 0.01$ compared with PBS-treated group. (*, $P < 0.01$)

See pages 17 - 62 for financial disclosure information.

Meclozine Facilitates Proliferation and Differentiation of Chondrocytes By Attenuating Abnormally Activated FGFR3 Signaling in Achondroplasia

***Masaki Matsushita, MD**; Hiroshi Kitoh, MD; Hiroshi Kaneko, MD, PhD; Kenichi Mishima, MD; Naoki Ishiguro, MD, PhD*
Nagoya University Graduate School of Medicine, Nagoya, Aichi, JAPAN

Purpose: Achondroplasia (ACH) is one of the most common skeletal dysplasias with short stature caused by gain-of-function mutations in FGFR3 encoding the fibroblast growth factor receptor 3. No rational therapy is currently available for ACH. The purpose of our study is to identify a clinically applicable drug that ameliorates abnormally activated FGFR3 signaling in ACH.

Methods: We used the drug repositioning strategy to identify an FDA-approved drug that suppresses abnormally activated FGFR3 signaling in FGF2-treated rat chondrosarcoma cells (RCS). The effects of the identified drug on chondrocyte proliferation and differentiation were analyzed in cell culture system of various chondrocyte cell lineages and bone explant culture.

Results: Meclozine, an anti-histamine drug that has long been used for motion sickness, facilitated chondrocyte proliferation and mitigated loss of extracellular matrix in FGF2-treated RCS cells. Meclozine ameliorated abnormally suppressed proliferation of human chondrosarcoma (HCS-2/8) cells expressing constitutively active mutants of FGFR3-K650E (thanatophoric dysplasia), FGFR3-K650M (SADDAN), and FGFR3-G380R (ACH). Meclozine rescued abnormally suppressed differentiation of ATDC5 chondrogenic cells expressing FGFR3-K650E and -G380R in micromass culture system. Meclozine alleviates FGF2-mediated longitudinal growth inhibition of embryonic tibia in bone explant culture. Meclozine also enhanced growth of embryonic tibia even in the absence of FGF2 treatment. In intracellular FGFR3 signaling experiments, meclozine downregulates phosphorylation of ERK but not of MEK. Meclozine enhanced proliferation of RCS cells expressing constitutively active mutants of MEK and RAF but not of ERK, suggesting that meclozine downregulates the FGFR3 signaling by attenuating ERK phosphorylation.

Conclusion: Meclozine inhibited FGFR3 signaling in RCS chondrocytes, HCS-2/8 and ATDC cells expressing constitutive active FGFR3 mutants, and FGF2-treated embryonic bone explant culture.

Significance: Meclozine, an over-the-counter (OTC) H1 blocker, is an attractive and potential therapeutic agent for treating short stature in ACH and other FGFR3-related skeletal dysplasias.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

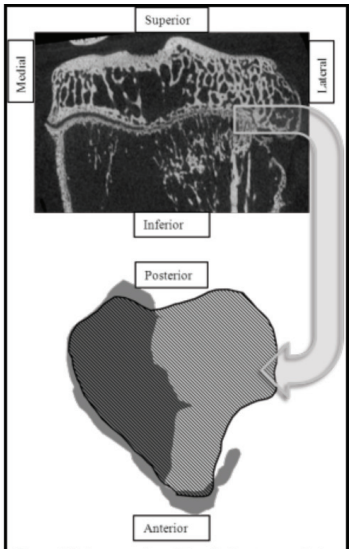
Periosteal Incarceration versus Interposition Adipose Grafting in Physeal Fractures: A Laprine Model

***Eric W. Edmonds, MD**; Josh Doan, MEng; Diana A. Glaser, PhD; Christine L. Farnsworth, MS*
Rady Children's Hospital, San Diego, California

Purpose: Physeal fractures risk arrest of growth. Surgical interposition of adipose has been proposed to prevent physeal bar formation and the purpose of this study was to identify if adipose responds differently than periosteum within acute physeal fractures.

Methods: Lateral proximal tibia physeal fractures were created in eleven 10-week-old rabbits with one of the following: cast only (***Fracture Only***, n=1), interposed flap of local periosteum (***Periosteum Group***, n=4), post-patellar tendon adipose autograft (***Fat Group***, n=5). Sham surgery was performed on opposite limb (***Sham Group***, n=10). Radiography: PA/Lat radiographs pre-op, post-op, 10-days (cast removal), and 6-weeks post-op were compared by: tibia medial-lateral length difference (TMLLD, mm), femoral-tibial angle (FTA, °) and tibia plateau angle (TPA, °). Pre-op to 6-weeks post-op measurements and postop to 10-day post-op measurements were compared using repeated measures ANOVA. Physeal bar presence was noted. MicroCT: The physes were reconstructed and open physeal area calculated. Fractured physeal areas (non-sham) were normalized to the sham-control from the same animal.

Results: Radiography: The Periosteum group showed significant increase in TMLSD between immediate post-op and 10-days later (p=0.028), showing a possible growth plate effect already present after 10 days, not seen in the other groups. The change in TMLLD between pre-operative and 6-week post-op was not different between all groups (p=0.161). FTA increased slightly following sham surgery at 10-days and 6-weeks. TPA remained consistent in the sham group, but decreased without significance in the 3 fracture groups. After 6-weeks, physeal bars were seen in Fracture Only (1/1=100%), Periosteum (4/4=100%), Fat (3/5=60%) and Sham (0/10=0%). MicroCT: Fracture Only normalized open physeal area was 0.51. Every Fat Group area was over 0.90 (mean 0.99±0.06). Only half of the Periosteum Group areas were over 0.90 (mean 0.81±0.24). Periosteum and Fat groups were not different (p=0.137).



Top: Mid-coronal µCT of Fracture Only tibia; physeal bar seen.
Bottom: Axial view of physis (flattened reconstruction). Right (fracture side from Top image, shaded grey) and left (sham side flipped, striped area) superimposed.

Conclusion: Adipose grafting does not appear to fully protect from bar formation in physeal fractures, but it appears to have less risk than incarcerated periosteum.

Significance: Fat interposition may prevent, or at least delay, bars across a fractured physis. Retrospective clinical studies suggest that surgical intervention to remove interposed periosteum may not be completely benign. Therefore, the possible benefit of adipose interposition versus simple removal of incarcerated periosteum warrants further exploration.

See pages 17 - 62 for financial disclosure information.

Leptin Enhances Bone Regeneration in Ischemic Femoral Head of Diet-Induced Obese Rats

Jung-Ryul Kim, MD, PhD
Chonbuk National University, Medical School, Jeonju, REPUBLIC OF KOREA

Purpose: Obesity is considered a clinical risk factor for Legg–Calve´–Perthes disease (LCPD). Leptin is primarily secreted by adipocytes, and it regulates adipose tissue mass and body weight. Obesity is clearly associated with increased leptin levels. Furthermore, leptin resistance significantly correlated with disease severity and treatment outcome in LCPD. The purpose of this investigation was to determine if leptin treatment can preserve the shape of the femoral head and stimulate bone regeneration in surgery-induced ischemic femoral head of diet-induced obese rats.

Methods: We fed the rats with a high-fat diet (HFD) or normal chow diet (NCD) for 16 weeks to examine a progressive development of HFD-induced obesity. Adenovirus-mediated of leptin gene (Ad-leptin) was given an intravenous injection at 16 weeks after HFD or NCD feeding. Rats were divided into the following groups; 1) the pair-fed group (the control group), 2) the sham-operated group (the sham group), 3) the Ad-Lacz-injected group (the Ad-Lacz group), and 4) the Ad-leptin-injected group (the Ad-leptin group) (n=20/group). At 4 weeks post-surgery animals were sacrificed and radiologic and histomorphometric assessments were performed. Total RNA was prepared from infarcted femoral head and analyzed for osteogenic marker protein expression using real-time RT–PCR analysis. Serum level of leptin and vascular endothelial growth factor (VEGF) were determined by ELISA. Leptin signaling was examined in tissues by Western blot.

Results: Radiographs findings showed better preservation of femoral head architecture in the Ad-leptin group than in the Ad-Lacz group. Histological findings and immunohistochemical staining of endothelial cells revealed that the Ad-leptin group animals showed significantly increased osteoblastic proliferation and vascularity in infarcted femoral heads. Serum levels of leptin and VEGF were significantly increased after Ad-leptin treatment. In HFD rats, Ad-leptin treatment significantly increased hypoxia-inducible factor-1α (HIF-1α) and nuclear factor κB (NF-κB) subunit p50 and p65. Runt-related transcription factor 2 and its target genes were significantly upregulated in the Ad-leptin group of HFD rats.

Conclusions: Our findings suggest that leptin therapy has a significant effect in promoting bone regeneration in ischemic femoral head of diet-induced obesity, and this effect may be mediated by the NF-κB-HIF-1α pathway.

Significance: Leptin resistance might play an important role in pathogenesis of ischemic necrosis of the femoral head. Leptin theray could have potential application in the treatment of ischemic necrosis of the femoral head.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Transplantation of a Scaffold-Free Cartilage Tissue Equivalent (CTE) Generated in Suspension Chondrocyte Culture to Physeal Cartilage Injury of the Proximal Tibia in Rabbit

Changhoon Jeong, MD
Bucheon St. Mary's Hospital, The Catholic University of Korea, KOREA

Introduction: The growth plate injury by trauma can cause premature closure of growth plate which can make problems like leg length discrepancy and angular deformity. The treatment is more challenging. The purpose of this study was to investigated the effects of a transplantation of a vitro-generated scaffold-free tissue-engineered cartilage tissue equivalent (CTE) using a suspension chondrocyte culture in a rabbit growth arrest model.

Material and Methods: We harvested cartilage cells from articular cartilage of the knee and hip joint of the New Zealand white rabbit and made CTE by suspension culture of $2x10^7$cell/ml. The animal model of growth plate defect was made by making the defect the medial side of proximal tibial growth plate of tibias in 4 mm in diameter and 3 mm in depth from in 6-week-old New Zealand white rabbit. The allogenic CTE was transplanted on the defect of right proximal tibia, no implantation on left proximal tibia as a control. Plain radiographs was performed at one week interval for evaluation of bone bridge formation and medial proximal tibial angle (MPTA) was measured for assessing the degree of angular deformity until postoperative 6 weeks. We harvested both tibias at postoperative 4 and 6 weeks to perform histological evaluation by HE and Alcian blue stain.

Results: In the experimental group, there was little angular deformity at plain radiographs for 6 weeks. However, in the control group statistically significant angular deformity was seen after 3 weeks post-transplantation ($p<0.05$). Histologically bone bridge formation was seen at postoperative 4 and 6 weeks in control group, cartilage tissue was maintained in the experimental group.

Conclusions: CTE transplantation as a treatment for growth plate injury recovers growth plate injury and minimizes deformity by blocking bone bridge formation. By this study, CTE transplantation can be clinically used as a treatment for growth plate injury.

Key words: growth plate injury, chondrocyte, cartilage-tissue- equivalent

See pages 17 - 62 for financial disclosure information.

Bilateral Oblique Anterior Pelvic Osteotomy in Classic Bladder Exstrophy

***Emmanouil Morakis**; Mohan V. Belthur, MD; Farhan Ali, MD; Raimondo M. Cervellione; Tahir Khan, FRCS*
Royal Manchester Children's Hospital, Manchester, UNITED KINGDOM

Purpose: To report our experience in the management of patients with classic bladder exstrophy treated with urologic reconstruction and bilateral anterior oblique pelvic osteotomies.

Methods: This is a retrospective study of 35 children treated, between 2007 & 2013. All patients were treated within the first two years of life with urologic reconstruction and primary abdominal wall repair. Bilateral anterior oblique pelvic osteotomies with external & internal (symphyseal sutures) fixation were done to facilitate tension free reconstruction. The average age of the patients at surgery was 5.1 months. There were 13 girls and 22 boys. The average follow up was 35 months. The patients were immobilized post-operatively with traction (15) or mermaid dressings (20) for 6-8 weeks. We measured clinical, radiologic, functional and patient satisfaction outcomes.

Results: All pelvic osteotomies healed and the external fixators were removed at 5.6 weeks post-operatively. Duration of hospital stay was 5.9 weeks. The average pre-operative, immediate post-operative and final follow-up pubic symphyseal diastasis was 42, 17 and 45 mm respectively. One patient had a partial wound dehiscence, which required revision surgery. There were no neurovascular, skin or bone complications. Three patients had a superficial pin tract infection that was treated with oral antibiotics. No patient showed acetabular dysplasia at final follow up. No patient had limb length discrepancy.

Conclusions: Bilateral oblique anterior pelvic osteotomies are safe and facilitate tension free urologic and abdominal wall closure in children with classic bladder exstrophy in the short and medium term follow-up.

Significance: Bilateral oblique anterior pelvic osteotomies is a safe and effective technique to allow the urologic and abdominal wall closure in children with classic bladder exstrophy. Long term follow-up is needed to assess its effect on the urologic and musculoskeletal function.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Utilization of the Dystrophic Index Predicts Outcome and Complications in Patients with NF-1 and Operative Spinal Deformity

Yavuz Saglam, MD*; Anna McClung, BSN, RN; Daniel J. Sucato, MD, MS*
Texas Scottish Rite Hospital for Children, Dallas, TX

Purpose: Neurofibromatosis type 1 (NF-1), is commonly associated with spinal deformity. The aim of this study is to examine the use of the dystrophic index (DI) as a predictor of outcomes and surgical complications in patients with operative spinal deformity and NF-1.

Methods: A retrospective analysis of any patient with NF-1 and an operative spinal deformity treated between 1972 and 2010 at a single pediatric orthopedic institution was performed. The medical records were carefully reviewed. Preoperative PA/LAT films were used to assess the total number of dystrophic features present on a given patient and equated their DI score. Patients with a higher DI (DI≥15) were then compared to those with a lower DI (DI<15).

Results: There were 77 patients identified with a mean DI of 15 (8.7±3.3 DI<15 vs. 21.6±6.1 DI≥15). A DI≥15was seen in 39 patients, who presented significantly earlier (7.7±4.5 vs. 10±3.2 years, p=0.015) than a DI<15. Clinical findings and family history of NF-1 were similar in both groups; however the DI≥15 group had a higher incidence of nerve tumors (Table 1). At surgery, the DI≥15 group was younger, though Cobb, kyphosis and balance measurements were similar between groups preoperatively (Table 1). Despite similar deformity, the DI≥15 group had 11 minutes more per level of surgical time, 142 mLs greater blood products transfused, and 2.6 more implants utilized (Table 1). Postoperative Cobb correction was greater in DI≥15 group (27.0% <15 DI vs. 35.6% DI≥15, p=.56), but all radiographic parameters were similar; at a mean follow up of 5.3±3.3 years (Table 1). Complications for the DI≥15 group were higher intra-operatively (21.7% vs. 11.1%, p=0.021) as well as post-operatively (29.8% vs. 17.7%, p=0.35).

Conclusion: The dystrophic index appears to be a useful tool to predict longer surgery, more implants used, greater use of blood products and correlates with greater incidence of both intraoperative and postoperative complications.

Significance: Operative NF-1patients categorized by a high dystrophic index were younger, had greater surgical time, intraoperative p blood products, and implants along with greater perioperative complications, despite similar preoperative Cobb magnitudes.

See pages 17 - 62 for financial disclosure information.

Table 1

	DI<15 (n=39)	DI≥15 (n=38)	p-Value
Physical Exam			
Café au lait	39 (100 %)	37 (97.3 %)	0.3
Freckling	15 (38.4 %)	20 (52.6 %)	0.39
Subcutaneous neurofibroma	17 (43.5 %)	19 (50 %)	0.55
Nerve tumor	4 (10.2 %)25	14 (36.8 %)	***0.01***
Family history of NF	(64.1 %)	21 (56.7 %)	0.79
Clinical Data			
Age at surgery	12.0 ± 2.9	10.8 ± 3.7	0.08
SurgicalTime (min.)/per level	31.6±12.9	42.1±19.1	***0.002***
EBL (cc.)/per level	89.0±55.0	92.2±65.6	0.74
Intra-op blood transfusion (cc.)	303.2±463.6	445.5±540.9	*0.07*
Levels Fused	10.3±2.9	10.8±3.4	0.42
Anchor points	9.2±4.1	11.8±4.6	***0.009***
Radiographic Data			
Cobb preop	63.1°	67.2°	0.38
Cobb last follow-up	46.0°	43.3°	0.56
Kyphosis preop	46.7°	39.7°	0.33
Kyphosis last follow-up	39.2°	35.7°	0.42
C7-CSVL preop	18.5mm	21.9mm	0.21
C7-CSVL last follow up	14.1mm	12.8mm	0.98
SB preop	28.3mm	31.3mm	0.35
SB last follow-up	33.7mm	29.4mm	0.47

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Characterisation of Hip Morphology in Children with Mucopolysaccharidosis Type I

Markus P. Baker, MRCS*; Elizabeth Ashby, FRCS; Deborah M. Eastwood, FRCS*
Great Ormond Street Hospital for Children, Eastwood, London, UNITED KINGDOM

Purpose: To characterise the prevalence, morphology and natural progression of hip disease in children with mucopolysaccharidosis (MPS) type I.

Methods: This is a retrospective case series report of hip anatomy of children with MPS type I at a teaching hospital from 2004 to 2013. Hip x-rays were examined to determine Reimer's index (as a measure of hip subluxation) and the shape of the femoral head. Children had an average of 4 hip x-rays with an interval of between 9 and 24 months between images.

26 patients had an x-ray performed of both hips at the age of 8. Reimer's index is reported at this age to give a 'snap-shot' of bony femoral head coverage. To assess head morphology, images were converted into digital line drawings and then converted to composite images. Deconvolution was used to create a single 'average' image. This image was then overlaid onto a normal matched hip to define and describe the morphological differences.

24 patients had a minimum of 3 hip x-rays over a 5-year period. The change in Reimer's index is reported for these patients to assess disease progression.

Results: 48 hips in 24 children age 8 years were radiographically analysed. 2 hips showed no evidence of subluxation. 45 hips were subluxed: 14 were mildly subluxed (Reimer's Index 1-20), 10 hips were moderately subluxed (Reimer's Index 21-50) and 23 hips were severely subluxed (Reimer's Index 51-99). 3 hips were dislocated. 48 hips in 24 patients were radiographically analysed over a 5-year period: 30% deteriorated significantly resulting in hip dislocation and 70% remained stable.
Image analysis using deconvolution revealed relative preservation of the metaphyseal region and lateral epiphyseal region, whilst there was proportionally greater disruption of the medial epiphysis.

Conclusions: Children with MPS type I have marked bony uncovering of the femoral head. Approximately one third of these hips progress to dislocation but two-thirds remain relatively stable and do not sublux further. With regards to femoral head morphology, there appears to be relative preservation of the lateral epiphysis but gradual disruption of the medial epiphysis with time.

Significance: With the evolution of new medial treatments for MPS, both life expectancy and quality of life are increasing. This study shows that almost one third of hips in these children will progressively sublux and eventually dislocate. These children should receive active hip surveillance and surgical hip intervention should be offered if appropriate.

See pages 17 - 62 for financial disclosure information.

Spinal Cord Injury Following Extremity Surgery in Children with Thoracic Kyphosis: Case Series

Blazej A. Pruszczynski, MD; ***William G. Mackenzie, MD, FRCS****; Kenneth J. Rogers, PhD, ATC; Amir Ahmadian, MD; Klane K. White, MD, MSc*
Department of Orthopedics, Nemours Alfred I. DuPont Hospital for Children, Wilmington, DE

Introduction: The aim of this study is to present the rare complication of spinal cord injury after lower extremity surgery in children with skeletal dysplasia (SKD) and thoracic kyphosis. Furthermore, we aim to examine factors that may contribute to this rare complication.

Material and Methods: A retrospective review was done of two patients with SKD that developed paraplegia after extremity surgery. Inclusion criteria were thoracic kyphosis greater than 50˚ and a new postoperative motor deficit. Outcome measures included operative time, intraoperative complications, estimated blood loss (EBL), oxygen saturation (O_2sat), mean arterial pressure (MAP), urinary output (UOP), patient positioning, time interval for manifestation of deficit and post surgery recovery of neuro-deficit. Post event motor and sensory deficit recovery and MRIs images were reviewed.

Results: First patient was an 8y6m male with spondyloepiphyseal dysplasia congenita (SEDC) with a 76˚ thoracic kyphosis apex at T4. The second child was a 6y6m male with mucopolysaccharidosis type I-H (MPS I-H – Hurler Syndrome) with a 80˚ thoracic kyphosis apex at T2. The first had a past history of upper cervical fusion without any neurologic deficit. The second one had no past medical history. First patient underwent bilateral proximal femoral osteotomies, while the second child had bilateral innominate and proximal femoral osteotomies. Neuromonitoring was not used in either case. The time of surgery was 293 minutes (lowest MAP value was 40mmHg noted twice for 15 minutes) and 252 minutes (lowest MAP value was 48mmHg for two hours) respectively. EBL and O_2sat were within normal limits. Post-op MRI demonstrated that the child with SEDC had an anterior cord injury at T4-T5, while the MPS I-H child a spinal cord injury at C7-T3 level. In both patients, the spinal cord injuries occurred at the apex of kyphosis, coinciding with abnormal spinal cord signals on MRI. The SEDC patient recovered motor function in 5 months; the MPS patient had no recovery at two years post surgery.

Conclusions: In SKD children with kyphosis who are undergoing extremity surgery the surgeon must be aware of the risk of spinal cord injury. Prolonged supine positioning under anesthesia should be avoided if possible, the MAP should be maintained at a safe level and neuromonitoring should be considered.

Significance: In children with skeletal dysplasia and thoracic kyphosis, spinal cord injury can occur during anesthesia for extremity surgery. Neuromonitoring should be considered.

Study design: Case series, **Level** 4

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Early Open Reduction of Dislocated Hips in Arthrogryposis. Short Term Results.

Hakan Senaran, MD*; Guney Yilmaz, MD; Fatih Durgut; Omer Faruk Erkocak, MD; Bahattin Kerem Aydin; Mehmet Ali Acar, MD*
Selcuk University Medical Faculty, Konya, TURKEY

Purpose: It is commonly believed that the results of open reduction of bilaterally dislocated hips in arthrogryposis is poor due to post-operative stiffness and no treatment is advocated. We have been performing early open reduction for hip dislocations in arthrogryposis and the aim of the current study is to report the results of early (3 to 4 months of age) open reduction of hip dislocations in arthrogryposis.

Methods: 12 consecutive cases (20 hips), operated between 2010 and 2013 due to arthrogrypotic hip dislocation, were retrospectively reviewed. All patients were diagnosed with hip ultrasound. Four of these patients were excluded from the study. One patient was excluded due to short follow-up, the next one was excluded because we were unable to reduce to hip during the procedure. This patient was one of the earliest patient in the group and was operated at the beginning of the learning curve. The next 2 patients were excluded due to older age (8 months and 14 months) at the time of reduction. All patients were kept in hip spica cast for 3 months postoperatively. Patients underwent serial clinical and radiographic follow-up after surgery. Continuity of the Shenton's line, acetabular index and signs of avascular necrosis were evaluated in the final follow-up.

Results: 15 hips in eight patients (4 male, 4 female) were included in the final evaluation. Seven patients had bilateral dislocation and one patient had unilateral dislocation. The mean age at the time of surgery was 3.6±0.5 months. The mean follow-up was 27.3±11.6 months. Anterior Smith-Peterson exposure was applied in two patients (4 hips). Six patients with 11 hips underwent medial open reduction. The mean acetabular index in the final follow-up was 20.6±4.5 degrees. Hips were stable and the Shenton's line was intact in all patients. There was no patient with avascular necrosis in the latest follow-up. There was no redislocation after the procedure. All patients had at least 90° of hip flexion and had limited adduction and internal rotation. Six patients had congenital bilateral club feet. Multiple other procedures were also applied due to joint contractures including: achillotomy and posterior ankle capsulotomy in six patients, bilateral proximal femur derotation osteotomy for external rotation contracture in two patients, midfoot osteotomy in one patient, Dega osteotomy for residual acetabular dysplasia in one patient and femur extension osteotomy in one patient.

Conclusion: Early open reduction of the hip through medial or anterior approach provides easier reduction before severe soft tissue contracture develops and makes femoral shortening unnecessary. Our results show that early reduction of the hips at 3 to 4 months of age in arthrogryposis has a low complication rate and provides concentric reduction and stable hips.

Significance: Early open reduction of dislocated hips at 3 to 4 months of age in arthrogryposis through medial or anterior approach is safe and effective.

See pages 17 - 62 for financial disclosure information.

Sandwich Allografts for Long Bone Non-Unions in Patients with Osteogenesis Imperfecta

Varun Puvanesarajah, BS; Jay R. Shapiro, MD; ***Paul D. Sponseller, MD, MBA***
Johns Hopkins Hospital, Baltimore, MD

Purpose: Patients with osteogenesis imperfecta (OI) often develop fractures that do not heal appropriately due to poor bone quality. Internal fixation has limited applicability in gracile diaphyses that are observed in OI patients. We report the long-term durability of sandwich allograft fixation, a fixation technique that brings circumferential stability and normal collagen to the non-union site in OI patients.

Methods: Between May 2003 and March 2011, ten OI patients with eleven non-unions were treated with compressed "sandwich" allograft cortical struts for humeral, radial, femoral, tibial, or ulnar non-unions. Struts were wide enough to allow for increased osteoconductive and osteoinductive surface area and approximated a hemicylindrical shape. When compressed together, these apposing grafts provided significant surface contact and rotational stability. Seven female and three male patients ranging from 12-78 years in age (mean: 37.4 years) were treated with this technique. Non-unions were present for an average of 27.9 months (range: 6-96 months) before final allograft fixation. Seven of the eleven non-unions failed previous surgical intervention, while the remaining four non-unions were initially treated non-operatively.

Results: All non-unions were healed with abundant, smooth allograft incorporation at last follow-up. Average follow-up was 4.7 years (range: 2-10 years). There were no infections or other acute complications associated with this procedure. However, one patient re-fractured at the previous non-union site and was successfully repaired with additional allograft struts. One patient required removal of prominent screws Final long-term follow-up has revealed no pain or re-fracture at the original non-union site.

Conclusion: Sandwich allograft struts constitute a durable, safe method for stabilization and healing of persistent long bone non-unions in patients with OI. These patients demonstrate ready incorporation of allograft to the native diaphysis. This technique has proven successful in patients who have failed previous surgical intervention.

Significance: Sandwich allograft fixation is a durable method that can heal non-unions that have resulted in deformity and/or have failed previous surgical intervention.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Figure 1:

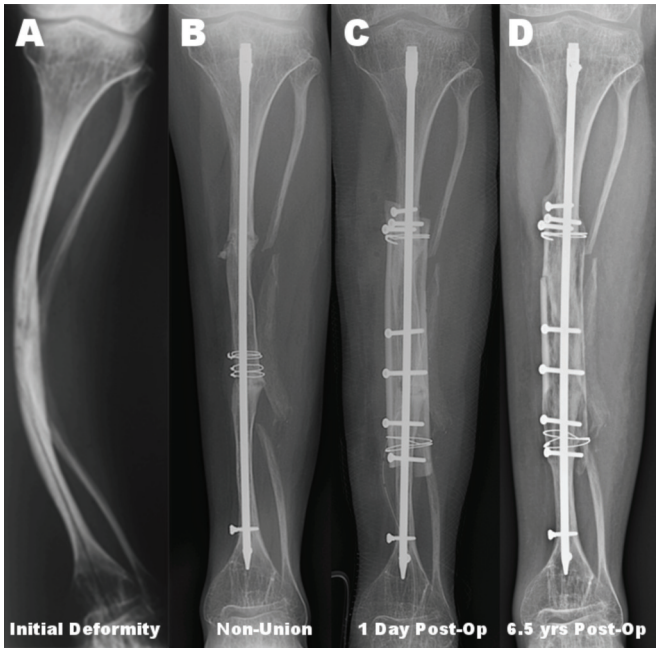
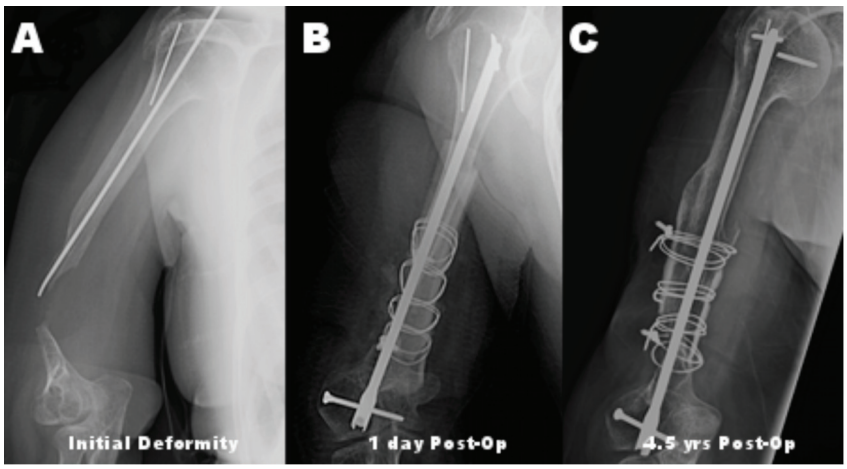


Figure 2:



See pages 17 - 62 for financial disclosure information.

The Diagnostic Utility of Muscle Biopsy for Suspected Myopathy: A Primer for Orthopedists

Brian J. Deignan, MD*; Corrine Link; Kenneth J. Rogers, PhD, ATC; William G. Mackenzie, MD; Mihir M. Thacker, MD*
Nemours Alfred I DuPont Hospital for Children, Wilmington, DE

Purpose: To review the results of muscle biopsies performed at our institution in order to determine the diagnostic yield and hence the utility of performing the procedure. This information can be used to make specific recommendations to an orthopaedic surgeon for when a muscle biopsy may be indicated, what it may diagnose, and the likelihood of obtaining a definitive diagnosis from the biopsy.

Methods: The Muscle Histochemistry Lab at our institution has maintained a log of samples dating back to 1981. This data was compiled and cross-referenced with our surgical database, which identified patients from 2000-2013 by Diagnosis and CPT code. Biopsies performed to diagnose a process other than myopathy (ie neoplasm or infection) were excluded. Biopsy specimens that were diagnostic were flagged. For biopsies performed after 2000, preoperative and postoperative diagnoses codes were compared to see if the biopsy results either confirmed or changed the suspected diagnosis.

Results: There were 583 biopsy specimens that met criteria for analysis. Of these, 234 of the biopsies yielded a molecular diagnosis. Thus, diagnostic yield was 40% for the entire sample. The three most common diagnoses made were muscular dystrophy (24%), neurogenic changes (21.8%), and mitochondrial myopathy (10.3%). Diagnosis codes were available for the 225 most recent biopsies performed starting in the year 2000. Of this subset, 97 of the biopsies were diagnostic (yield of 43.1%), 51 of which confirmed the preoperative diagnosis. Thus, when the biopsy was diagnostic, the preoperative diagnosis was correct just 52.6% of the time.

Conclusion: Orthopaedic surgeons are sometimes consulted by their colleagues in genetics or neurology to biopsy the muscle of a patient with a suspected myopathy. The patients in question are often children, with a biopsy requested to assist in diagnosing the cause of motor delay, such as suspected muscular dystrophy or congenital or metabolic myopathy. Based on our findings, the likelihood of making a diagnosis from the biopsy procedure is 40%. In the instance when the biopsy is diagnostic, it confirms the preoperative diagnosis just half (52.6%) of the time. The above information may be useful when discussing risks and benefits of a procedure with a patient and/or parents.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Characterization of Lower Limb Deformity in Children with Mucopolysaccharidosis Type I and Treatment with Guided Growth

Elizabeth Ashby, FRCS*; Markus P. Baker, MRCS; Deborah Eastwood, FRCS*
Great Ormond Street Hospital for Children, London, UK

Aim: To describe lower limb deformity in children with mucopolysaccharidosis (MPS) type I and the outcome of treatment with guided growth.

Method: This is a retrospective case series report of lower limb alignment in children with MPS type I from 2004 to 2013. Standardised full-length standing leg x-ray films were examined to determine the tibio-femoral angle. Children had an average of 6 x-rays with an interval of between 12 and 24 months between images.

22 patients had full-length standing leg x-rays at the age of 8. Average tibio-femoral angle and range are reported at this age. These patients had a minimum of 3 x-rays performed over a period of 5 years. This allowed analysis of disease progression over time.

12 of the 22 patients had their deformity treated with guided growth in the form of 8-plate insertion. We report the average time for the deformity to correct and the outcome following 8-plate removal.

Results: At age 8 years the average tibio-femoral angle was 18 degrees valgus (range 4 to 34 degrees valgus). Over a period of 5 years, 3 legs showed spontaneous improvement in alignment, 24 legs remained stable and 17 legs developed a gradually worsening deformity.

12 patients were treated with guided growth and this was initially successful in all cases. Average deformity at the start of treatment was 26 degrees valgus. 6 patients still have the 8-plates in-situ and in 6 patients the 8-plates have been removed. The average tibio-femoral angle at the time of 8-plate removal was 4 degrees valgus (normal alignment). The plates remained in-situ for an average of 22 months. Since removal, 4 patients have developed a recurrent leg deformity almost equal to pre-surgery levels.

Conclusions: Children with MPS type I have a valgus knee deformity. Approximately half of these deformities worsen with time and half remain stable. Treatment with guided growth is initially successful. When 8-plates are removed, the deformity commonly recurs. Further investigation is needed to assess if leaving the 8-plates in longer (allowing over-correction) could lead to a more permanent deformity correction.

Significance: Valgus knee deformity in children with MPS type I can be treated using guided growth. Once the 8-plates are removed the deformity can recur.

See pages 17 - 62 for financial disclosure information.

Medial Malleolar Screw Hemiepiphysiodesis for Ankle Valgus Revisited

Sean M. Caskey; David J. Wilson, MD; Glen O. Baird, MD;
Bryan J. Tompkins, MD; ***Paul M. Caskey, MD***
Shriners Hospital for Children, Spokane, WA

Purpose: We reported a large review of complications of medial malleolar screw hemiepiphysiodesis for ankle valgus in 2009 and recommended using fully threaded 4.5 mm screws to avoid hardware complications. The purpose of this study is to report our experience with medial malleolar screw hemiepiphysiodesis after our conversion to fully threaded 4.5 screws exclusively.

Methods: A retrospective review of medial malleolar screw hemiepiphysiodesis from 2007 to 2012 was performed. Inclusion criteria; clinical and radiographic evidence of ankle valgus treated with a fully threaded 4.5mm screw, minimum follow up to screw removal or completion of growth. Preoperative, post-operative and follow-up clinical and radiographic data were collected. Measurements of tibial talar angle and complications related to the procedure were collected.

Results: Our population who met the inclusion criteria for the study consisted of 54 ankles in 35 patients, 23 males and 12 females. Common underlying diagnoses were clubfoot, multiple hereditary exostosis and neurologic problems. Mean age at screw insertion was 10 years (range of 6.25 to 14.9 years) and mean age of screw removal or maturity of 11.9 years (range of 8.5 to 16.3 years). Mean preoperative tibial talar angle was 11.2 degrees valgus (range 1 to 31 degrees) and mean tibial talar angle at screw removal/maturity was 0.5 degrees valgus (range 32 degrees valgus to 9 degrees varus). The average rate of correction of ankle valgus was 0.72 degrees/month (range 0 to1.5 degrees/month). We had no major complications, defined as requiring additional surgery. Minor complications occurred in 7.4% of ankles including 2 ankles with temporary pain over incision at first follow up and two screws in one patient that migrated with continued correction.

Conclusion: Medial malleolar screw hemiepiphysiodesis is a safe, reliable means of correcting ankle valgus. The average rate of correction of the valgus deformity is comparable to other means of correction using guided growth and the complication rate was low especially when 4.5mm fully threaded screws were used exclusively. We prefer the medial malleolar screw technique for correction of ankle valgus because the insertion and removal of the screw can be performed percutaneously.

Significance: Medial malleolar screw hemiepiphysiodesis remains a safe, reliable means of correcting ankle valgus in growing children.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Can Radiographs Predict Outcome in Patients with Idiopathic Clubfoot Treated with the Ponseti Method?

Conor Patrick O'Halloran, BS; Blaise A. Nemeth, MD; Matthew A. Halanski, MD; Catherine Carlyle Zimmerman, MD; ***Kenneth J. Noonan, MD***
University of Wisconsin-Madison School of Medicine & Public Health, Madison, WI

Purpose: The aim of this study is to determine if radiographic measurements, taken prior to tenotomy, can predict recurrence in children with idiopathic clubfoot treated in the manner of Ponseti.

Methods: A retrospective chart and radiographic review was performed on children with idiopathic clubfoot treated in the manner of Ponseti over a ten-year period with follow-up to at least 2 years of age. Other inclusion criteria included having a forced dorsiflexion lateral foot radiograph prior to tenotomy. The following angles were measured in duplicate on the pre-tenotomy radiographs: foot dorsiflexion (defined as the angle between the tibial shaft and the plastic plate used to dorsiflex the foot), tibio-calcaneal, talo-calcaneal, and talo-first metatarsal angles. Clinical review of patient records identified patients who had a recurrence, defined as requiring additional tenotomy or other operative procedure.

Results: 45 patients (71 feet) were included in the study. The median follow up was until 4.6 years of age. The Intra-reader reliability (ICC) was acceptable for all measures. 13 of the 71 feet required additional surgery, occurring at a median age of 3.6 years. Of the four radiographic measures, only foot dorsiflexion had a statistically significant Hazard Ratio (HR). (HR=1.04, p=.03). Youden's method identified 16.6 degrees of dorsiflexion as the optimal cut-off. Feet with at least that amount of dorsiflexion (n=21) experienced no recurrences, feet with less than that amount of dorsiflexion (n=50) experienced 13 recurrences (p=0.007).

Conclusions: Reduced foot dorsiflexion on lateral forced dorsiflexion pre-tenotomy radiograph was associated with an increased risk of recurrence. This information may guide treatment by identifying patients in whom casting has not produced sufficient correction to proceed to tenotomy. In the opinion of the authors, radiographic measurements of dorsiflexion are more objective and reproducible than clinical measurements of equinus, and therefore more clinically relevant. Dorsiflexion to 15 degrees past neutral appears to predict successful treatment via the Ponseti method.

Significance: Dorsiflexion measured via a forced dorsiflexion lateral radiograph predicts recurrence in infants with idiopathic clubfoot treated in the manner of Ponseti. This information may be useful in deciding which patients should possibly undergo additional casting prior to or after tenotomy. In addition, this information may identify which patients should have closer follow-up or be prescribed orthosis with higher rates of compliance.

See pages 17 - 62 for financial disclosure information.

Predicting the Need for Surgical Intervention in Patients with Idiopathic Clubfoot

Rachel Y. Goldstein, MD, MPH*; Derek A. Seehausen, BA; Alice Chu, MD;*
Debra A. Sala, MS, PT; Wallace B. Lehman, MD
NYU Hospital for Joint Diseases, New York, NY

Purpose: The purpose of this study was to determine the early factors associated with the need for surgical interventions in patients with idiopathic clubfoot treated with the Ponseti method.

Methods: All patients with idiopathic clubfoot treated with Ponseti method at our institution with greater than three years of follow-up were evaluated. Age at presentation, history of previous treatment, number of casts used, need for percutaneous Achilles tenotomy (PAT), age of initiation of foot abduction orthosis (FAO), compliance with FAO, and need for additional casts were recorded. Dimeglio/Bensahel and Catterall/Piriani scores were recorded at initial presentation, at initiation of FAO, at one, two, three year follow-up, and at the most recent follow-up.

Results: Since 2000, 86 patients (134 feet) had greater than three years of follow-up from time of initial presentation, and 43 of these feet (32%) had undergone surgery beyond a PAT. Patients who were non-complaint with the FAO were 7.9 times more likely to need surgery than those who were compliant (CI: 2.8-22.0, $p<0.001$). Female patients were 5.4 times more likely to need surgery than male patients (CI: 1.8-16.6, $p=0.003$). For every one point increase in Dimeglio/Bensahel score at presentation, patients were 1.3 times more likely to need surgery (CI: 1.0-1.5, $p=0.033$). For every one point increase in Dimelgio/Bensahel score at initiation of the FAO, patients were 1.5 times more likely to need surgery (1.1-2.0, $p=0.005$). And, for each additional cast required before the initiation of the FAO, patients were 1.5 times *less* likely to need surgery (CI: 1.1-2.7, $p=0.030$). No other variable significantly contributed to predicting the need for surgery.

Conclusion: At presentation female patients and those patients with higher Dimeglio/Bensahel scores are at increased risk for needing surgical intervention. At initiation of the FAO, higher Dimeglio/Bensahel scores and fewer casts increase the risk for future surgical intervention. And, noncompliance with the FAO is associated with the highest risk for surgical intervention.

Significance: There are early factors that can be used to predict increased risk for surgical intervention in patients undergoing treatment for idiopathic clubfoot.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Painful Flatfoot in Clubfeet Treated By Ponseti Casting

Pooya Hosseinzadeh, MD*; Christopher B. Hayes, MD; Kevin A. Murr, MD; Ryan D. Muchow, MD; Henry J. Iwinski, MD; Janet Walker, MD; Vishwas R. Talwalkar, MD; Todd A. Milbrandt, MD, MS*
Lexington Shriners Hospital for Children, Lexington, KY

Purpose: Overcorrection is a well described complication in clubfeet treated by comprehensive soft tissue release. The treatment of clubfoot has changed significantly in the past two decades with Ponseti casting as the most popular method used in North America. The rate of overcorrection (flatfoot) after Ponseti treatment is not reported in the literature. We studied the rate of overcorrection and its association with pain in clubfeet treated by Ponseti casting and studied the effect of Tibialis anterior tendon transfer (TATT) on the rate of overcorrection and incidence of pain.

Methods: Patients with clubfoot treated by Ponseti method at our institution between 2001 and 2005 were included. Patients less than 8 years of age at the time of last follow up and patients with posterior or posteromedial release were excluded from the study. Pedobaraographic measurements are done routinely at our institution for all patients with clubfoot. Pedobarographic studied were used to identify patients with overcorrected feet (flatfoot) defined as the loss of medial arch. Medical records were reviewed to identify patients with painful feet and to document if other surgeries have been performed in the course of treatment.

Results: 87 patients with 115 clubfeet were included in the study. 44 feet (38%) were treated by TATT during the course of treatment. 14 feet were defined as overcorrected (12%). From the 14 flatfeet, 7 complained of pain during daily activities (50%). Among 101 feet that did not show overcorrection, 32 complained of pain during daily activities (32%). Chi-Square analysis showed that rate of pain during daily activities is significantly higher in overcorrected feet compared to the non overcorrected group ($P<0.001$). TATT surgery was not associated with increase in the rate of overcorrection ($P=0.4$) or pain ($P=0.3$).

Conclusion: Overcorrection can occur after treatment of clubfeet by Ponseti method and is associated with increased incidence of pain during daily activities.

Significance: This study makes clinicians aware of this possible complication after treatment of clubfoot with Ponseti method.

See pages 17 - 62 for financial disclosure information.

Success of Non-Operative Treatment of Proximal Fifth Metatarsal Fractures in Children

Melissa J. Wilcox, BA; Joanna H. Roocroft, MA; Tracey P. Bastrom, MA;
Eric W. Edmonds, MD
Rady Children's Hospital, San Diego, CA

Purpose: The purpose of this study was to evaluate whether children with proximal fifth metatarsal fractures in Zones I, II and III (Zone I or apophyseal fractures, Zone II or diaphyseal/Jones' fractures, and Zone III or proximal shaft/dancer's fractures) had poor long term functional outcomes because of the reduced vascular supply in this watershed area.

Methods: A retrospective chart review was performed of children identified by ICD-9 code to have sustained a 5th metatarsal fracture treated during 2006–2007 with initial non-operative management and immobilization. Exclusion criteria for assessment of radiographs was duration of treatment less than 4 weeks, unless evidence of union already present. All children identified in review were then invited to participate in a survey by telephone interview. For those agreeing to participate, outcome measures were obtained, including: AOFAS midfoot scores, FAOS scores, and SF-8 scores.

Results: 124 children were identified has being treated during the study period, but only seventy-six patients (mean age 12.6± 2 yrs) had radiographs available for a valid assessment of union. Children with confirmed radiographic union were followed a mean 4.99 weeks, while those without confirmed union were followed a mean 8.25 weeks (p=0.033). Thirty (24%) children agreed to participate in the phone interview at a mean 6.6±0.5 years after injury. The mean for all the outcome scores were 89% or higher (AOFAS 98.5±37%, FAOS Pain 95±12%, FAOS Symptoms 96±8%, FAOS ADL 97±7, FAOS Sports 93.5±13%, FAOS QOL 89.8±20%). Of these 30 children, 24 had confirmed union at final visit, but 6 were lost to follow-up prior to radiographic union. The outcome scores were similar between these two groups, with better scores observed in the non-union cohort for FAOS Pain (p=0.05) and Sports (p=0.04) domains.

Conclusion: Children who sustain base of the 5th metatarsal fractures have good functional outcomes, at intermediate-term follow-up (mean of almost 7 years) and experience minimal residual disability with conservative treatment. Radiographic union at last documented follow-up did not appear to be associated with enhanced function in the long term.

Significance: The majority of children with proximal 5th metatarsal fractures treated with cast immobilization for 4 to 6 weeks achieved satisfactory union with high functional outcome scores after six to seven years. Those who do not achieve satisfactory union at final follow-up also trended to have a high functional status with minimal disability suggesting that continued radiographic monitoring until complete union may not be necessary in this age group.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Demographics and Epidemiology of Osteochondritis Dissecans of the Ankle in Children and Adolescents

Jeffrey I. Kessler, MD*; Hooman Nikizad; Kevin G. Shea, MD; John C. Jacobs, Jr., BS; Judith D. Bebchuk, PhD; Jennifer M. Weiss, MD*
Kaiser Permanente Southern California, Los Angeles, CA

Purpose: The purpose of the present study is to assess the demographics and epidemiology of osteochondritis dissecans (OCD) of the ankle in children.

Methods: A retrospective chart review of an integrated health system was done on ankle OCD patients aged 2-19 from 2007-2011, with over 1 million patients in this cohort. Lesion location, laterality, and all patient demographics were recorded. Ankle OCD incidence was determined for the group as a whole and by both gender and age group (divided into ages 2-5, 6-11, and 12-19). Patient differences based on age, sex, and ethnicity were analyzed and, using multivariable logistic regression models, we assessed the risk of ankle OCD for age group, gender and ethnicity.

Results: 85 patients fit the inclusion criteria. No ankle OCD lesion was found in 2-5 year olds. 61 (71.8%) of lesions were in the medial talus, 19 (56.5 %) of lesions were right sided, 37 (43.5%) left sided, and none were bilateral. The incidence of ankle OCD for patients aged 6-19 was 4.6 per 100,000 overall, and 3.2 and 6.0 per 100,000 for males and females, respectively. 12-19 year olds represented the vast majority of OCD, with an incidence of 6.8 per 100,000 versus 1.1 in 6-11 year olds. Females had an incidence of 1.5 and 8.9 per 100,000, respectively, in 6-11 and 12-19 year olds, respectively, while males had an incidence of 0.7 and 4.8 per 100,000, respectively. The overall female/male ratio of ankle OCD was 1.6/1. A multivariable logistic model revealed a 6.9 times increased risk of ankle OCD in 12-19 year olds compared to 6-11 year olds, and females had a 1.5 times greater risk of ankle OCD than males. Based on race and ethnicity, non-Hispanic Whites had the highest odds ratio for elbow OCD in comparison to all other ethnicities.

Conclusions: In this population-based cohort study of pediatric ankle OCD, females had a higher incidence of OCD, and a 1.5 times greater risk of ankle OCD compared to males. Those aged 12-19 had nearly 7 times the risk of ankle OCD as compared to 6-11 year-olds.

Significance: This is the first true population-based epidemiologic and incidence study of pediatric ankle OCD in a stable population.

See pages 17 - 62 for financial disclosure information.

Ponseti Casting for Infants with Idiopathic Clubfoot: Does onset of Treatment Matter?

Conor P. O'Halloran, BS; ***Blaise A. Nemeth, MD, MS****; Matthew A. Halanski, MD; Catherine Carlyle Zimmerman, MD; Kenneth J. Noonan, MD*
University of Wisconsin School of Medicine and Public Health, Madison, WI

Purpose: Most practitioners initiate Ponseti treatment for idiopathic clubfoot as soon as possible after birth Casting may complicate treatment of other health issues in the first few weeks of life. To date, little data exists to support or refute immediate cast application. This study aims to determine if better results are obtained when infants are treated within the first two weeks of life.

Methods: A retrospective review was performed to evaluate the results of children with idiopathic clubfoot treated using the Ponseti method over a ten-year period with at least 2-years follow-up. Patient records were reviewed to identify the age at placement of the first cast, as well as identify patients who had a recurrence. Recurrence was defined as requiring repeat tenotomy, tendon transfer, or other operative procedure. Patients were divided into two groups. Group I had their first cast placed between 0-14 days of life, Group II had their first cast placed between 15-28 days of life.

Results: Forty-one patients (65 feet) were included in the study. The median follow up was 4.6 years of age. Thirty-four feet (21 patients) were in Group I, 31 feet (20 patients) were in Group II. Thirteen feet (9 patients) experienced a recurrence. There was no significant difference in number of casts required for initial correction (p=.29) or risk of recurrence between Groups I and II (p=.76).

Conclusions: This data suggests that there is no difference in the number of casts to obtain correction, the time in casts, or the risk of recurrence between patients undergoing Ponseti method earlier or later within the first month of life. This information may help prioritize treatment of other infantile health issues if they exist; and give new parents time to adjust to their new baby before starting treatment without detriment.

Significance: The initiation of the Ponseti method in infants with idiopathic clubfoot should be approached with more flexibility and less dogma, allowing other neonatal concerns to be overcome prior to the initiation of long leg casting.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

e-Poster #25

Do Surgeons and Third Party Payors Agree on the Criteria to Diagnose Femoroacetabular Impingement?

John C. Clohisy, MD*; Ira Zaltz, MD; Geneva Baca, BA; David A. Podeszwa, MD; Perry L. Schoenecker, MD; Daniel J. Sucato, MD, MS; Robert T. Trousdale, MD; Christopher M. Larson, MD; James Ross, MD*
Washington University, St. Louis, MO

Purpose: Femoroacetabular impingement (FAI) is characterized by abnormal, repetitive contact between the femoral head and the acetabular rim leading to articular cartilage delamination, labral tears and secondary osteoarthritis. Disagreement between third party payor policies and clinical diagnoses can delay or prevent treatment. The purpose of this study was to compare the clinical diagnoses of FAI with third party payor policies to determine the level of agreement/disagreement.

Methods: 1085 hips undergoing surgery for FAI were identified from a prospective, multi-center database of over 2250 hip preservation procedures. The coverage policies of 3 insurance companies with strict criteria for the surgical treatment of FAI were applied to this patient population to determine if the treating surgeon's evaluation met the criteria of FAI diagnosis. Criteria included various combinations of symptom duration, age, positive impingement test, radiographic osteoarthritis, radiographic signs of cam and/or pincer impingement, and intra-operative Outerbridge classification.

Results: 1085 patients (1085 hips) underwent FAI surgery between May 2007 and April 2012. The patient demographics included 55% females, average age 28 years and average BMI 26.5 kg/m2. Acetabular and femoral head chondral disease was noted at surgery in 82.8% and 24.0% of hips respectively. 98.3% of hips demonstrated labral and/or chondral disease. Application of the three different insurance policies to this group of patients resulted in 39%, 57%, and 81% being defined as having appropriate criteria for surgical treatment of FAI. Inclusion increased from 39 to 66% and 57 to 76% for the 2 policies when the intra-operative Outerbridge classification was excluded from the inclusion criteria for FAI.

Conclusion: 19 to 61% of FAI diagnoses made by treating surgeons do not meet the criteria of third party payors.

Significance: These data indicate a major need for improved consensus regarding the diagnosis of FAI and the indications for surgical intervention.

See pages 17 - 62 for financial disclosure information.

Staphylococcus Aureus Musculoskeletal Infections and Methicillin-Resistance Over the Past Decade

Eric J. Sarkissian, BS; Itai Gans, BS; Melissa Gunderson, BA; ***John (Jack) M. Flynn, MD***
The Children's Hospital of Philadelphia, Philadelphia

Purpose: The spectrum of pediatric musculoskeletal *Staphylococcus aureus* (SA) infections is changing. Prior small series have indicated a growing concern over the rise and invasiveness of community-acquired methicillin-resistant SA (caMRSA). The purpose of our study was to conduct a large decade-long cohort comparison between acute caMRSA and MSSA musculoskeletal infections at our institution with respect to clinical course and complexity of care.

Methods: We studied a consecutive series of patients presenting to our institution with a diagnosis of osteomyelitis, septic arthritis, or both between January 2001 and June 2010. Inclusion criteria were acute SA infections proven by positive culture of blood, bone, or joint aspirate. Exclusion criteria were infectious etiologies other than caMRSA or MSSA and patients older than the age of 18 years. In an effort to minimize bias caused by nosocomial infections, post-operative and chronic infections were excluded. Data related to hospital course, laboratory values, and number of surgical interventions were collected and compared between caMRSA and MSSA groups.

Results: In our study cohort, there were 148 cases of acute musculoskeletal SA infection (25% caMRSA, n=37 and 75% MSSA, n=111). The proportion of musculoskeletal infections caused by caMRSA increased from the beginning of the decade to the end (9% to 29%). The average duration of hospitalization was longer in the caMRSA than MSSA group (13 days vs. 8 days, p=0.01). Multiple surgical procedures (n>1) were performed more frequently in caMRSA- than MSSA-infected patients (38% vs. 15%, p=0.004). The mean presenting CRP level was higher in the caMRSA than MSSA group (14.7 mg/L vs. 9.8 mg/L, p=0.02). Infection-related complications (deep venous thrombosis, septic emboli, septic shock, recurrent infection, and/or avascular necrosis) were more common in patients with caMRSA than MSSA infections (24% vs. 6%, p=0.002).

Conclusion: In our study, the largest known comparative series of children and adolescents with musculoskeletal *Staphylococcus aureus* infections, we found a 3.2-fold increase in the frequency of caMRSA over the past decade. Compared to MSSA infections, caMRSA infections led to significantly longer inpatient stays, greater number of surgical interventions, higher presenting CRP level, and increased risk for developing complications.

Significance: As the rate of community-acquired MRSA pediatric musculoskeletal infections has increased over the past decade, heightened awareness and aggressive treatment is paramount for avoiding sequelae and improving patient outcomes.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Does Tranexamic Acid Reduce Blood Loss and Transfusion Requirements Associated with the Periacetabular Osteotomy?

Scott A. Wingerter, MD, PhD; Angela D. Keith, MS; Perry L. Schoenecker, MD; Geneva Baca, BA; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

Purpose: Tranexamic acid (TXA) has shown safety and efficacy in reducing blood loss associated with various surgical procedures. However, there is a paucity of information regarding the impact of TXA on blood loss and transfusion requirements associated with the periacetabular osteotomy (PAO). Minimizing blood loss in young active patients undergoing pelvic osteotomy surgery facilitates recovery and avoids the risk of complications associated with transfusions. The purpose of this study is to determine whether TXA reduces blood loss and transfusion rates associated with the PAO. Secondly we analyzed whether TXA was associated with an increased risk of thromboembolic events.

Methods: A consecutive series of 100 PAO procedures performed by a single surgeon was reviewed to compare the groups immediately prior to and following the implementation of the routine use of tranexamic acid (two prospective longitudinal cohorts). TXA dosing followed an established protocol based on risk with a standard dose of 1g IV infused over 10 minutes prior to skin incision and an additional 1g IV at wound closure, Outcome measures include estimated blood loss intraoperatively (EBL), intraoperative cell saver utilization, postoperative drain output, and transfusion rate.

Results: The average estimated blood loss intraoperatively (675.4mL vs. 391.0mL, $p<0.001$) and total blood loss including postoperative drain output (1020.6mL vs. 706.16mL, $p=0.001$) were significantly less in the patients receiving TXA. The transfusion rate during the hospital course decreased from 58% to 24% with a decrease in average number of units transfused per patient dropping from 1.02 to 0.28 ($p=0.013$). No cases of postoperative deep vein thrombosis (DVT) or pulmonary embolus (PE) were identified in either group.

Conclusion: TXA reduces transfusion rates and blood utilization without any increase in thromboembolic events when used in association with the periacetabular osteotomy for the treatment of acetabular dysplasia.

Significance: Tranexamic acid safely reduces transfusion rates and blood utilization when used in association with the periacetabular osteotomy for the treatment of acetabular dysplasia.

See pages 17 - 62 for financial disclosure information.

Impact of Obesity on Risk of Complications Following Periacetabular Osteotomy for the Treatment of Symptomatic Hip Dysplasia in Children and Adolescents

Eduardo N. Novais, MD*; Young Jo Kim, MD, PhD; Perry L. Schoenecker, MD; John C. Clohisy, MD; Rafael Jose Sierra, MD; Robert T. Trousdale, MD; Gorden D. Potter, III, MD; Patrick Carry, MA; Michael B. Millis, MD*
Boston Children's Hospital, Mayo Clinic Rochester, Shriners Hospital St. Louis

Purpose: The Bernese Periacetabular osteotomy (PAO) has been increasingly performed for the treatment of symptomatic hip dysplasia with encouraging early results. The purpose of this study was to evaluate to the effect of obesity on the risk of complications among children and adolescents undergoing PAO.

Methods: Clinical and radiographic data were retrospectively collected from 84 children and adolescents (<20 years of age) who underwent PAO at one of three different institutions and were followed for minimum of 12 months. BMI percentiles were calculated based on the 2000/CDC growth charts. Complications were defined according to a modified Clavien-Dindo complication scheme for hip preservation surgery. A logistic regression analysis was used to identify factors related to the development of a complication that required treatment outside of routine postoperative care (complications grades II-V). Multi-variable linear regression analyses were used to compare change in radiographic parameters including Tönnis acetabular roof angle, anterior center-edge-angle (ACEA) and lateral center-edge-angle (LCEA) among obese vs. non-obese subjects.

Results: A total of 10.7% of the population was considered obese. The mean age at surgery for the 67 (79.8%) females and 17 (20.2%) males in the cohort was 16.5 (range 12-19.9 years old). Obesity [p<0.0001] was the only variable significantly related to the development of a complication in both univariable and multi-variable analyses. After controlling for study site, the odds of an obese subject developing a complication were 10.3 [95% CI: 1.9 to 59.8] times greater than odds of a non-obese subject developing a complication. The most common complications among obese subjects were: infection superficial (22%) and wound hematoma (22%). Among the non-obese subjects, the most common complication was sciatic neurapraxia (temporary, requiring medication only) 2.67%. Among all subjects, significant improvements in LCEA [p = 0.0004], ACEA [p = 0.006] and Tönnis [p<0.0001] angles were achieved following surgery. The degree of radiographic correction achieved among obese subjects was similar to the correction achieved among non-obese subjects in relation to LCEA [mean difference: 3.2°, p =0.2899], ACEA [mean difference: -3.2, p = 0.4394], and Tönnis angles [mean difference: -1.4°, p =0.5656].

Conclusions: Obesity was the strongest predictor of the development of a complication following PAO. Radiographic correction was similar among obese and non-obese patients.

Significance: In terms of deformity correction, both obese and non-obese patients benefit from PAO. However, the pediatric orthopaedic surgeons should be aware of the higher risk for complications among obese subjects.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Accuracy of Acetabular Correction in Periacetabular Osteotomy

Stephen T. Duncan, MD; Gail Pashos, BS; Angela D. Keith, MS;
Geneva Baca, BA; Perry L. Schoenecker, MD; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

Purpose: Acetabular reorientation during the periacetabular osteotomy (PAO) is complex and is a key step in optimizing clinical outcomes of the procedure. Achieving hip joint stability without creating secondary femoroacetabular impingement is challenging and criteria for an optimal acetabular correction have not been determined. This study proposes radiographic target ranges for the PAO acetabular reorientation and examines the frequency in which the acetabular correction is within the predetermined target ranges.

Methods: Retrospective review of the hip preservation database for patients with acetabular hip dysplasia undergoing PAO from January 2007 to December 2011 was performed. Patients with a diagnosis other than classic hip dysplasia of the affected hip were excluded. Patient demographic and radiographic data was collected. We defined the acceptable ranges for acetabular reorientation to be: lateral center edge angle (LCEA, 25^{o}-40^{o}), anterior center edge angle (ACEA, 18^{o}-38^{o}), acetabular inclination (0^{o}-10^{o}), extrusion index (0-20%), and medial offset (0-10 mm).

Results: There were 93 females (78%) and 27 males (22%). Mean age was 27 years and the average BMI was 25 kg/m^2. Comparison of preoperative and follow-up radiographs demonstrated an average improvement of 18.4° (from 11.0° to 29.4°, $p < 0.001$) in the LCEA with 78% meeting our target, an average improvement of 17.3° (from 13.8° to 31.1°, $p<0.001$) in the anterior center-edge angle with 83% meeting our target, and an average improvement of 14.7° (from 18.2° to 3.5°, $p<0.001$) in acetabular inclination angle with 83% meeting our target. The extrusion index improved an average of 18.9% (from 34.2 to 15.3%, $p<0.001$) with 77% meeting our target, and the hip center was translated medially an average of 4.8 mm (from 13.8 mm to 9.0 mm, $p<0.001$) with 61% meeting our target. When combining the LCEA, the ACEA, the acetabular inclination angle, and the extrusion index, 49% PAOs met the target ranges for all the parameters.

Conclusion: Our proposed radiographic target ranges for individual parameters of acetabular reorientation were achieved in the majority of cases (61-83%), while obtaining desired corrections for all four parameters simultaneously was less common (49%). Refined strategies to consistently obtain optimal, multidimensional acetabular correction with the PAO are needed.

Significance: Accuracy of correcting the acetabulum during a PAO is a key step for optimizing outcomes and occurs in the majority of the cases for single radiographic parameters but occurs less commonly for simultaneous correction of all parameters.

See pages 17 - 62 for financial disclosure information.

Idiopathic Cam Morphology Is Not Caused By Subclinical Slipped Capital Femoral Epiphysis: A MRI and CT Study

Shafagh Monazzam, MD; James D. Bomar, MPH; ***Andrew T. Pennock, MD***
Rady Children's Hospital, San Diego, CA

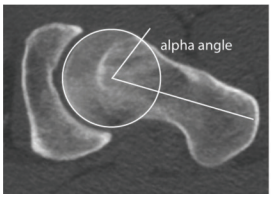
Purpose: Our purpose was to determine if cam impingement is the result of a subclinical slipped capital femoral epiphysis (SCFE). To that end, we: 1) evaluated the normal development of the proximal femoral physis tilt angle from ages 5 to 19. 2) compared the physeal tilt angle between 3 cohorts: Idiopathic cam morphology (Cam_{IP}), cam morphology secondary to known SCFE (Cam_{SCFE}), and normal hips. 3) evaluated the correlation of physeal tilt angle and cam size among the three cohorts.

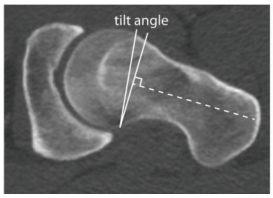
Methods: A database of 192 abdominal/pelvic scans (ages 5-19), with no known orthopaedic issues were utilized for the normal cohort. Patients treated for femoroacetabular impingement (FAI) with preoperative advanced imaging were separated to Cam_{IP} and Cam_{SCFE} cohorts. The alpha angle and tilt angle were measured on each hip on an axial-oblique image.

Results: The mean tilt angle among the normal patients was 12.1° with 1.9% of the variation in tilt angle being explained by age with each additional year of age decreasing the tilt angle by 0.27˚($p=0.008$). The tilt angle for the Cam_{SCFE} cohort (mean 44.5°) was found to be significantly greater than both the Cam_{IP} cohort (mean 5.9°) ($p < 0.001$) and the control cohort (mean 12.8°)($p < 0.001$). The tilt angle for the Cam_{IP} cohort was found to be significantly less than the control cohort ($p = 0.003$). The alpha angle and tilt angle were positively correlated in the Cam_{IP} cohort but no correlation was found in the other cohorts.

Conclusion: The proximal femoral physis normally has a posterior tilt that becomes more anterior through maturation. Idiopathic cam morphology has a drastically different physeal tilt angle than cam morphology secondary to SCFE suggesting that the majority of idiopathic cam morphology is not the result of subclinical SCFEs. The correlation found between physeal tilt and alpha angle in the idiopathic cam morphology group supports a physeal disturbance as a causative factor of idiopathic cam morphology.

Significance: The physeal tilt of hips with cam morphology secondary to SCFE and idiopathic cam morphology significantly differ suggesting subclinical SCFEs are not the cause of idiopathic cam morphology.





	alpha angle	tilt angle
Normal	43.2	12.1˚
Cam_{IP}	66.1	5.9˚
Cam_{SCFE}	75.8	44.5˚

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

What Is "Acetabular Retroversion" and How Should We Measure Femoral Head Coverage: Evaluation of Acetabular Morphology By Volume-Rendered Ct

***John R. Faust, MD**; Stephen Little, MD; Tim Schrader, MD*
Children's Healthcare of Atlanta at Scottish Rite, Atlanta, GA

Purpose: Hip pathology involving acetabular version and femoral head coverage is a complex and dynamic 3-dimensional problem; consequently, evaluation with radiographs has limitations. This study presents a new method of assessing acetabular version and femoral head coverage using volume-rendered CT and evaluates the source of radiographic "acetabular retroversion."

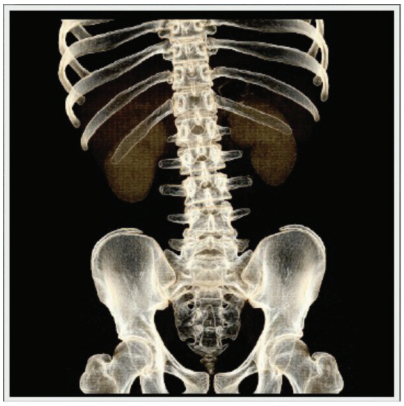
Methods: 168 hips in 84 consecutive patients (44 male, 40 female; ages 13-20 years) who underwent abdominal/pelvic CT for non-hip related complaints were retrospectively examined. Examinations were performed for a variety of complaints, including, abdominal pain, nephrolithiasis, vomiting, etc. Patients with obvious hip pathology were excluded. These studies were used to create a volume-rendered 3-D CT model of the pelvis and hip joints. Pelvic inclination was measured and corrected to neutral (60°) to standardize the images. Measurements of femoral head diameter (FHD), anterior femoral head coverage (FHC_A), and posterior femoral head coverage (FHC_P) were obtained. Femoral head area (FHA) was defined as $\pi*(FHD/2)^2$. Percent anterior femoral head coverage ($\%FHC_A$) was defined as $(FHC_A/FHA)*100$. Percent posterior femoral head coverage ($\%FHC_P$) was defined as $(FHC_P/FHA)*100$. Acetabular version by volume-rendered CT (AV_{VR}) was defined as (FHC_P/FHC_A).

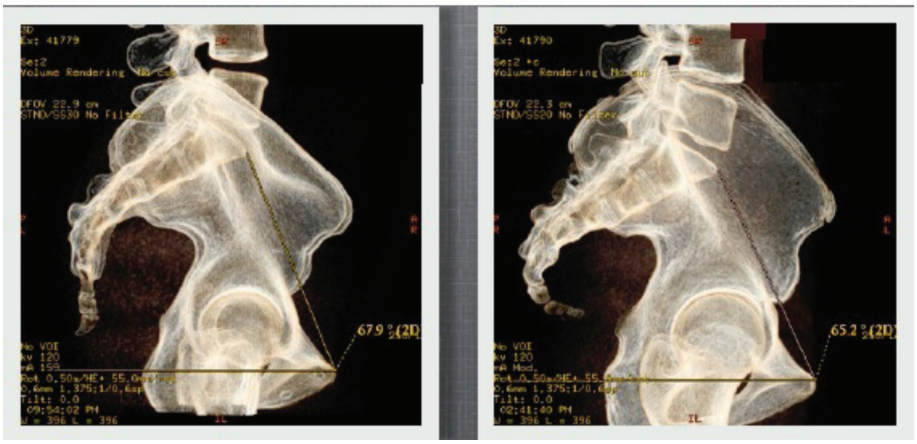
Results: The average uncorrected pelvic inclination angle was higher for females (70.9°, sd = 5.6) than males (64.8°, sd = 6.3). After standardizing the images, males had a higher $\%FHC_A$ (22.7, sd = 4.9) than females (18.6, sd = 5.6) and consequently a reduced average AV_{VR} (2.44) than females (3.40). The radiographic findings of the cross-over, ischial spine sign, and posterior wall sign could be reproduced with a 3-D pelvis model by tilting the pelvis anteriorly.

Conclusion: Volume- rendered CT is capable of providing an objective measurement of acetabular version and femoral head coverage that can provide a better understanding of this complex anatomy. In normal individuals, apparent "acetabular retroversion" may be a consequence of pelvic orientation rather than true acetabular retroversion.

Significance: This new technique allows the orientation of the pelvis to be corrected to population norms or to the patient's true standing position if referenced to a standing lateral radiograph. This avoids issues with AP pelvic radiographs and allows for dynamic evaluation of the hip. This technique also demonstrates that the source of radiographic "acetabular retroversion" can be anterior pelvic tilt or rotation rather than posterior facing acetabuli and draws into question current techniques for the characterization of acetabular morphology.

See pages 17 - 62 for financial disclosure information.





♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Does Pain Chronicity in Patients with Symptomatic Acetabular Dysplasia Correlate with Intra-Articular Disease?

Geneva Baca, BA; ***John C. Clohisy, MD****; Ira Zaltz, MD; Perry L. Schoenecker, MD; Daniel J. Sucato, MD, MS; Young Jo Kim, MD, PhD; Paul E. Beaule, MD; Michael B. Millis, MD; Christopher L. Peters, MD*
Washington University, St. Louis, MO

Purpose: Bernese periacetabular osteotomy (PAO) has become a common treatment for symptomatic acetabular dysplasia. More advanced intra-articular disease is thought to be associated with suboptimal clinical results. Therefore, identifying risk factors for advanced intra-articular disease is important in patient selection for surgery. The purpose of this study was to analyze the association between duration of hip symptoms and intra-articular disease severity in patients with symptomatic acetabular dysplasia.

Methods: We queried our multicenter prospective database for patients with symptomatic acetabular dysplasia treated with PAO. The chronicity of symptoms, pre-operative standardized outcomes, and intra-operative pathology were reviewed. Statistical analyses were performed to determine differences in intra-articular disease findings relative to the chronicity of symptoms.

Results: 794 cases (794 patients) were analyzed. Pain chronicity < 6 months in 5%; 6-12 months 23%, and > 1 year 72%. The mean pre-operative mHHS, 64.1 and UCLA, 7. Acetabular labral damage was in 64%, detachment 19.5% , and labral degeneration 39% . Abnormal labral morphology was present in 55%, hypertrophic labrum 39%. Chondromalacia of the femoral head-neck junction 40%; malacia 36%, full-thickness defect 2%, and cleavage/thinning in 1%. Hips with 6 - 12 months of pain had labral damage with degeneration at 26% compared to 47% with pain 12-36 months and 54% ≥ 5 years (p 0.024). Labral morphology was also significantly different (p 0.005) between ≤6 months (12.5% hypertrophic), 12-32 months (35% hypertrophic) and ≥ 60 months (57%). Hips with 6-12 months of pain had chondromalacia in 26.9%, 12-36 months of pain 27.9% and ≥ 60 months of pain 57% (p 0.001).

Conclusion: The chronicity of hip pain was significantly associated with the presence and severity of acetabular labral pathology and chondromalacia at the femoral head-neck junction. Pain chronicity was not associated with increased acetabular articular cartilage degeneration. Hips ≤ 6 months to 32 months of symptoms had a significant association with labral degeneration, and those with symptoms ≥ 60moths had significant association with femoral head-neck chondromalacia.

Significance: In this population, prolonged symptoms are associated with an increased risk of labral tears and head neck junction chondromalacia, and if indicated, acetabular labral repair and head-neck junction osteochondroplasty may be considered in these patients.

See pages 17 - 62 for financial disclosure information.

Femoroacetabular Impingement in Adolescents: Characteristics and Intraoperative Pathology of a Prospective, Multicenter Cohort

Jeffrey Nepple, MD; Mark Leland Miller, MD; Geneva Baca, BA; ***John C. Clohisy, MD***
Washington University, St. Louis, MO

Purpose: Femoroacetabular impingement (FAI) is increasingly recognized and treated, including in adolescent patients. FAI in adolescents may be considered complex when associated with residual deformities of pediatric hip disease (SCFE, Perthes). The purpose of the current study was to define clinical characteristics, preoperative disability, and intraoperative pathology of a prospective multicenter cohort of adolescent patients undergoing surgical treatment of FAI.

Methods: A prospective, multicenter study of surgical treatment of FAI, including 12 surgeons at 8 sites, was performed. Patients were enrolled between January 1, 2008 and December 31, 2011. The subgroup of adolescent patients less than 18 years of age was investigated. Exclusion criteria included: primary diagnosis of acetabular dysplasia, initial treatment of SCFE or Perthes disease. Clinical characteristics, preoperative clinical scores, intraoperative pathology, and surgical treatment were summarized. Clinical diagnosis was classified as primary FAI, post-SCFE, or residual Perthes. FAI subtype was classified as cam, pincer, or combined.

Results: The cohort included 230 patients undergoing surgical treatment of FAI. Patients had a mean age of 16.0 years and included 131 females (57%) and 101 males (43%). Previous surgery was reported in 11.5% of patients, including 17 patients post-SCFE and 12 patients with residual Perthes. FAI was classified as cam (n=87; 37.8%), pincer (n=16; 69.6%), or combined (n=127; 55.2%). The mean preoperative mHHS was 61.8 $\pm$15.5 and UCLA activity score was 7.6 $\pm$ 2.7 (50.4% UCLA $\geq$ 9). Alpha angle of preoperative plain radiographs average 61.6°**.** Acetabular cartilage pathology was present in 67.9% of hips, including full-thickness cartilage lesions in 12.0%. Femoral head articular cartilage damage was present in 24.8%. A labral tear or ossification was present in 60.0% of hips.

Conclusion: Surgical treatment of FAI in adolescent patients commonly includes primary FAI and the treatment of residual deformity from SCFE and Perthes disease. Despite the young age of these patients, chondral and labral pathology are present in the majority of hips.

Significance: Establishment of this prospective multicenter cohort will allow for future investigations into the outcomes of surgical treatment, and identification of predictors of good outcomes.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Descriptive Epidemiology of Symptomatic Acetabular Dysplasia in Adolescents: A North American Cohort

John C. Clohisy, MD*; Geneva Baca, BA; Stephen T. Duncan, MD; Ira Zaltz, MD; Michael B. Millis, MD; Ernest L. Sink, MD; Robert T. Trousdale, MD; Young Jo Kim, MD, PhD; David A. Podeszwa, MD; Perry L. Schoenecker, MD*
Washington University, St. Louis, MO

Purpose: Symptomatic acetabular dysplasia is associated with hip pain, functional limitations and secondary osteoarthritis. Delays in diagnosis, inaccurate diagnoses and ineffective treatments are common in affected patients. Large patient cohorts are needed to define characteristics of "at risk" patients, and to evaluate the clinical effectiveness of orthopaedic interventions. Therefore, we have established a multicenter, prospective, longitudinal cohort of patients undergoing PAO for symptomatic acetabular dysplasia. The purpose of this study is to report the descriptive epidemiology and contemporary surgical treatment trends for adolescent patients undergoing a PAO for symptomatic acetabular dysplasia.

Method: Upon approval of the Institutional Review Boards at seven institutions, nine surgeons enrolled patients undergoing PAO for symptomatic acetabular dysplasia from 2008-2013. Patient demographics, physical exam, radiographic data, diagnoses, operative data, and standardized patient reported outcome measures are collected. The first 269 cases are analyzed in this study.

Results: 262 consecutive patients (269 hips) are enrolled. 85% are female, 15% male, the average age is 15 years, BMI is 22.9 and 79% were Caucasian. Pre operative outcome averages are: Modified Harris Hip, 63; UCLA 7; WOMAC's normative pain 68.7, function 73.8 and total 72.13; SF12 physical component 40.34 and mental component 53.53. Of the 269 cases 17% (47 hips) had failed previous surgery with pelvic osteotomy (34%) and proximal femoral osteotomy (34%) being the most common followed by arthroscopy (24%). A family history of hip surgery was reported by 27% of patients of those 50% were a parent or grandparent, 40% aunt, uncle or cousin and 10% sibling. All hips were treated with a PAO, yet variability in surgical techniques and approach was noted. 40% of hips had an osteochondroplasty of the femoral head-neck junction, 7% a labral refixation/debridement, 6.3% a combined femoral osteotomy, 17% had combined hip arthroscopy and 4% combine surgical dislocation.

Conclusion: Discussion and Conclusion: These data indicate that symptomatic acetabular dysplasia (treated with a PAO) occurs predominantly in active, female, Caucasian patients with normal BMI and is associated with major hip dysfunction and physical limitations. Previous treatment is common and contemporary treatments frequently include an adjunctive femoral osteochondroplasty to prevent secondary femoroacetabular impingement.

Significance: Symptomatic acetabular dysplasia occur predominantly in active Caucasian females of normal BMI. Contemporary treatment commonly includes adjunctive femoral osteochondroplasty.

See pages 17 - 62 for financial disclosure information.

What Is the Relationship Between Childhood Obesity and Femoral Retroversion?

Benjamin J. Shore, MD, FRCSC*; Patricia Miller, MS; Benjamin Allar, MS; Travis H. Matheney, MD; Young Jo Kim, MD, PhD*
Department of Orthopaedic Surgery, Boston Children's Hospital, Harvard Medical School, Boston, MA

Purpose: Obesity and femoral retroversion have long been implicated with the development of slipped capital femoral epiphysis. The purpose of this study was to examine the relationship between body weight and femoral retroversion.

Methods: We performed an IRB approved, prospective cross-sectional study of children presenting to either our fracture or obesity clinics. We defined two groups of children as either of normal weight (BMI >5%ile and <75%ile) or obese (BMI >95%ile for more than 2 consecutive years). Inclusion criteria were children aged 4 to 13 without underlying lower extremity injury, musculoskeletal or systemic condition. All patients were evaluated by a single recorder using a standard measurement technique. Supine abduction, adduction, and hip flexion were measured with the pelvis stabilized. Internal and external rotation was measured in hip extension in the prone position as well as with the hip and knee flexed to 90 degrees. Left and right measurements were recorded separately. All subjects completed a UCLA activity score at the time of their range of motion recording. Range of motion measurements and UCLA activity scores were compared between groups (normal versus obese) using t-test and Mann-Whitney U-tests, as appropriate.

Results: We measured 130 hips in 65 patients including 27 boys and 38 girls with a mean age of 8.8 years (range 5-12 years). Thirty-nine normal subjects and 26 obese subjects defined our comparison groups. We found that obese children demonstrated significant lower maximal flexion and extension compared to normal weight children (108.8° $\pm$ 10.7 vs 123.1° $\pm$ 7.3 and -3.1° $\pm$ 6.9 vs. -8.6° $\pm$ 5.2, $p<0.001$) respectively. In addition, a significant decrease in internal rotation in both flexion and extension was also seen within the obese group (30.8° $\pm$ 8.6 vs 43.2° $\pm$ 7.8 and 34.3° $\pm$ 8.9 vs 44.6° $\pm$ 8.8, $p<0.001$) respectively. No differences were recorded in hip extension, abduction or adduction between the two groups. Obese children also demonstrated significantly lower UCLA activity scores compared to normal weight children (5.5 vs 10, $p<0.001$).

Conclusions: Obese children demonstrate significant differences in activity and hip range of motion compared to normal weight children, specifically losing internal rotation or increasing retroversion.

Significance: This is the largest study of its kind examining the relationship between obesity and retroversion. The results of this pilot study support further investigation using three-dimensional imaging to correlate the loss of internal rotation and degree of retroversion associated with prolonged obesity across the pediatric population.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Interleukin-6 in Pediatric Musculoskeletal Infection: A Pilot Study

Byron F. Stephens, II, MD; Jeffrey R. Sawyer, MD; William C. Warner, Jr., MD; James H. Beaty, MD; David D. Spence, MD; Alice A. Moisan, BSN, RN, CCRP;
Derek M. Kelly, MD
Le Bonheur Children's Hospital, Memphis, Tennessee

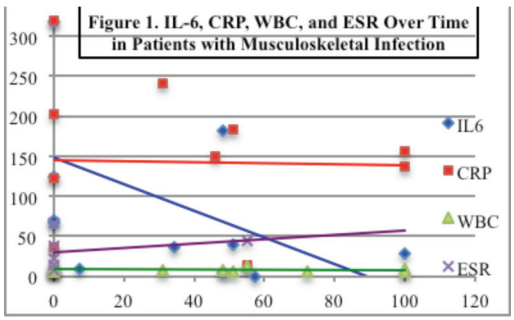
Purpose: Pediatric musculoskeletal infection represents a diagnostic challenge and the clinical consequences of delayed treatment can be devastating. While many institutions utilize the criteria identified by Kocher et al. in evaluating patients with suspected musculoskeletal infection, others have called the validity of this model into question. In addition, interleukin-6 (IL-6) has recently been identified as the most sensitive marker of prosthetic joint infection. Our study seeks to evaluate the utility of IL-6 as a 1) diagnostic tool and 2) marker of therapeutic response to treatment in pediatric patients presenting with suspected musculoskeletal infection.

Methods: After obtaining IRB approval and informed consent, IL-6 serum levels were collected prospectively in 12 pediatric patients with suspected musculoskeletal infection. Patients with known immunodeficiency were excluded. These samples were then assayed in triplicate using a Quantikine ELISA assay. Additional data collected included demographic information, symptom duration, number of Kocher criteria, number of physicians seen prior to presentation, traditional inflammatory markers, temperature, final diagnosis, treatment procedures, and any organisms identified via intraoperative cultures.

Results: 8 patients were diagnosed with suppurative musculoskeletal infection. 4 patients were diagnosed with "other" etiologies (3 with transient synovitis and 1 with superficial cellulitis). The mean IL-6 level for patients with musculoskeletal infection was 214.5 pg/ml, versus 68.63 pg/ml in patients with "other" diagnoses ($p = 0.107$). Descriptive analysis of trendline data reveals that IL-6 has the steepest slope, possibly indicating that it is a more sensitive marker of therapeutic response than the traditional markers.

Conclusion: In this small pilot study, we have identified preliminary evidence to support the clinical utility of IL-6 in pediatric musculoskeletal infection. Continued research in this area is justified and necessary before definitive conclusions can be made regarding the clinical benefit of using this new inflammatory marker.

Significance: Our preliminary results justify further research efforts in this area. The use of IL-6 in the diagnosis and treatment of pediatric musculoskeletal infection could provide physicians with added confidence with both the initial diagnosis and efficacy of the treatment course.



See pages 17 - 62 for financial disclosure information.

A Clinical Algorithm or Hip Joint Aspiration: Which Is Better for the Diagnosis of Septic Arthritis of the Hip?

Uri Givon, MD*; Amir Herman, MD, PhD; Amos Schindler, MD;*
Boaz Liberman, MD
Edmond and Lilly Safra Hospital for Children, Sheba Medical Center, Tel Hashomer, ISRAEL

Purpose: The differential diagnosis between septic arthritis of the hip joint (SAHJ) and transient synovitis (TS) is important as the former may cause devastating complications. Clinical algorithms were reported, but their value was doubted in later studies. The aim of this study was to compare diagnostic hip joint aspiration to a well accepted clinical algorithm.

Methods: We reviewed 231 patients with TS and 27 patients with SAHJ who underwent a hip joint aspiration under ultra-sound (US) on admission to the hospital. The US findings - thickened joint capsule and increased joint width ≥5mm, and the aspirated fluid cell count and appearance were compared to Kocher's criteria (KC). The diagnosis value were calculated using sensitivity (Sen), specificity (Spec), positive and negative predictive values (PPV; NPV) and the number needed to diagnose (NND). P value of less than 0.05 was considered as statistically significant. All p values are two sided.

Results: The value of the KC was found to be ideal when we used 2 or more criterions for the diagnosis SAHJ. In this case the NND was 2.07. The value of US findings for the diagnosis of SAHJ was found to be low, *i.e.,* PPV and NPV for thickened joint capsule were 15.3% and 85.5%, respectively; PPV and NPV for the difference of joint width over 5mm were 9.6% and 79.1%, respectively . The highest diagnostic value was found for the hip joint aspiration findings. The NND was the lowest (1.03) when either the leukocyte count was higher than 50 K/dL or the aspirate was opaque. This low NND represents a very high sensitivity (100%) and specificity (96.2%), twice as good as the best NND for KC.

Conclusions: Hip joint aspiration was superior to the accepted clinical algorithm. The lowest NND was found a combination of aspirate WBC count and opacity, and it was twice as good as the best NND for KC. Hip joint aspiration is a simple procedure, can be performed under sedation and US control and is an excellent diagnostic tool to rule out SAHJ.

Significance: Hip joint aspiration is an excellent modality for diagnosis of SAHJ in children. We recommend performing a hip joint aspiration in patients who are unable to bear weight and are evaluated for possible SAHJ.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Acute Rheumatic Fever and Septic Arthritis in Children: The Diagnostic Value of Serological Inflammatory Markers

Matthew J. Boyle, MD; Raakhi M. Mistry, MBBS; Diana Lennon; Wesley P. Bevan, MD; Chris Frampton; ***Haemish A. Crawford, MD***
Starship Children's Hospital, Auckland, NEW ZEALAND

Introduction: Joint pain and elevated serological inflammatory markers are features of both of acute rheumatic fever (ARF) and septic arthritis, often posing a diagnostic challenge to clinicians. Despite these similarities, important differences in the presenting serological profile may assist patient diagnosis. The goal of this study was to determine the diagnostic value of serological inflammatory markers on presentation in differentiating between ARF and septic arthritis in children, in order to assist appropriate initial management.

Methods: Following institutional ethical approval, clinical records of two pediatric institutions from January 2005 to December 2012 were reviewed. Records of all patients under the age of 16 years who were admitted with a new diagnosis of ARF (defined by the Jones Criteria) or septic arthritis (defined by joint fluid cytology and culture) were analyzed. The ARF group was compared with the septic arthritis group with respect to baseline characteristics (age, gender, ability to bear weight on affected limb, fever, use of non-steroidal anti-inflammatory drug (NSAID) or antibiotic administration prior to presentation, rate of multiple joint involvement) and serum laboratory values on presentation (erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), white blood cell count (WCC)). Power analysis indicated that 110 patients per group were required to detect a difference in ESR of 15% between the ARF group and septic arthritis group as statistically significant (two-tailed alpha=0.05) with 90% power.

Results: We included 114 children with ARF and 111 children with acute septic arthritis in our final analyses. At the time of hospital presentation, the ARF patients were significantly older (mean age 10.4 years vs. 5.2 years, $p<0.001$) and were less often febrile (51.8% vs. 73.9%, $p<0.001$) than the septic arthritis patients, however there was no significant difference in gender (59% vs. 64% of patients male, $p=0.399$) or inability to bear weight on the affected limb (97.4% vs. 100% of patients, $p=0.85$). Prior to hospital presentation, ARF patients received antibiotics (19.3% vs. 4.5%, $p<0.001$) or NSAID medication (10.5% vs. 1%, $p=0.002$) more often than septic arthritis patients. A substantial proportion (30%) of children with the final diagnosis of ARF initially presented with monoarthritis.

At the time of hospital presentation, ARF patients displayed a significantly higher ESR (median 95.0 mm/hr vs. 50.0 mm/hr, $p<0.001$), a significantly higher CRP (median 92.0 mg/L vs. 52.5 mg/L, $p=0.003$), and a significantly lower WCC (mean 10.8 $x10^9$/L vs. 13.1 $x10^9$/L, $p<0.001$) than septic arthritis patients.

Logistic regression analyses identified patient age >8.5 years, serum ESR >64.5 and serum WCC <12.1 $x10^9$/L as three independent risk factors for ARF. If a patient in our study displayed all three of these risk factors on presentation there was a 94% likelihood of ARF as the final diagnosis. If polyarthritic patients were excluded, a patient presenting with all three risk factors had a 71% likelihood of ARF as the final diagnosis.

See pages 17 - 62 for financial disclosure information.

Conclusion: In this retrospective comparative study of 114 children with ARF and 111 children with acute septic arthritis, we have identified important differences in the presenting patient profile that will assist with patient diagnosis. We found that an older child presenting with a high serum ESR and low serum WCC was much more likely to have ARF rather than septic arthritis as the final diagnosis. We also found that a substantial proportion of patients with ARF initially presented with acute monoarthritis. It is clearly important to consider ARF and septic arthritis as potential diagnoses in all children presenting with acute joint pain.

Significance: This paper demonstrates the important features to consider when trying to delineate between septic arthritis and acute rheumatic fever. The early diagnosis of either disease is important in preventing both short and long term complications.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Are there Disparities in Community-Acquired Pediatric Musculoskeletal *S. Aureus* Infections?

Jorge L. Rocha, BA; Sheldon L. Kaplan, MD; Edward O. Mason, PhD; Danielle Guffey, MS; Charles G. Minard, PhD; ***Howard R. Epps, MD***
Texas Children's Hospital, Houston, TX

Purpose: Musculoskeletal infections are a common reason for admission to children's hospitals. The purpose of this study is to determine whether disparities exist for this disease.

Methods: We performed an IRB-approved retrospective of review of all community-acquired *S. aureus* musculoskeletal infections (osteomyelitis, septic arthritis, myositis, pyomyositis) admitted to a large children's hospital over a 3-year period. Patients were identified using a multi-year *S. aureus* prospective surveillance database. Hospital-acquired infections were excluded. Demographic and clinical data were extracted from the electronic medical record of the identified cohort. Patients were divided for analysis by race (Black, Caucasian, Hispanic, Other/unknown) and insurance type (Private vs. Government). Variables for analysis included duration of symptoms before admission, initial and maximum CRP, initial and maximum ESR, initial WBC count, initial ANC, duration of hospitalization, subperiosteal abscess, number of surgeries, complication rate and re-hospitalizations. Complications were defined as ICU admission, multifocal involvement, pulmonary embolism, deep venous thrombosis or pathologic fracture. P-values were adjusted using Holm's step down Bonferroni method and statistical significance was assessed at the 0.05 level.

Results: 173 patients met the inclusion criteria. Patient characteristics did not significantly vary by race. There were no differences for any clinical variable by race after multiple comparison adjustment. The payer distribution was similar to that for hospital admissions overall. There was no difference in initial CRP by insurance type, but the initial ESR was significantly higher in patients with government insurance (63 vs. 49; $p=0.03$). There was no statistical difference by insurance type in the symptom duration prior to hospitalization, length of hospital stay, complications, and number of surgeries. Patients with government insurance had a higher rate of re-hospitalization (22%) compared to private insurance (5%), ($p=0.046$). After adjusting for age, diagnosis, gender, complications and duration of symptoms prior to hospitalization, the odds of readmission was 75% lower for those with private insurance compared to government insurance (OR=0.25; CI=(0.08, 0.83); $p=0.01$).

Conclusion: While we did not find differences by race, we did identify disparities with regards to type of insurance. Patients with government insurance present with a significantly higher ESR, which suggests longer duration of illness compared to patients with private insurance. They are also more likely to be readmitted after discharge, despite equivalence in other clinical variables.

Significance: With the advent of pediatric APR-DRGs, the 22% rate of readmission for patients with government insurance requires closer examination.

See pages 17 - 62 for financial disclosure information.

Arthroscopic Irrigation of the Hip Joint with a Simplified Technique

Prasad Gourineni, MD*; Summer Watkins, APN; James E. Ho, MD*
Advocate Children's Hospital, Oak Lawn, IL

Purpose: Septic arthritis of the hip is treated with urgent lavage to reduce cartilage damage. Previous studies have demonstrated that arthroscopic treatment of the acute septic hip to be successful with faster recovery compared to arthrotomy. Arthroscopic lavage runs a large volume of fluid quickly for thorough irrigation of the joint. Despite this, arthroscopic hip lavage has remained limited in its use by the general orthopedist due to its consideration as a technically demanding procedure with an elaborate equipment setup.

Methods: The technique was used in 16 patients (age10 months to 12 years) suspected of septic arthritis. In addition to a basic arthroscopy set, a cannulated switching stick and a nitinol wire are used. The patient is placed supine on the radiolucent table with the hip flexed to 30-40 degrees. Using anatomical landmarks and fluoroscopy, a spinal needle is introduced from a superior anterolateral portal into the peripheral compartment for aspiration of joint fluid. Then a nitinol wire is passed through the spinal needle and an arthroscopic cannula is inserted over the wire with a cannulated switching stick. After visualization of the joint, irrigation is performed by alternate distension and evacuation of the joint using the single cannula. Gentle joint motion and manual distraction enhance intra-articular irrigation and visualization. A drain is inserted through the cannula. A second portal may be added if synovectomy is required.

Results: Arthroscopic lavage was completed successfully in all hips. One patient sustained an indentation to the femoral neck due to aggressive cannulation which can be avoided with gentle twisting to initiate capsular entry and side to side gliding to avoid bone injury. One patient required a second arthroscopic irrigation on the third postoperative day for inadequate response and the same portal was used again. There were no other complications. All patients were asymptomatic at a minimal follow-up of 4 weeks with normal radiographs, weigh bearing, and hip motion.

Conclusion: The arthroscopic technique was successfully used in sixteen children with septic arthritis. The limited extra equipment required, the ease of landmark identification, and its safety through a broad range of age can broaden the utilization of the technique.

Significance: Arthroscopic lavage is safe and effective in children and simplification of the technique may encourage its use by the general pediatric orthopaedic surgeon.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Can Glucose Level of Joint Fluid Predict Diagnosis of Septic Arthritis? A Preliminary Report

***Maki Kinugasa, MD**; Daisuke Kobayashi, MD; Shinichi Satsuma, MD; Yoshiyuki Shinada, MD*
Kobe Children's Hospital, Kobe, JAPAN

Purpose: Differentiation between septic and reactive arthritis in children can be difficult. Although the glucose level of the joint fluid has been recognized as a diagnostic aid in arthritis, few studies have been made. The purpose of this study was to investigate the reliability of the glucose level of the joint fluid for differentiating septic arthritis from reactive arthritis in children.

Materials and Methods: Twenty joints in twenty patients who had clinical variables suspected septic arthritis were reviewed. The mean age at the first visit was 3.5 years (range, 5 months to 10.5 years), and 15 hips, three knees, one ankle and one elbow were involved. We excluded the patients who were already treated by antibiotics therapy. At the first visit, after arthritis was confirmed by ultrasonography or magnetic resonance imaging, the joint fluid was aspirated for determination the synovial glucose level using a portable glucose meter and bacteriological culture. When the glucose level was less than 40 mg/dl, we administrated arthrotomy followed by intravenous antibiotics therapy. When the glucose level was more than or equal 40 mg/dl, only simple observation was applied regardless the result of blood examination. The final diagnosis of true septic arthritis was based on a positive joint fluid culture or further development of a disease process.

Results: Seven patients had joint fluid glucose levels of less than 40 mg/dl. All seven (100 %) had positive joint fluid cultures and were diagnosed with true septic arthritis. On the other hand, 13 patients had synovial glucose levels above or equal to 40 mg/dl. Three of these (23.1%) had positive joint fluid cultures and were diagnosed with true septic arthritis consequently. Univariate analysis demonstrated a significant difference ($P<0.05$) between 10 patients with true septic arthritis and 10 patients with true reactive arthritis based on the joint fluid glucose level: 36.3 ± 35.0 compared with 90.0 ± 23.05 mg/dl.

Conclusions: Our study suggests that patients with a joint fluid glucose level less than 40mg/dl had a high risk for true septic arthritis. Further, even if the glucose level is more than 40mg/dl, we cannot eliminate the possibility of septic arthritis. Careful and repeated observation is needed to avoid overlooking the true septic arthritis.

Significance: Measurement of the joint fluid glucose level is an easy, convenient and reliable procedure to make a differential diagnosis between septic arthritis and reactive arthritis in children.

See pages 17 - 62 for financial disclosure information.

Leg Length Discrepancy in the Digital Age: Transitioning Management to the EOS Machine

Michael T. Milone, MD; Victor M. Ho-Fung, MD; B. David Horn, MD;
Richard S. Davidson, MD
Children's Hospital of Philadelphia, Philadelphia, PA

Purpose: This study used composite leg models of known length to 1) quantify discrepancies between the EOS machine and traditional imaging modalities and 2) describe scenarios in which switching between methods could lead to significant errors for limb length prediction and treatment.

Methods: Sawbones leg models of known lengths were imaged and measured by the EOS system as well as by CT, scanogram, orthoroentgenogram, and teleroentgenogram. To approximate obesity's effect on the alteration of the relationship between patient and film, model position was adjusted by a radiolucent scaffold, creating two "obesity" configurations that distort hip and knee joints positions by 4 and 2 inches and 8 and 4 inches, respectively. Four blinded observers measured each image twice in a randomized order and statistical analyses were performed to compare all modalities to tape measure-derived true values as well as to compare traditional modalities to EOS measurements.

Results: Mean magnification error was -7 mm or -1.0% for AP EOS images and -4 mm or -0.5% for lateral EOS images ($p<0.001$). AP EOS underestimation increased with model angulation from 3 mm for the control up to 14 mm for the obesity models. The lateral CT did not overestimate or underestimate models ($p=0.64$); however, the AP CT underestimated by up to 16 mm ($p<0.001$) in obesity models. Unlike the EOS machine and CT, the scanogram, orthoroentgenogram, and teleroentgenogram overestimated by 5 mm, 23 mm, and 49 mm, respectively ($p<0.001$), and the degree of overestimation relative to EOS increased in obesity models (Table 1).

Conclusion: Although the EOS, CT, and scanogram produce accurate measurements of leg length, switching between imaging techniques for a single patient may yield inaccurate perceptions of LLD. For example, switching from scanogram measurements (which can overestimate by 2.1 cm) to EOS (which underestimates) would lead to an erroneous conclusion that growth has stopped or severely slowed down. Discrepancies between plane imaging and AP EOS are maximized in obese patients because plane imaging modalities increase their overestimation of these legs while the EOS tends to underestimate them, especially in the AP projection.

Significance: This study is the first to compare scanogram, orthoroentgenogram, teleroentgenogram, and CT in a single study using manufacturer specifications of specimens as well as the first to compare these traditional modalities to the new EOS machine. This work most importantly discusses the implications of inconsistent imaging on projections of LLD at maturity.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Table 1. Discrepancies between traditional imaging modalities and EOS Machine. Reported mm indicate magnification relative to tape measurements for EOS and relative to EOS for other modalities

Comparison	Modality	N	Relative magnification (mm) by model configuration			
			Control	Overweight	Obese	All
Tape Measure	AP EOS	32	-3	-5	-14	-7
			-0.3%	*-0.6%*	*-1.9%*	*-1.0%*
	Lateral EOS	32	-4	-5	-3	-4
			-0.5%	*-0.6%*	*-0.4%*	*-0.5%*
AP EOS	AP CT	32	4	5	-3	2
			0.5%	*0.6%*	*-0.4%*	*0.3%*
	Lateral CT	32	4	6	11	7
			0.5%	*0.8%*	*1.4%*	*0.9%*
	Scanogram	16	3	13	21	12
			0.4%	*1.7%*	*2.7%*	*1.6%*
	Orthoroentgenogram	48	37	59	72	56
			4.8%	*7.6%*	*9.4%*	*7.2%*
	Teleoroentgenogram	48	13	31	45	30
			1.7%	*4.0%*	*5.9%*	*3.9%*
Lateral EOS	AP CT	32	6	5	-13	-1
			0.8%	*0.6%*	*-1.7%*	*-0.1%*
	Lateral CT	32	6	6	0	4
			0.8%	*0.8%*	*0.0%*	*0.5%*
	Scanogram	16	5	13	11	9
			0.6%	*1.7%*	*1.4%*	*1.2%*
	Orthoroentgenogram	48	39	58	61	53
			5.0%	*7.5%*	*7.9%*	*6.8%*
	Teleoroentgenogram	48	15	31	34	27
			1.9%	*4.0%*	*4.4%*	*3.5%*

See pages 17 - 62 for financial disclosure information.

Pseudarthrosis of the Fibula After Lower Limb Lengthening - The Risk of Developmental Ankle Valgus Deformity

***Daisuke Kobayashi, MD**; Shinichi Satsuma, MD; Maki Kinugasa, MD*
Kobe Children's Hospital, Kobe, JAPAN

Purpose: Pseudarthrosis of the fibula after lower limb lengthening is occasionally noted; this could be a cause of developmental ankle valgus due to the proximal migration of the lateral malleolus. However, this has rarely been reported. This study aims to investigate how often pseudarthrosis of the fibula was seen following lower limb lengthening and its condition as a risk factor of ankle valgus.

Materials & Methods: In this study, 54 limbs in 49 patients who underwent lower limb lengthening using a circular device (Ilizarov or Taylor frame) were reviewed retrospectively. Distal and proximal tibio-fibular fixations with wire during the distraction were performed in all cases. The average age at surgery was 8.3 years (range: 3.0 -14.2) and the average duration of the follow up was 4.0 years (range: 2.0-6.5). To evaluate the proximal migration of the fibula, malleolar tip distance was measured and to evaluate the ankle valgus, the tibio-talar angles (TTA) from the standing anteroposterior radiographs at preoperative, immediate removal of external fixator, and final visits were used.

Results: The average tibial length gain was 44.0 mm (range: 35-70), and the average healing index was 46.9 days/cm (range: 28.3-75.2). All lengthening was performed by monofocal lengthening, and all osteotomies of the fibula were performed in the middle third portion. Mean gap distance of the fibular osteotomy site at immediately post-surgery was 2.5mm (range: 0.5-20). Pseudarthrosis of the fibula was seen in 12 (22.2%) of the 54 limbs; these 12 had a mean proximal migration of the lateral malleolus of 3.4 mm (range: 1-9mm) between before surgery and final presentation. A high rate of pseudarthrosis (62.5%; 5 of 8 limbs) was noted in patients with fibular hemimelia (FH), and these 5 showed a significant increase in ankle valgus (average 12.2^{o}, range: 7-15). In the other 7 patients with fibular non-union, 2 (28.6%) presented with ankle valgus (increase of TTA > 5 ^{o}), while the remaining 5 showed no progression of ankle valgus.

Conclusions: In patients with FH, pseudarthrosis of the fibula after limb lengthening was common, and once nonunion occurs, it predisposes patients to a significant increase in ankle valgus deformity. In patients with other underlying conditions, pseudarthrosis of the fibula may relatively predispose them to ankle valgus.

Significance: We should consider the risk of developmental ankle valgus due to the proximal migration of lateral malleolus following pseudarthrosis of the fibula after limb lengthening.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

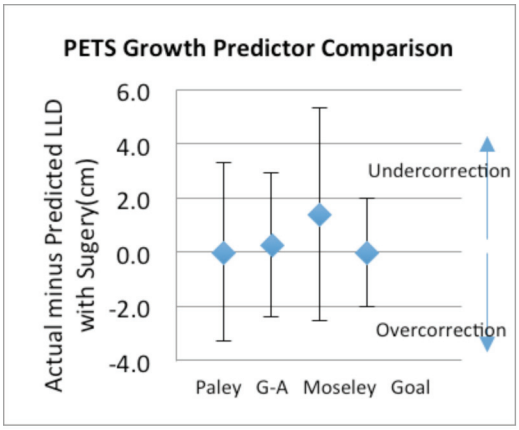
Percutaneous Epiphysiodesis Using Transphyseal Screws (PETS) for Limb Length Discrepancies (Outcome and Accuracy of Growth Prediction Models)

*Bryan Monier, MD; **David D. Aronsson, MD**; Jennifer Lisle, MD; Michael Sun, BS*
Fletcher Allen Hospital, University of Vermont, Burlington, VT

Purpose: The purpose of this study was to evaluate the PETS technique (percutaneous epiphysiodesis with transphyseal screws) for effectiveness in the treatment of limb length discrepancies and to determine which of the three most commonly used growth predictor models (Green-Anderson Growth Remaining, Moseley Straight Line Graphs, or Paley's Multiplier) most accurately predicted final limb length discrepancies after PETS.

Methods: 17 patients underwent PETS (of the distal femur, proximal tibia, or both) for limb length discrepancies from 1998-2013 at our institution (mean chronologic age 13 years 10 months). We retrospectively reviewed their cases and applied the three growth predictor models to obtain the anticipated correction with surgery and compared these results to the actual limb lengths and discrepancies achieved at skeletal maturity with surgery. We evaluated femurs and tibias separately as well as overall limb discrepancies. We also evaluated screw placement across the physis (parallel or crossed).

Results: The average difference between actual and predicted measurements (overall LLD) at maturity with the Paley Multiplier was 0.0cm (95% Confidence Interval 2.6cm), Green-Anderson Method was 0.3cm (CI 2.7cm), and Moseley Graph was 1.4cm (CI 3.9cm); with positive values indicating under correction. Paired T-tests showed no significant difference in predictions for the epiphysiodesed leg vs the short leg. Complications included 6/17 patients having screws removed due to pain (all 6 with parallel screws). No angular deformities, infections or other complications were suffered.



Conclusion: PETS is a reliable and safe technique for treating limb length discrepancies. None of the three growth predictor methods were significantly different and all had average LLD within 0-2cm, however all three showed a great deal of variability. Screws placed in a crossed pattern in both the femur and tibia decreases the need for future screw removal due to pain.

Significance: This is the 2nd North American study to show the success of the PETS technique in treating LLD and the first study to compare the accuracy of the three most commonly used growth predictor methods when performing PETS. Our study shows that clinicians may use the growth predictor of their choice, however none of the three can confidently predict a final LLD within the desired goal of 0-2cm. Clinicians may reliably counsel patients on the safety and success of PETS and may place screws in a crossed pattern to decrease the risk of post-operative pain.

See pages 17 - 62 for financial disclosure information.

Lengthening for Congenital Limb Length Discrepancy Using the Precice™

Kevin Debiparshad, MD; David Chong, MD; ***Dror Paley, MD***
Paley Advanced Limb Lengthening Institute, West Palm Beach, FL

Purpose: Lengthening for congenital limb length discrepancy (LLD) is usually carried out using external fixation which can bridge across the knee and ankle to protect these joints. The PRECICE™ is a recently FDA approved lengthening nail which can be used in older patients with LLD. The purpose of this study is to review its' use in congenital LLD.

Methods: The prerequisites were bone length at least 230mm and diameter allowing reaming 12.5mm; growth plates closed for the tibia and growth plates open or closed for the femur. The hip had to be stable, knee and ankle braceable and daily physiotherapy required. Forty congenitals, mean age 18.4 years (10.3 – 43.7 yrs) were lengthened by the PRECICE™. The pre-operative measured/predicted mean LLD was 5.7cm (1.5 – 18.2cm). There were 34 femur and 7 tibia lengthenings and one simultaneous femur+tibia lengthening.

Results: The mean lengthening was 4.3cm. The distraction rate was 0.80mm/day (0.5 – 1.07mm/day), and the mean time for bony healing was 140.7 days (61 – 262 days). Four patients required a bone grafting procedure. Five patients stopped distraction early due to complications. There were two deep infections requiring surgery. In total there were 12 unplanned surgeries to treat and resolve complications.

Conclusion: This study demonstrates that lengthening with the PRECICE™ can be done safely for congenital LLD. Rate control and ability to achieve desired length was excellent. Bracing can protect the unstable knee and ankle from subluxation in most cases. The mechanism of lengthening was reliable in all but one patient. Complication rates were comparable or lower than previous internal or external lengthening devices. Latent intramedullary infection is a risk in patients that had previous external fixation lengthening.

Significance: Lengthening for congenital LLD is practical with the PRECICE™ if certain precautions are taken.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Early and Late Fracture Following Lower Limb Lengthening

Hiroshi Kitoh, MD, PhD*; Hiroshi Kaneko, MD, PhD; Kenichi Mishima, MD; Masaki Matsushita, MD; Naoki Ishiguro, MD, PhD*
Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine, Nagoya, Aichi, JAPAN

Purpose: Fracture after limb lengthening is a serious complication which leads to a considerable increase in morbidity. Two types of fractures, early and late fractures, have been reported following lower limb lengthening. The purpose of this study is to determine the factors associated with these two types of fracture.

Methods: We retrospectively reviewed 133 lower limb lengthenings to determine factors predisposing to early and late fractures. The former was defined as fracture occurred within one-month of the screw removal, and the latter as fracture noticed over one-month after screw removed. Statistical analyses were performed on the occurrence of early and late fractures to assess the differences with regard to sex, age at surgery, underlying disease, lengthened bone, additional treatment, body mass index, amount and percentage of lengthening, and healing index.

Results: There were 22 early fractures (17 %). Most of them occurred either concave shaped callus or hypodense lesion in the middle of the regenerate. Late fracture was observed in 14 bones (11 %) and the mean duration from removal of the screws and the fracture was 160 days. It generally occurred at the sclerotic regenerate where medullary cavity was not completely formed. The amount of lengthening was the only statistical variable related to early fracture. The average length gained was significantly larger in the bones with early fracture (8.6 cm) than those without the fracture (7.3 cm). On the other hand, larger healing index was the only significant risk factor associated with late fracture. The occurrence of late fracture was much higher in the bones of healing index ≧ 50 days/cm (27%) than in those of healing index < 50 days/cm (5%).

Conclusion: We should make an effort not to create a thin or radiolucent callus in the middle of the regenerate during distraction to prevent early fracture for patients with excessive lengthening. For the bones with larger healing index, careful follow up will be needed until continuous medullary cavity throughout the regenerate is confirmed on radiographs.

Significance: We clearly described the fracture patterns and predisposing factors for early and late fractures following lower limb lengthenings, and provided important implications for medical treatment and patient care to prevent regenerate fracture.

See pages 17 - 62 for financial disclosure information.

Core Decompression and Bone Marrow Aspirate Concentrate for Femoral Head AVN Secondary to Sickle Cell Disease

***Karen Bovid, MD**; Tim Schrader, MD*
Children's Healthcare of Atlanta at Scottish Rite/Children's Orthopaedics of Atlanta, Atlanta, GA

Purpose: Femoral head osteonecrosis frequently develops in patients with sickle cell disease and presents a challenging problem. Core decompression with or without bone grafting has been used to treat osteonecrosis of the femoral head prior to collapse to promote revascularization and provide pain relief. The primary aim of this study is to determine the radiographic and clinical outcomes in pediatric patients with osteonecrosis of the femoral head secondary to sickle cell disease who underwent core decompression and autologous bone grafting using bone marrow aspirate concentrate (BMAC).

Methods: This study was IRB-approved. We retrospectively reviewed pediatric patients with osteonecrosis of the femoral head secondary to sickle cell disease treated by a single surgeon with core decompression and BMAC at our institution from 2010 to 2012. Outcomes measured included hip range of motion (ROM), strength measured by hand held dynamometer (HHD), radiographs, and subjective patient outcome questionnaires.

Results: Eight patients, (6 male and 2 female, 12 hips) ranging in age from 8 to 17 years at time of surgery met the inclusion criteria for this study. Five patients (8 hips, 67%) completed ROM, strength and subjective questionnaire follow-up at a mean of 1.3 years following surgery. Radiographic follow-up was obtained on all patients. Average number of nucleated cells delivered with BMAC injection was 1827.6±1353.1 million. Radiographs measured by the Steinberg classification remained the same stage in 8 hips and worsened by 1 stage in 4 hips. One patient (2 hips) with stage IV-C hips at time of core decompression and BMAC had worsening clinical symptoms and radiographic progression ultimately requiring total hip arthroplasty. For the remaining 4 patients (6 hips), postoperative PedsQL was 69±29 physical and 68±30. HOOS scores were: symptoms 65±35, pain 82±28, ADLs 79±31, sports 75±33, and QOL 48±31. LEFS score was 61±26. SF-36 scores were 41±16 physical and 44±10 mental.

Conclusion: Children and adolescents with osteonecrosis of the femoral head secondary to sickle cell disease reported improvement in hip pain following treatment with core decompression and BMAC, however outcome scores indicate continued disability related to the hip, as well as decreased quality of life and overall mental and physical health. The decreases reported were often related to other symptoms of sickle cell disease.

Significance: Core decompression and BMAC is an option to treat hip pain in adolescents with osteonecrosis of the femoral head secondary to sickle cell disease, but other aspects of the disease contribute to this challenging problem.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

In-Toeing: A Primary Care Problem Referred to Pediatric Orthopaedic Clinic?

John Sielatycki, MD; ***William L. Hennrikus Jr, MD***
Orthopaedics, Penn State College of Medicine, Hershey, PA

Purpose: In-toeing diagnoses include conditions such as metatarsus adductus (MTA), tibial torsion (TT), and femoral torsion (FT). Parents and grandparents often seek medical attention for the child due to concerns that the condition is cosmetically disfiguring and may cause permanent musculoskeletal problems or interfere with athletics as the child matures. The majority of cases of in-toeing resolve spontaneously and require no treatment; however, to our knowledge the prevalence of in-toeing cases indicated for active treatment remains unknown. The purpose of this study is to determine the percentage of in-toeing consults indicated for treatment and follow- up , to identify the percentage of in-toeing consults that turn out to be another diagnosis, and to determine the percentage of in-toeing consults that could be cared for by a primary care physician.

Methods: 143 consecutive patients referred with a new consult noted as "in-toeing" were studied. Active treatment was defined as casting for rigid metatarsus adductus in infants and osteotomy for rotational abnormalities more than 2 standard deviations from normal in children older than 8 years of age. Each patient underwent a careful history and physical exam to exclude neurologic disorders, osseous malformations, or inflammatory conditions. A rotational profile was documented. An explanation of the natural history of the disorder and a handout about the disorder were provided at each visit. For some parents/grandparents displaying overabundant anxiety, a follow up evaluation was arranged for family reassurance and to minimize detrimental patient satisfaction scores.

Results: 143 patients were referred for 'in-toeing.' After the pediatric orthopaedic evaluation, 121 of 143 (85%) patients were confirmed with an 'in-toeing diagnosis'. For example, 61 (43%) patients demonstrated internal tibial torsion, 23 (16%) internal femoral torsion, 12 (8%) metatarsus adductus and 25 (17%) had a combination of TT, FA, or MTA. No patient was indicated for treatment by casting or surgery. 74% of patients with in-toeing were discharged from care after the initial consultation and 18% after the first follow up visit. 8% of patients had more than 2 visits. 22 additional patients who presented with 'in-toeing' on the consult were diagnosed with a condition other than classic in-toeing. For example, 12 (8%) had flexible flat feet, 2 (1%) physiologic genu varum, 3 (2%) had tight heel cords and cerebral palsy, and 4 (3%) with normal exams. 126 (88%) patients were referred from a primary care physician, 9 (6%) from a general orthopaedic surgeon, and 8 (6%) were self-referred. The ave age was 3.8 years (range 2 mo to 13 years). 85 (59%) were female and 58 (41%) were male.

Conclusions: Treatment other than education and reassurance for in-toeing disorders in childhood is rarely indicated. 25% of patients with an in-toeing problem will receive serial clinic visits in order to reassure the parents. 15% of consults labeled as 'in-toeing' actually have another diagnosis including 2% with a subtle neurologic diagnosis.

Significance: More than 95 % of patients could be readily managed by a primary care physician. The finding of this study have implications for pediatric musculoskeletal education, pediatric orthopaedic reimbursement under the Affordable Care Act, and pediatric orthopaedic workforce needs.

See pages 17 - 62 for financial disclosure information.

Comparison of Bovine Xenograft and Allograft in Calcaneal Lengthening Osteotomy for Correction of Pes Planus Foot in Children with Cerebral Palsy

Alfred A. Mansour, III MD; Jason T. Rhodes, MD; Zhaoxing Pan, MB, PhD; Nancy H. Miller, MD; Breanna M. Pritchard, BA; ***Frank M. Chang, MD***
Children's Hospital Colorado and University of Colorado, Aurora, CO

Purpose: Bovine xenograft is currently being used in calcaneal lengthening osteotomies for treatment of pes planus in patients with cerebral palsy, but limited data exists supporting its efficacy. The purpose of this study is to compare results of isolated calcaneal lengthening osteotomies utilizing allograft versus xenograft in patients with cerebral palsy.

Materials/Methods: After IRB approval, children ages 4-18 years with a diagnosis of cerebral palsy who underwent an isolated calcaneal lengthening osteotomy utilizing bovine xenograft or allograft were reviewed. Pre- and post-operative weight-bearing radiographic measurements, performed independently by two orthopaedic surgeons, were recorded along with graft incorporation and clinical data. The extent of post-op changes was compared between the two groups using a two-sample t-test and Wilcoxon rank sum test; to adjust for potential confounding effect of length of follow-up, linear regression was applied.

Results: A total of 39 allografts and 33 xenografts were followed an average of 3.9 and 2.7 years, respectively. There were no differences in secondary surgery (allograft 2.6%, xenograft 9.1%, p=0.33), pain at final follow-up (allograft 5.1%, xenograft 12.1%, p=0.40), or clinical recurrence (allograft 35.9%, xenograft 36.4%, p=0.97). Intra-class correlation coefficient between the surgeons measuring radiographs was high, ranging from 0.89 to 0.97 for each of the five measurements. The bovine graft had a more significant improvement in 3 of 5 radiographic measures on the first post-op radiograph (average 1.45 months post-op) as compared to the allograft (Table 1). However, there were no statistically significant differences at longer follow-up between the two groups with any radiographic parameter with the exception of the lateral talocalcaneal angle (Table 1). A Kaplan-Meier survival analysis showed that median time to grade 4 incorporation (defined as difficulty in discerning graft site radiographically) was 10.5 months for the allograft group and 29.8 months for the xenograft group (p=0.117).

Table 1

Outcome Measure	Time Frame	Mean ±SD, Allograft (deg)	Mean±SD, Xenograft (deg)	P value
Calcaneal pitch (lateral)	Change from baseline @1st post op	2.3 ± 6.8	5.9 ± 7.3	0.039
	Change from baseline @last post op	2.2 ± 7.8	2.7 ± 7.1	0.774
Talo-first metarsal (lateral)	Change from baseline @1st post op	-10.7 ± 11.1	-18.6 ± 11.2	0.005
	Change from baseline @last post-op	-8.8 ± 15.1	-14.3 ± 11.7	0.097
Talocalcaneal (lateral)	Change from baseline @1st post-op	-4.6 ± 6.3	-6.0 ± 8.4	0.431
	Change from baseline @last post-op	3.4 ± 10.0	-8.5 ± 8.8	0.025
Talonavicular (AP)	Change from baseline @1st post-op	-11.6 ± 10.4	-19.3 ± 13.1	0.012
	Change from baseline @last post-op	-12.8 ± 15.4	-15.8 ± 13.7	0.393
Talo-first metarsal (AP)	Change from baseline @1st post-op	-11.2 ± 10.7	-12.8 ± 11.7	0.558
	Change from baseline @last post-op	-7.0 ± 15.8	-7.4 ± 11.7	0.899

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Conclusions: At last follow-up, results indicate no significant differences between allograft and bovine xenograft in 4of 5 radiographic parameters when utilized in calcaneal lengthening osteotomies in cerebral palsy. Bovine xenograft demonstrates a delayed incorporation when compared to the allograft.

Significance: Multiple pediatric foot surgeries depend upon the use of structural graft material; however, few studies address the utilization of different graft materials. The current work indicates that either allograft or bovine xenograft options for pes planus correction in patients with cerebral palsy maintain similar results.

See pages 17 - 62 for financial disclosure information.

Retrospective Comparison of Age At Surgery and Rate of Remodeling of Distal Femoral Extension Osteotomies in Children with Cerebral Palsy

David Roy, MSIV; Breanna Pritchard, BA; Zhaoxing Pan, MB, PhD; Jason T. Rhodes, MD; ***Frank M. Chang, MD***
Children's Hospital Colorado and University of Colorado, Aurora, CO

Purpose: The optimal age to perform a distal femoral extension osteotomy for the treatment of crouch gait in children with cerebral palsy is controversial. In skeletally immature patients, the distal femoral physis will remodel, potentially causing a recurrence of knee flexion deformity. The purpose of this retrospective analysis is to compare the rates of femoral bone remodeling with age at the time of surgery.

Methods: Following IRB approval, subjects with a diagnosis of cerebral palsy who underwent a distal femoral extension osteotomy between January 1999 and April 2013 were included. Nine measures comparing angles between the distal osteotomy and the proximal femur were made on lateral radiographs. A random linear coefficient model was used to ascertain a post-op profile of measures. An interaction of time by age of surgery was introduced into the mixed model to see if age at surgery was related to post-op change in radiographic measures.

Results: 69 patients (49 males and 20 females) underwent distal femoral extension osteotomies on 124 legs. Average age at surgery was 13.6 ±2.9 years. Slope (rate) was significant for every outcome; this rate was positive, indicating all measures increased over the post-op period. Pearson correlation of estimated slope with age at surgery was negative and significant in 8 of 9 outcomes, indicating the older the subject had the surgery, the slower the remodeling process of the distal femur after the surgery (Table 1).

Table 1

Angle	Average rate of remodeling (deg/mon)	Pearson correlation: age vs remodel rate	P-value
Proximal anterior cortex to distal anterior cortex	0.9184	-0.25618	0.0041
Proximal anterior cortex to distal posterior cortex	0.7907	-0.30786	0.0005
Proximal anterior cortex of the femur and the physis	0.5415	-0.05580	0.5382
Proximal anterior cortex to Blumensaat's line	0.6305	-0.22279	0.0129
Middle of the prox. femur to the middle of the distal femur	0.6769	-0.23486	0.0086
Proximal posterior cortex to distal anterior cortex	0.8607	-0.20326	0.0236
Proximal posterior cortex to distal posterior cortex	0.5288	-0.21167	0.0183
Proximal posterior cortex to physis	0.6455	-0.30208	0.0007
Proximal posterior cortex to Blumensaat's line	0.6176	-0.44468	<.0001

Conclusions: An average rate of remodeling was identified for all measures. Older subjects with cerebral palsy who underwent a distal femoral extension osteotomy exhibited slower remodeling rates of the distal femur when compared to younger subjects in our cohort.

Significance: To date, this is the largest study looking at remodeling rates of distal femoral extension osteotomies in children with cerebral palsy. The average rate indicates that the correction obtained decreases over time, and this rate differs depending on age at surgery. The data presented here suggests that providers should take the differing rates into account when deciding when and how much correction to obtain in a distal femoral extension osteotomy.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Solving the Pediatric Lower Extremity Vascular Trauma Dilemma: Improved Care with a Vascular Trauma Protocol

*Itai Gans, BS; **Keith D. Baldwin, MD, MPH, MSPT**; Michael L. Nance, MD, FACS; John (Jack) M. Flynn, MD; Joseph M. Serletti, MD; Stephen J. Kovach, III, MD; L. Scott Levin, MD, FACS*
The Children's Hospital of Philadelphia, Philadelphia, PA

Purpose: Combined lower extremity (LE) vascular and musculoskeletal injuries present unique challenges for pediatric trauma centers because LE microvascular repair-capable surgeons are not usually available on staff as they are at adult hospitals (where the surgeons also perform elective vascular surgery). The combined injuries occur relatively infrequently; however, the rate of morbidity (including limb loss) can be high, particularly if revascularization is delayed for >8 hours. In order to offer timely care to children with these injuries, we developed a LE vascular trauma protocol (LEVP) that includes adult LE microvascular surgeons capable of small vessel anastomosis, available only directly through the attending trauma surgeons, to provide uninterrupted coverage to our children's hospital. We studied our experience with combined injuries at our Level 1 pediatric trauma center with focus on patient management before and after LEVP initiation.

Methods: We queried our trauma database for cases of LE musculoskeletal trauma over a 13 year period (2000–2013) and identified patients presenting with an ischemic LE requiring urgent management. We compared treatment team, time to operating room (OR), and number of pre-operative radiographic vascular studies performed before and after LEVP initiation.

Results: We identified 22 ischemic presentations (mean age 11 years, range 2-17 years). Sixteen patients were treated before the initiation of LEVP and 6 patients after LEVP initiation. Vascular management included observation in 1 case, fracture reduction alone in 4 cases, detethering of the neurovascular bundle in 1 case, distal artery ligation in 3 cases, arterial end-to-end anastamosis in 2 cases, and artery repair with vein graft in 11 cases. The mean time from admission to definitive vascular care was 6.4 hours pre-protocol (20% >8 hours) and 4.6 hours post-protocol (0% >8 hours). Before protocol initiation, 38% of LE vascular injuries were treated by LE microvascular repair-capable surgeons compared to 100% after protocol initiation. Prior to protocol initiation, 37.5% had a pre-operative radiographic vascular study compared to 0% after protocol initiation.

Conclusion: Since our LEVP initiation we have required no pre-operative radiographic vascular studies, there has not been a revascularization delay of >8 hours, and staff surgeon confidence in the flow of care has improved with the new ability to address and care for these severe injuries.

Significance: To potentially improve the timeliness of vascular care and better match the skills of the practitioner to the injury, pediatric centers should consider implementation of a LEVP within their institutions.

See pages 17 - 62 for financial disclosure information.

First Assist in Pediatric Orthopaedics: Implications for Financing Graduate Medical Education

Jeffrey Abildgaard, MD; M. Wade Shrader, MD; Alexander C. McLaren, MD; ***Lee S. Segal, MD***
Phoenix Children's Hospital, Phoenix, AZ

Purpose: The primary objective for graduate medical education (GME) and ACGME residency training programs is to maximize the educational experience of the residents. Academic institutions, even with Medicare reimbursement for resident services, are continually challenged to fund education. Private medical insurance companies do not reimburse for first assist services rendered by orthopaedic residents or for other unsupervised services such as fracture reductions in the emergency department. The goal of this study was to determine the amount of reimbursement an orthopaedic resident would be able to collect on a busy pediatric orthopaedic service if they were able to bill for their services.

Methods: Case log reports were reviewed for all residents rotating on the pediatric orthopaedics service in 2012. All Current Procedural Terminology (CPT) codes were included from six residents (PGY-3 and PGY-4). Relative value units (RVUs) for these CPT codes were recorded, and collections for the CPT codes were calculated by multiplying the Medicare conversion factor of $34.0376/RVU by the corresponding RVU and a standard collection rate of 16% for a first assistant. Collections for CPT codes corresponding with fracture reductions performed in the emergency department were calculated by multiplying the Medicare conversion factor by the corresponding RVU.

Results: Residents were involved with 1316 procedures in 2012, with 768 (57.9%) of these eligible for first assistant billing. This represented 9482 RVUs and first assistant collections of $52,523. Sixty-nine reductions were performed in the emergency department, generating 435 RVUs and $14,813 in resident services. Incomplete procedural coding was noted on 58 out of 83 pediatric spine deformity cases; inclusion of proper spinal instrumentation CPT codes would have generated an additional $4239 annually. Total annual collections for an orthopaedic surgery resident at our institution would be $40,900.

Conclusion: A previous study of general surgery residents reported a potential collection of $41,414 for 1st assist fees. This compares favorably with our findings. Resident assistance in the operating room provides significant savings to private health insurance companies by reducing the fees paid for a surgical assistant. Additional services including emergency room reductions are performed routinely that aid in cost savings to institutions and insurance companies. Only surgical procedures, including reductions, are included in this study.

Significance: Private health insurance companies save significantly with the use of residents in the operating room. As other studies have suggested, academic institutions should consider other sources of external funding to support GME funding in our current healthcare system.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Radiation Exposure for Spinal Fusion in Children Using O-Arm and C-Arm

G. Ying Li, MD*; Alejandro Dabaghi Richerand, MD; Michelle S. Caird, MD; Frances A. Farley, MD*
University of Michigan, Ann Arbor, MI

Purpose: To compare radiation exposure associated with instrumentation placement in posterior spinal fusion using O-arm with C-arm.

Methods: Height, weight, Local Density Function (LDF),Dose Area Product (DAP), body region, number of views, and part of the body were used to calculate the radiation exposure to the patient in mSev in 44 children in whom screw placement was aided by C-arm and 37 children with O-arm. Both groups had posterior spinal fusions during the same time period by 3 surgeons between November 2012 and August 2013. Calculation of the radiation dose was made by the following method: for the C-arm, and the fluoroscopic/digital acquisitions part of the O-arm examinations we estimated the effective dose using the program PCXMC 2.0 (STUK-TR 7, Helsinki 2008). For the cross-sectional imaging part of the O-arm examinations we used the dose-length-product (DLP) from the radiation dose reports of the O-arm unit and published DLP to effective dose conversion factors. An unpaired T test was used to determine significant difference between the two groups.

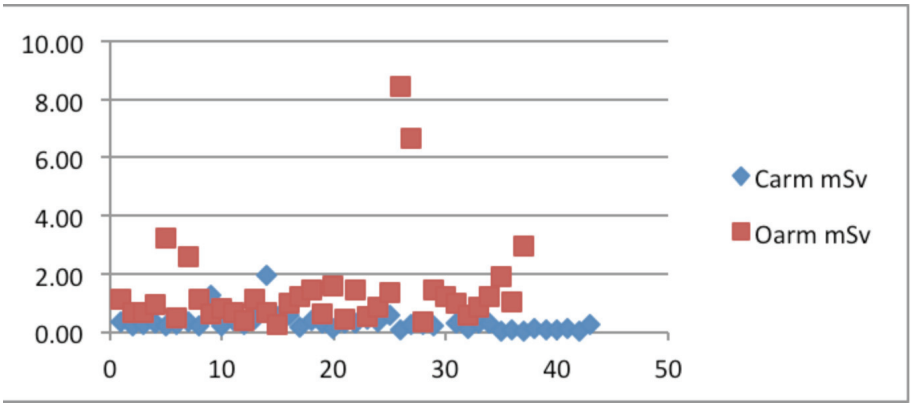
Results: The average mSev for the O-arm patients was 1.48+/-1.66. For the C-arm patients the average mSev was 0.34+/-0.36. These two groups were significantly different (p=0.0012). Three patients had high mSev associated with O-arm. All three had high BMI's: 29.08, 35.93 and 34.92 with high mSev 1.1, 6.7 and 2.9 respectively. If these obese patients are excluded the mean for O-arm is 0.934+/-0.396 mSev and 0.333+/-.362 (p=0.0037). The diagnosis for each groups are shown in table 1 and the radiation exposure in Figure 1.

O- Arm	**C- Arm**
23 Idiopathic 62.16%	32 Idiopathic 72.72%
6 Congenital 16.21%	7 neuromuscular 15.90
5 Neuromuscular 13.51%	3 congenital 6.81%
2 Tumor 5.40%	2 OI 4.54%
1 Scheuermann's Xyphosis 2.70%	

Conclusion and Significance: O-arm use for instrumentation placement associated with spinal fusion in children results in significantly more radiation to the child than C-arm. Families need to be counseled about radiation exposure associated with O-arm. O-arm use should be tailored to placing instrumentation where the benefit is the highest.

See pages 17 - 62 for financial disclosure information.

Radiation Exposure (mSev)



Patient Number

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Switching to A Pediatric Dose O-Arm Protocol in Spine Surgery Significantly Reduced Patient Radiation Exposure

A. Noelle Larson, MD*; Tianyi David Luo, BS; Amy L. McIntosh, MD; Anthony A. Stans, MD; Jennifer A. Winkler; Beth Schueler*
Mayo Clinic, Rochester, MN

Purpose: The use of the O-arm imaging system during spine surgery improves the accuracy of screw placement. Radiation exposure to the patient, however, remains a primary drawback. Abul-Kasim et al.^ described accurate pedicle measurements on cadaveric pig spines using a low radiation dose O-arm technique. We recently adopted these settings in clinical use for all pediatric O-arm imaging. We sought to compare the estimated O-arm radiation doses for the manufacturer default acquisition technique, our previous low dose protocol, and the new pediatric dosing technique.

Methods: Cohort study of consecutive patients under the age of 18 years who underwent an intraoperative O-arm scan. Techniques (kV and mAs) for the manufacturer default were manually adjusted based on spinal level and weight (Table). Similarly, a low dose technique chart developed at our institution adjusted kV and mAs values for spinal level and weight. Pediatric dose techniques (per Abul-Kasim et al.) were 80kV/80mAs with no adjustment for level or weight. Adequacy of image quality was assessed by the treating surgeon. The mean estimated effective dose between the three protocols was compared.

Results: Fifty scans were performed in 26 patients (manufacturer default - 11, low dose - 17, pediatric dose - 22). Diagnoses included spondylolisthesis, kyphosis, scoliosis and congenital deformity. Patient weight in the pediatric dose cohort ranged from 19-70 kg.

For reference, the mean annual natural background radiation from all sources for the US is approximately 3 mSv (chest x-ray examination approximately 0.1 mSv). Use of the manufacturer default technique resulted in a mean dose per scan of 4.65 mSv, while low dose settings resulted in 2.52 mSv. The pediatric dose protocol reduced the mean dose to 0.65 mSv per scan ($p<0.0001$). Accounting for multiple scans per patient, the mean dose per surgery was: pediatric dose - 1.19 mSv, low dose - 4.29 mSv, and manufacturer - 12.79 mSv. All scans were found to have satisfactory image quality. There were no neurologic complications or screw-related complications.

Conclusion: The estimated radiation dose received by the pediatric patient during an O-arm scan was reduced by nearly 75% by using a low dose protocol without compromising surgeon satisfaction. Never use the manufacturer default O-arm techniques in pediatric spine imaging.

Significance: We successfully used a pediatric-dose protocol in clinical practice, reducing the dose per scan to less than ¼ mean annual natural background radiation. This may be an acceptable level of radiation to ensure accurate screw placement.

See pages 17 - 62 for financial disclosure information.

Table 1. Comparison of Effective Dose for O-Arm Scan

O-Arm Protocol	N (number of scans)	Tube Voltage (kV)	Milliamperage (mAs)	Mean Effective Dose per O-Arm Spin (mSv)	Mean Spins per Patient (range)	Mean Total Radiation Dose per Patient (mSv, range)
Manufacturer Default Technique	11	115-120*	128-256*	4.65	2.75 (2-4)	12.79 (8.71-19.60)
Institutional Low Dose Technique	17	90-110*	100-200*	2.52	1.7 (1-3)	4.29 (1.49-10.53)
Pediatric Technique^	22	80	80	0.65	1.8 (1-3)	1.19 (0.65-1.96)

^ Abul-Kasim et al. (J Spinal Disord Tech 2012)
* Dosing based on spinal level and patient weight.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Pre-Operative Fears in Pediatric Patients Scheduled for Orthopaedic Surgery

Lauren Rife; Michelle Peterson, BA, CCLS; Amy Krahe, MPT; Melanie A. Morscher, BS;
Kenneth T. Bono, MD
Akron Children's Hospital, Akron, OH

Purpose: Previous studies have shown that children have fear and anxiety prior to surgery; however, research focused specifically on pediatric orthopaedic patients is limited. By identifying and analyzing these fears, interventions can be designed to lower the child's anxiety or distress, which may have a positive impact on the child's overall adjustment and recovery. The purpose of this study is to identify and analyze pre-operative fears in the pediatric orthopaedic surgery patient.

Methods: This prospective study was approved by the Institutional Review Board at a single pediatric institution. Any scheduled orthopaedic surgery patient less than 18 years of age, who saw a peri-operative certified child life specialist (CCLS) prior to surgery, could participate. From July to December 2012, 258 patients (122 females, 136 males) enrolled in the study. Data was obtained from medical records and CCLS patient interviews and interventions. No changes were made to the CCLS intervention for this study. The CCLS was asked to document the child's fears and comment whether the intervention reduced these fears or anxiety. Factors that could influence childhood fears were analyzed (age, gender, previous surgical experience, etc.). Descriptive statistics were used to analyze the data.

Results: Of the 258 patients enrolled in the study, 70% expressed some fear prior to surgery. The most commonly expressed fears included fear of needles (20%), pain (10%), and general anxiety (11%). In this series, CCLS intervention reduced the child's anxiety in 69% of the cases. Factors that may lead to increased childhood fears include a negative prior surgical experience.

Conclusion: This is the first study to report on fears expressed by children prior to orthopaedic surgery. The majority of these fears related to perceived physical discomfort (needles, pain), but many children also expressed a generalized anxiety toward surgery. In our series, CCLS intervention decreased childhood fears prior to surgery in 69% of the cases; however further research on specific interventions is warranted.

Significance: Studies have shown that preoperative anxiety has been linked to adverse outcomes such as increased pain and behavioral changes. By understanding the pre-operative fears identified in this study, the orthopaedic surgeon can address those fears.

See pages 17 - 62 for financial disclosure information.

Institutional Variation in the Perioperative Care of Scoliosis in Cerebral Palsy: A Multi-Center Comparison of the Drivers of Cost and Outcome

***Brian Scannell, MD**; Peter O. Newton, MD; Burt Yaszay, MD; Suken A. Shah, MD; Paul D. Sponseller, MD; Firoz Miyanji, MD; Mark F. Abel, MD; Harry L. Shufflebarger, MD; Harms Study Group*
Rady Children's Hospital, San Diego, CA

Purpose: The purpose of this study was to identify variations in perioperative care of cerebral palsy patients with scoliosis at separate institutions and determine if these variations are predictive of different perioperative outcomes.

Methods: Data from a multicenter prospective study of scoliosis in children with cerebral palsy was analyzed. Pre-operative variables included: Gross Motor Function Classification Scale (GMFCS), blood work, radiographic measurements, curve type. Intraoperative variables included: surgical approach, type and level of fixation, estimated blood loss (EBL), and operative time. Post-operative variables included: length of stay (LOS), ICU LOS, and mechanical ventilation (MV) days. A multivariate analysis was performed to determine predictors of longer LOS, ICU LOS, and MV days.

Results: 6 institutions had 10 or more patients enrolled (range 10-54) for a total of 174 patients that underwent scoliosis surgery. There were no significant differences in pre-operative hemoglobin, hematocrit, albumin, total protein, radiographic measurements (mean major curve Cobb angle was 82°), or GMFCS Level (76% Level V; 17% Level IV, $p>0.05$). One institution had significantly higher blood loss and longer MV days, ICU LOS, and LOS ($p<0.05$). In the multivariate analysis, factors predicting increased LOS were EBL as a % of blood volume (OR 3.99), patients with uncontrolled seizures (OR 4.64), and institution (OR range from 4x less likely to have LOS >median to 20.5x more likely). Predictors of an ICU stay > than the median were EBL as a % of blood volume (OR 2.5) and institution (OR range from 8x less likely – 7x more likely to have a stay > than the median).

Conclusions: Significant variations exist in the perioperative course of scoliosis in patients with cerebral palsy amongst major pediatric institutions as related to blood loss, operative time, hospital stay, ICU stay, and days of intubation. Efforts are needed to identify best practices, with the goal of reducing the variation and improving the quality of care.

Significance: Efforts to standardize intra-operative and postoperative protocols to limit variations that may compromise care and drive up cost such as the need for blood transfusion, days of ventilation, as well as ICU and total hospital LOS are clearly warranted based on these findings. These variations appear to be affecting both sides of the value equation: cost and quality.

Harms Study Group received support from DePuy Synthes Spine for this study.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Variation in Documentation of Pediatric Supracondylar Fractures

Carissa L. Meyer, MD; Ebrahim Paryavi, MD, MPH; ***Joshua M. Abzug, MD***
University of Maryland School of Medicine, Baltimore, MD

Purpose: Supracondylar humerus fractures are the most common pediatric elbow fracture. As children can be difficult to examine and many may have associated neurovascular injuries that can alter timing of treatment, the purpose of this study was to assess adequacy and accuracy of documentation regarding neurovascular injuries.

Methods: A retrospective chart review was performed of all pediatric supracondylar fractures in children under the age of 15. Data collected included patient age, type of fracture (Type I, II, III extension, flexion), clinician type (Emergency Department or Orthopaedic surgeon) and level of training, motor exam documentation (anterior interosseous nerve, radial nerve and ulnar nerve function) and presence of nerve palsy. Linear regression was used to analyze documentation with regards to patient age and clinician level of training.

Results: Thirty patients were identified during the study period, including 3 patients with associated nerve palsies (2 AIN and 1 radial nerve palsy). In all cases, the nerve palsy was not recognized by the ED physicians or the orthopaedic resident(s) prior to the orthopaedic attending evaluation. In patients with a nerve palsy, motor documentation continued to be incomplete or failed to document a nerve palsy in >50% of notes even after attending documentation of the nerve palsy. Incomplete motor exam documentation occurred in 97% of ED notes. There was no correlation between motor exam documentation and year of orthopaedic residency training. Improved documentation by orthopaedic residents was significantly improved as patients increased in age (p-value 0.046). Documentation was complete in 90% of patients aged 6 years or older. There was no correlation between improved motor documentation and correctly identifying a nerve palsy (odds ratio 0.88, p-value 0.43).

Conclusions: Inadequate or incorrect documentation may occur at any step of the evaluation process and may persist despite appropriate documentation by an attending surgeon. Motor exam documentation improved with patient age and reached 90% for patients 6 and older, implying that barriers exist to appropriate neurologic examination in young children.

Significance: Improved education of emergency department physicians and orthopaedic residents is important to provide specific and age-appropriate neurologic examinations in young children with skeletal trauma. Proper documentation is necessary to improve recognition and monitoring of neurologic status in pediatric patients with supracondylar humerus fractures.

See pages 17 - 62 for financial disclosure information.

Anterior Cruciate Ligament Reconstruction in Main Hospital vs. Hospital Owned Ambulatory Surgery Facility: Comparison of Surgical Time and Operation Room Efficiency

Muayad Kadhim, MD*; Itai Gans, MD; Keith D. Baldwin, MD; John (Jack) M. Flynn, MD; Theodore J. Ganley, MD*
Children's Hospital of Philadelphia, Philadelphia, PA

Purpose: The aim of this study was to examine differences in anterior cruciate ligament reconstruction (ACLR) surgical time and operation room (OR) work efficiency between inpatient and ambulatory facilities within the same institution.

Methods: Patients studied included those who underwent primary ACLR that were performed by a single orthopedic surgeon on elective surgery days. Time variables calculated for ACLR surgeries were the duration of surgery as well as the duration of ancillary services including nursing and anesthesia. Time variables were also calculated for surgeries that were done on the same elective surgery days to measure total procedure duration and turnover times. The OR work efficiency was calculated as the percentage of procedure time that was completed before noon relative to the total OR procedure time.

Results: Two-hundred and twenty-seven ACLR surgeries were performed on 187 elective surgery days, 153 ACLR surgeries were performed at the inpatient facility and 74 at the outpatient facility. The mean age at the time of surgery was 14.9±2.2 years. The ACLR surgeries that were done at the ambulatory facility were of shorter duration than those at the inpatient facility ($p<0.0001$). The ACLR surgeries performed at the ambulatory facility had a greater percentage of on time starts than those performed at the inpatient facility and were 25 minutes shorter than the booked time ($p<0.0001$). One OR was most commonly utilized and 2-3 surgeries were done on most surgery days at both facilities. Seven nurses served as alternating circulators at the ambulatory facility compared to 41 nurses serving in the same capacity at the inpatient facility. The median turnover time was 45 minutes at the inpatient facility which was longer than the ambulatory facility (median=26), $p<0.0001$. Also total procedure time was shorter at the ambulatory facility (229.6±64 minutes) compared to the inpatient facility (325.3±94.4 minutes), $p<0.0001$. OR work efficiency (work done before 12pm) was 64.5% at the ambulatory facility and 37.8% at the inpatient facility, $p<0.0001$.

Conclusion: Despite the common variables of the same surgeon performing the same surgery at the same institution primarily working in a single OR, differences exist in OR procedure time, and work efficiency.

Significance: It has been theorized that physicians perform more surgical procedures at privately owned ambulatory facilities. This study reveals however that the variability may be more related to the OR systems and the use of consistent teams than the surgeon when performing high volumes of the same surgical procedure.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Does Simulation Training Improve Residents' Performance When Placing Short Arm Casts?

Joshua M. Abzug, MD; *Ebrahim Paryavi, MD, MPH; Robert V. O'Toole, MD; Robert S. Sterling, MD*
University of Maryland School of Medicine, Baltimore, MD

Purpose: Application of short arm casts are often performed by orthopaedic residents while not being directly supervised by attending physicians. It is thought that residents have been taught to place casts during interaction with attending physicians, interaction with more senior residents, formal teaching sessions, and simulation training. Last year we assessed our residents' ability to place short arm casts prior to the institution of our simulation program. The purpose of this study was to formally evaluate application of short arm casts by residents following our simulation training.

Methods: All orthopaedic residents (n=20) were excused from clinical activity one morning and asked to place a short arm cast under direct attending supervision as part of a previously presented study. A checklist for short arm cast application had been made indicating the appropriate steps that should be performed as well as criteria to assess the final product. Scores were derived from these checklists and means and standard deviations were calculated. This process was repeated one year later to see if the simulation training provided after the last session improved their ability to place and remove the casts.

Results: The initial assessment demonstrated a mean score 6.15 out of a total possible score of 8, with an average 1.07 increase per year of training ($p<0.001$). Uneven cast padding application and a lack of full thumb motion were the most common reasons for losing points. Following simulation training and formal education of cast application, the mean score improved to 7.2 out of 8. All residents, except 1, obtained a score of 6 or higher.

Conclusions: The ability of a resident to appropriately apply and remove a short arm cast significantly improves with formal education and simulation training.

Significance: Simulation training utilized in pediatric orthopaedic surgery can improve resident performance and potentially improve patient outcomes while decreasing complications.

See pages 17 - 62 for financial disclosure information.

Simulation Training and Objective Structured Clinical Examinations: The Residents' Perspectives

Joshua M. Abzug, MD*; Robert V. O'Toole, MD; Robert S. Sterling, MD*
University of Maryland School of Medicine, Baltimore, MD

Introduction: Utilization of simulation training and Objective Structured Clinical Examinations (OSCEs) has become a routine part of medical students and some residency programs education. These tools are becoming increasingly popular in orthopaedic surgery residency programs as well. The purpose of this study was to assess the residents' subjective perspectives of these educational tools.

Methods: All orthopaedic residents PGY2-5 were excused from clinical duties and participated in an educational program over 2 non-consecutive days that included procedural simulation training and OSCEs. Anonymous questionnaires were provided to all participants to evaluate these teaching and training tools. Questions focused on the usefulness of the specific procedural skill as well as the need to formally assess communication skills and professionalism.

Results: Regarding procedural simulation training, the vast majority of residents found the simulation vey or extremely useful for operative procedures; (N=18) 100% for ex-fix application, 94% for ankle fracture fixation, 93% for anterior hip exposure, 93% for ankle approaches, 92% for patella tendon realignment, 80% for percutaneous TAL/open Achilles lengthening, 84% for hamstring autograft harvest, 64% for carpal tunnel release, 60% for cubital tunnel release 50% for flexor tendon repair, and 47% for trigger finger release. These numbers decreased for procedures that were typically performed outside of the operating room or incorporated "basic" concepts in nature; 13% for short arm cast application, 40% for paronychia I&D, and 57% for lag screw insertion. The residents were less positive about the OSCE experience; 75% and 87% felt it was not an important part of their clinical training, 64% and 81% felt it was not similar to a real patient encounter, and 71% felt it would not make them a better physician.

Discussion and Conclusion: Despite the ACGME stating that OSCEs provide the best method of assessing professionalism and communication skills, our orthopaedic residents did not find the encounters to be extremely useful. However, the residents do feel that procedural simulation is very/extremely useful.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Intraoperative Neuromonitoring for AIS: Multimodal Motor Evoked Potential Monitoring Utilizing Simultaneous Transcranial MEP and Neurogenic MEP

Daniel J. Sucato, MD, MS*; Anna McClung, BSN, RN*
Texas Scottish Rite Hospital for Children, Dallas, TX

Introduction: Intraoperative neuromonitoring (IONM) is critical in the evaluation of patients undergoing AIS surgery. Although somatosensory evoked potentials (SSEP) are standard, motor evoked potentials (MEP) data can be obtained using neurogenic MEP (NMEP) or transcranial MEP (TcMEP). There are no studies which have analyzed the simultaneous use of both methods of MEP monitoring in combination with SSEP.

Methods: A retrospective review of a consecutive series of AIS patients over a 10 year period at a single institution undergoing a posterior surgery using SSEP, NMEP and TcMEP monitoring was performed. Comparisons were made between groups NMEP, TcMEP and DualMEP.

Results: There were 592 patients who were 14.9 years at surgery (483 F/109 M). The major Cobb was 59.5° and corrected to 54.1% at surgery. Mode of motor monitoring was NMEP (47.5%), TcMEP (47.8%) and DualMEP (4.7%). Preoperatively, the DualMEP group had larger main curves (65.0 vs 60.5° vs 57.9° ($p<0.01$) and were more likely to get an MRI preoperatively (64.3% vs 32.7% vs 39.9%) ($p<0.01$) for DualMEP, NMEP and TcMEP, groups, respectively. Overall, critical IONM changes occurred in 13 (2.2%) patients- more common with thoracic curves ($p=0.0039$), larger main thoracic Cobb (77.6° vs. 59.0°, $p=.0003$), and proximal thoracic Cobb (34.5° vs. 26.0°, $p=.013$), a higher incidence of preoperative MRI of the spine (76.9% vs. 36.8%, $p=.003$), and a greater BMI (25.6 vs. 21.4kg/cm2, $p=.042$). Intraoperatively there were no significant differences among groups for levels fused, surgical time and EBL. The incidence of critical IONM changes by group were: NMEP1.78%, TcMEP1.410% and DualMEP 14.3% ($p<0.0001$). 1of 592 (0.17%) had transient weakness associated with IONM changes identified in a patient in the DualMEP technique (TcMEP and NMEP changes were noted). The weakness resolved over 1 week and the instrumentation was performed successfully 2 weeks from the initial surgery.

Conclusions: Patients with greater thoracic deformity, increased BMI and a curve that triggers the surgeon to order a preoperative MRI are more prone to critical IONM change. However, multimodal IONM can be successfully performed in AIS surgery to prevent neurologic deficit. A new approach with combination SSEP together with two types of MEP (neurogenic and transcranial) were used more often for challenging curves and resulted in a higher likelihood of critical changes allowing for surgeon response to prevent permanent neurologic deficit.

Significance: A 10 year experience of monitoring posterior AIS surgery including using combined transcranial MEP and neurogenic MEP together with SSEP data provided accurate monitoring especially for larger curves without permanent neurologic deficit.

See pages 17 - 62 for financial disclosure information.

Adolescent Idiopathic Scoliosis Patients Are At Increased Risk for Pulmonary Hypertension

Rachel E. Borlack, BS; Michael P. DiLorenzo, MD; Vishal Sarwahi, MD; Aviva G. Dworkin, BS; Terry D. Amaral, MD; ***Sarika Kalantre, MD***
Children's Hospital at Montefiore Medical Center and Albert Einstein College of Medicine, Bronx, NY

Purpose: The incidence of structural cardiac disease and pulmonary hypertension in Adolescent Idiopathic Scoliosis (AIS) patients has been infrequently studied. Pulmonary Hypertension has a high mortality. Objective of this study is to determine the incidence of structural cardiac anomalies and pulmonary hypertension in AIS patients and its relationship with curve severity.

Methods: A retrospective chart review of all patients with AIS having spinal fusion surgery at our institution from September 2009 to 2012 and between the ages of 11 and 21 years was carried out. Data collection included: Cobb angle, echocardiographic presence of structural heart disease, aortic root dimensions, Tricuspid regurgitant jet velocity (TRV), and patient demographics. Right ventricular systolic pressure (RVSP) was estimated using the Bernoulli's equation ($4*(TRV)^2$) plus the right atrial pressure. The RVSP was used as a surrogate marker for pulmonary hypertension. RVSP >/= 25mm of Hg was used to indicate pulmonary hypertension. All echocardiograms were read by board certified Pediatric Cardiologists. 2D echocardiograms of a control group of 50 age matched healthy adolescents of similar demographics were compared to the AIS patients. Spearman correlation test was used to determine correlation between the cobb angle and RVSP. Logistic Regression was carried out for finding of TRV between the two groups.

Results:160 patients had spinal fusion surgery in the study period. Of these, 120 had AIS and 107 had screening echocardiograms. 72 (67%) were female, with an average age of 14.8 ± 2.2 years, and average BMI of 22.4 ± 5 kg/m2. The average Cobb angle was 50.9±12.3 degrees. Two (1.7%) patients had ASD and 2 patients (1.7%) had VSD. Left sided abnormalities included, mitral valve prolapse in 3 (2.8%), trivial regurgitation in 60 (56%), and mild regurgitation in 4 (3.7%) patients. On the right side there was a higher incidence of mild tricuspid regurgitation (N=24 vs 1 in the control group, p=<0.001) and higher average estimated RVSP (21.5±5.5 mmHg plus RAP) (p=0.04) suggestive of pulmonary hypertension. There was no evidence of aortic root dilation or aortic valve abnormalities .Spearman correlation coefficient between cobb angle and RVSP was 0.32 in AIS patients (p=0.04). This shows that there was a significant correlation between increasing cobb angle and worsening RVSP. Logistic Regression also showed that AIS patients have an odds ratio of 3.29 for elevated TRV (p value= 0.007), which is an indirect measure of pulmonary hypertension.

Conclusion: Screening echocardiograms play an important role in identifying patients with structural heart defects and pulmonary hypertension. Patients with elevated RVSP on echocardiograms should be considered for early spinal fusion surgery to prevent progression of pulmonary hypertension and worsening of restrictive lung disease.

Significance: This is the first study to show that worsening degree of scoliosis leads to worsening pulmonary hypertension.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

At What Levels Are Free Hand Pedicle Screws More Frequently Malpositioned?

Mark Heidenreich, BS; Yaser M.K. Baghdadi, MD; Anthony A. Stans, MD; Amy L. McIntosh, MD; William J. Shaughnessy, MD; ***A. Noelle Larson, MD***
Mayo Clinic, Rochester, MN

Purpose: On CT evaluation, pedicle screws placed by freehand technique in pediatric deformity surgery have up to a 9% rate of malposition. We sought to determine which region of the spine is associated with the greatest risk for screw malposition in pediatric patients with and without deformity.

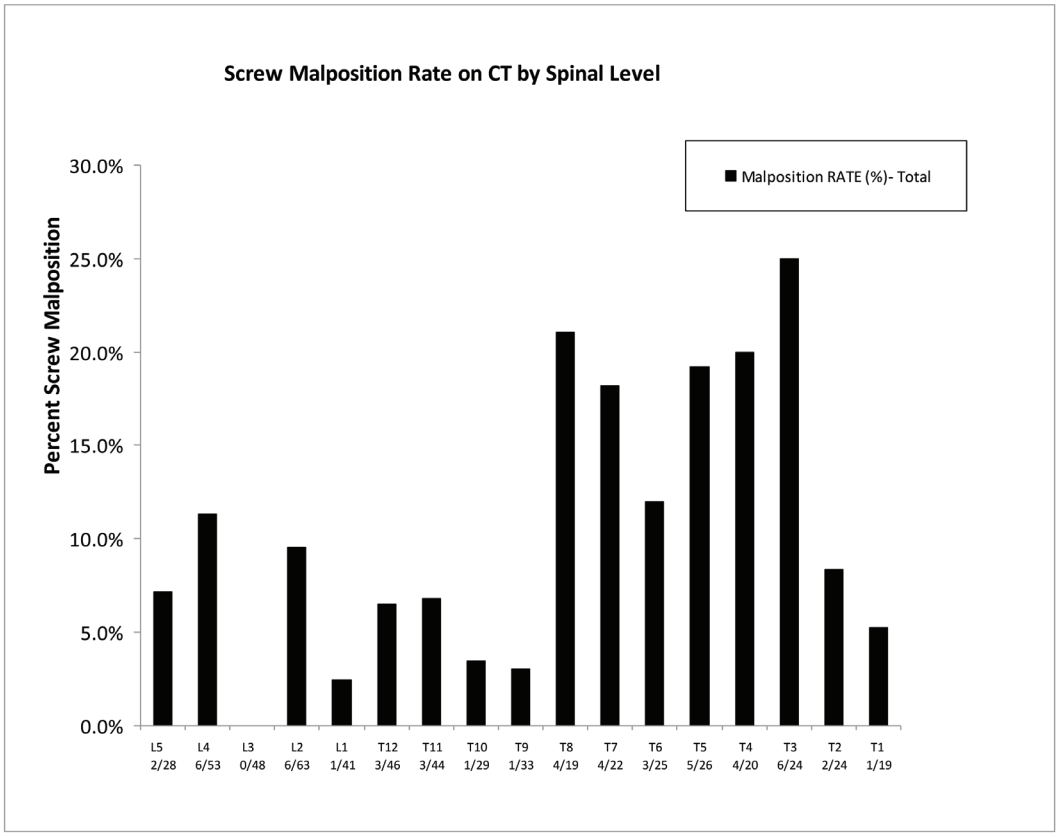
Methods: Incidental postoperative CT exams were available in 85 pediatric patients (605 screws) treated with posterior spinal fusion using freehand pedicle screw technique. Of the screws imaged, 355 were in patients without deformity (fracture, tumor), and 250 screws in patients with deformity (scoliosis, any type). Malposition/breaches were categorized as mild (< 2 mm), moderate (2-4 mm), or severe (> 4 mm). We hypothesized that screws at the apical concavity would have a higher rate of malposition.

Results: Screws in pediatric patients with deformity had a higher rate of moderate/severe malposition compared to pediatric patients without deformity (19% vs. 27%, p=0.02). For severe malposition (> 4mm), no difference was found between patients without deformity and patients with deformity (9.6% vs. 8.6%, p=0.40). Overall, the highest rates of severe screw malposition were at T3 through T8 (Figure), which is also the region of smallest pedicle diameter in children. In patients with deformity, no higher rate of screw malposition was detected at the apical levels, or at the apical concavity. Severe medial breaches were more common in patients with deformity (8 of 19) compared to patients without deformity (6 of 34, p=0.005).

Conclusion: The clinical significance and acceptable rate of asymptomatic pedicle screw breaches in children has not yet been determined. There does not appear to be a higher rate of malposition in the apical concavity, although medial breaches were more frequent in patients with deformity. Efforts to reduce the rate of pedicle screw malposition would likely be most effective at T3 to T8, where screw malposition using the freehand technique is most frequent.

Significance: Pedicle screws placed by the freehand technique were found to have the highest rate of malposition from T3 to T8 (19% vs. 6%, p=0.0001). Medial breaches were more frequent in pediatric patients with deformity.

See pages 17 - 62 for financial disclosure information.



♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Validation and Reliability of the Simplified Skeletal Maturity Scoring System

Prakash Sitoula, MD; Kushagra Verma, MD; Laurens Holmes, Jr., PhD; Peter G. Gabos, MD; Kerry L. Loveland, MD; Petya Yorgova, MS; Geraldine Neiss, PhD; Kenneth J. Rogers, PhD; Satyendra Verma, PhD; James O. Sanders, MD; ***Suken A. Shah, MD***
Nemours/Alfred I. duPont Hospital for Children, Wilmington DE

Introduction: The simplified skeletal maturity score (SSMS) described by Sanders has been utilized to predict curve progression in idiopathic scoliosis. This study aimed to validate the SSMS with a substantially larger cohort of male and female patients of all curve types. In addition, the intra and inter observer reliability of the SSMS (stage 1-8) was determined taking into consideration observer familiarity and variability within a stage.

Methods: Retrospective review of 1100 patients (age 8-16) with idiopathic scoliosis evaluated between 2005 and 2011. Data collected at initial and final follow-up: age, height, weight, gender, menarchal status, curve magnitude, curve type (Lenke 1-6), Risser stage, and initial SMSS score. Patients were followed (2.4 ± 1.2 years) until skeletal maturity, curve progression to ≥50˚, or spinal fusion. In addition, five participants (senior faculty: SR, clinical and research fellows: CF/RF, orthopaedic resident: OSR) independently scored 275 hand x-rays on two separate occasions using the SSMS. A Chi square test and logistic regression were used to build the predictive model using the SSMS and Cobb angle. Intra-observer agreement was estimated using Pearson's and Spearman's correlation coefficients. Inter-observer agreement was estimated by the unweighted Fleiss kappa coefficient.

Results: There were 113 females (12.3 ±1.2 years; 81%) and 30 males (13.9 ±1.1; 19%). Overall, 36% of patients progressed (n=161, 53% male, 35% female progression). All of the following patients progressed: (1) SSMS 2 and initial Cobb of ≥25° (16/16), (2) SSMS 1 or 3 and Cobb of ≥35° (10/10). Regardless of SSMS score, 93% of patients with an initial Cobb of ≥40° had significant progression. In contrast, no patient with an initial Cobb ≤15° went on to surgery. Statistical significance was achieved for most but not all of the SSMS/Cobb angle combinations. In addition, the Spearman's correlation for intra-rater reliability improved progressively with observer familiarity (range 0.956 to 0.998) respectively. However, inter-rater reliability did not vary with experience: junior faculty (κ = 0.65), senior faculty (κ= 0.65), and overall (κ= 0.66). Overall, 98% of disagreements occurred only within one stage. Stage 2, 3, and 4 accounted for most of the variability and stage 3 was the most frequently scored stage, corresponding to a period of peak growth.

Conclusion: This substantially larger cohort of male and female patients of all curve types validates the previous findings of Sanders et al. and identifies SSMS and initial Cobb angle as highly predictive. Patients in SSMS stage 1, 2, and 3 with curves above 25° are at highest risk for curve progression and may benefit most from bracing or early intervention. The SSMS has excellent intra-observer and substantial inter-observer agreement; the latter improves with observer familiarity. Discrepancies occur most when classifying stages 2, 3, and 4 and may improve with teaching.

See pages 17 - 62 for financial disclosure information.

Curve	SSMS1* p (n),%, (95% CI), *p*	SSMS2 p (n),% (95% CI), *p*	SSMS3 p (n),%, (95% CI), *p*	SSMS4 p (n),% (95% CI), *p*	SSMS5 p (n),%, (95% CI), *p*	SSMS6 p (n),%, (95% CI), *p*	SSMS7 p (n),%,(95%CI), *p*
10°	-	0 (2), 0%	0 (3), 0%	0 (2), 0%	-	-	-
15°	-	0 (2), 0%	0 (6), 0%	0 (7), 0%	0 (1), 0%	0 (4), 0%	-
20°	-	4 (8), 50% (15-85%), 0.005*	1 (12), **8%** (-7-24%), 0.30	2 (9), **22%** (-5 – 49%), 0.11	-	0 (6), 0%	-
25°	1 (2), **50%** (-19-92%), 0.16	4 (4), 100%	2 (5) , 40% (-2-83%), 0.06	0 (4), 0%	0 (2), 0%	0 (6), 0%	0 (1), 0%
30°	2 (3), 67% (13-80%), 0.01*	5 (5), 100%	3 (7) , 43% (7-80%), 0.02*	3 (11), 27% (9-54%), 0.04*	0 (1), 0%	0 (6), 0%	-
35°	1 (1), 100%	2 (2), 100%	4 (4), 100%	1 (9), **11%**, (-9-32%), 0.30	1 (1, 100%)	3 (5), 60% (17-98%), 0.01*	-
40°	1 (1), 100%	4 (4), 100%	2 (2), 100%	3 (3), 100%	1 (1), 100%	3 (3), 100%	0 (1), 0%
45°	-	1 (1), 100%	2 (2), 100%	-	1 (1), 100%	1 (1), 100%	-

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Does Apical Vertebral Body Derotation Result in Equal Improvement in Thoracic and Lumbar Scoliometer Readings? - A 3D Analysis of Axial Trunk Deformity in AIS

***John W. Kemppainen, MD**; Burt Yaszay, MD; Krishna Ravi Cidambi, MD; Fredrick G. Reighard, MPH; Tracey Bastrom, MA; Peter O. Newton, MD*
Rady Children's Hospital, San Diego, CA

Purpose: Derotation of the apical vertebra is routinely performed in AIS surgery to minimize transverse plane trunk deformity. This study determines the relationship of scoliometer readings to absolute apical vertebral rotation (AVR) before and after surgery for thoracic and lumbar AIS.

Methods: Fifty-five AIS patients treated with posterior fusion were identified at a single center. Apical rotation of the primary instrumented curves, determined without thoracoplasty pre- and postoperatively by EOS® 3D reconstructions, was compared to the patients' corresponding scoliometer measurements.

Results: Preoperatively, the mean Cobb angle was 54±10° for thoracic (n=33) and 47±8° for lumbar (n=22) curves. Scoliometer readings were similar in thoracic and lumbar curves (15±4° and 15±6°), however AVR was lower in thoracic curves (13±6° vs. 22±7°, $p<0.001$). Postoperatively scoliometer readings were higher in thoracic curves (7±3° vs. 2±2°, $p<0.001$), while AVR was lower compared to lumbar curves (4±4° vs. 11±5°, $p=0.002$). Despite these variances, scoliometer readings were found to strongly correlate with AVR in both thoracic and lumbar curves (Figure).

Conclusion: Derotation of the apical vertebra improves scoliometer readings in thoracic and lumbar curves. However, greater clinical deformity remains in the thoracic spine, despite greater apical vertebra axial plane correction than in the lumbar spine. This may be due to permanent shape change of the ribs associated with scoliosis. In contrast, near complete resolution of the lumbar prominence occurred in lumbar curves, even in the presence of modest residual axial plane vertebral rotation.

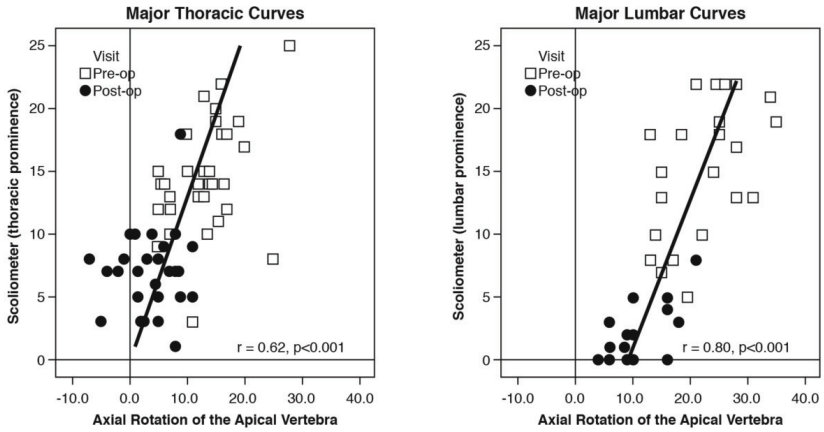


Figure 1: Correlation of scoliometer readings to apical vertebral rotation.

See pages 17 - 62 for financial disclosure information.

Significance: Stereo radiographic 3D reconstructions have improved the ability to directly measure apical vertebral body rotation. This study demonstrates that apical rotation, measured using such methods, correlates with scoliometer readings in both the thoracic and lumbar spine while confirming the component of the trunk rotation that remains due to rib deformity.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Effect of Vertebral Body Stapling on Sagittal Profile

Elias Dakwar, MD; Amer F. Samdani, MD; Giuseppe Orlando, MD; Michael Auriemma, MD; Joshua M. Pahys, MD; Randal R. Betz, MD; ***Patrick J. Cahill, MD***
Shriners Hospitals for Children, Philadelphia, PA

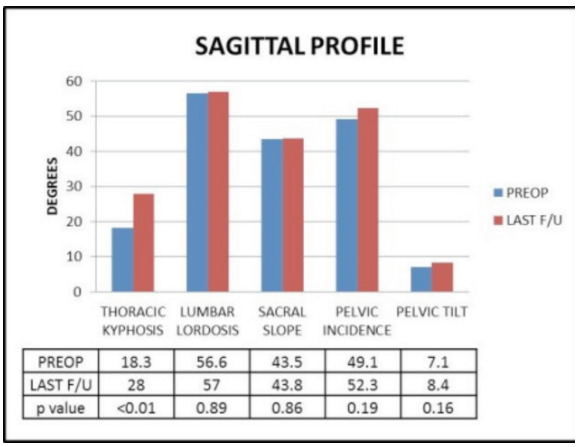
Purpose: VBS has been shown to be a safe, fusionless, and feasible alternative treatment of coronal deformity in idiopathic scoliosis of the growing spine. However, the effect of VBS on sagittal profile has not been reported. The objective of this study is to determine the effect of VBS on sagittal profile, especially thoracic kyphosis.

Methods: We retrospectively reviewed all patients who underwent VBS for idiopathic scoliosis at our institution from 2001-2009 and were followed for a minimum of two years. We reviewed sagittal parameters including thoracic kyphosis, lumbar lordosis, and spinopelvic parameters.

Results: 54 patients underwent anterior VBS for scoliosis from 2001 to 2009 at our institution and had complete pre- and postoperative sagittal measurements. There were a total of 73 curves (thoracic 54, lumbar 19) in this study group of 45 girls and 9 boys. The mean age was 10.7 years and the mean follow-up was 3.5 years. The overall mean preoperative Cobb angle was 32.3° (thoracic 32.6°, lumbar 31.4°). The preoperative, 1 year, 2 year, and last follow-up thoracic kyphosis (T5-12) was 18.3°, 23.6°, 29.4°, and 28°, respectively (p=0.0002). However, there was no statistical difference between the lumbar lordosis, pelvic tilt, pelvic incidence, and sacral slope between the preoperative values and those at any postoperative time point.

Conclusion: Idiopathic scoliosis is commonly associated with thoracic hypokyphosis. We report that in our experience, VBS improves thoracic kyphosis without affecting lumbar lordosis or spinopelvic parameters.

Significance: Growth modulation of idiopathic scoliosis, including increased thoracic kyphosis, occurs with vertebral body stapling.



PREOP	18.3	56.6	43.5	49.1	7.1
LAST F/U	28	57	43.8	52.3	8.4
p value	<0.01	0.89	0.86	0.19	0.16

See pages 17 - 62 for financial disclosure information.

72% of Spine Fusions Have Postoperative Fevers, But This Does Not Correlate to Surgical Site Infection

Gideon W. Blumstein, MS; Derek A. Seehausen, BS; Liam Harris, BS; Lindsay Andras, MD; Patrick Ross, MD; ***David L. Skaggs, MD, MMM***
Children's Hospital Los Angeles, Los Angeles, CA

Purpose: To determine the frequency and clinical significance of postoperative fevers in pediatric patients undergoing posterior spinal fusion (PSF).

Methods: A retrospective chart review of consecutive patients undergoing PSF at a single institution between 6/1/2005 and 4/1/2011 was performed. Patients undergoing PSF with minimum 2 year follow-up were included. Exclusion criteria were previous spine surgery, a combined anterior-posterior approach, and patients who did not have primary wound closure. Fever >38 degrees was classified as low-grade (LGF) and fever >39 degrees was classified as high-grade (HGF).

Results: 278 patients with average age 13 years (1-22) met inclusion criteria, with the following diagnosis: adolescent idiopathic scoliosis 43%, neuromuscular/syndromic scoliosis 39%, congenital scoliosis 11%, spondylolisthesis 4%, Scheuermann's kyphosis 3%. Seventy-two percent (201/278) of patients had LGF in the postoperative period, and 9% (27/278) also had HGF in the postoperative period. During a typical 4 day hospital stay, the percentage of postoperative fevers trended down (POD 1=56%; POD 2=44%, POD 3=19%, POD 4=11%. Of the patients that were hospitalized for more than 4 days, 14% (31/214) had LGF, and 1% (2/214) had HGF after POD 4. Blood cultures were obtained from 18% of patients during their hospital course, of which 3(6%) were positive. Urine cultures were obtained from 17% of patients, of which 16% (7/45) were positive. Patients with HGF or fevers after POD 4 were not more likely to have positive cultures (HGF: p= 0.81; >POD 4: p=1.00). All patients with positive cultures received antibiotic treatment. During the 2 year follow up period the overall infection rate was 4% (12/278). There was no significant difference in infection rates between afebrile patients and patients with either LGF (p=1.00) or HGF (p=0.49) in the postoperative period. There was no correlation between LGF after POD 4 and either superficial wound infection (p=1.00), deep wound infection (p=1.00), or positive cultures (p=1.00).

Conclusion: 72% of pediatric patients undergoing posterior spinal fusion experienced postoperative fever >38 degrees. There was no difference in either superficial or deep wound infection rates between febrile and afebrile patients. Of those patients who were cultured, there was a small but significant percentage of positive blood or urine cultures. All patients with positive cultures received antibiotic treatment and there was no correlation with later implant infection in these patients.

Significance: Although the majority of patients undergoing posterior spinal fusion had a postoperative fever, this did not correlate to later development of superficial or deep infection.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Sub-Axial Cervical Spine Injuries in Children and Adolescents

Robert Francis Murphy, MD*; Austin R. Davidson, BS; William C. Warner Jr., MD; Derek Michael Kelly, MD; David D. Spence, MD; Jeffrey R. Sawyer, MD*
University of Tennessee - Campbell Clinic Lebonheur Childrens' Hospital, Memphis, TN

Purpose: Limited data exists on pediatric sub-axial cervical spine injuries. The goal of this study was to characterize a large retrospective consecutive series of patients by injury type, neurologic injury, associated non-spine injuries, and treatment.

Methods: Medical records of all patients at one institution from 2003-2013 were reviewed. Data abstracted included age, injury type (fracture, dislocation, both, pure ligamentous injury), associated injuries, neurologic status, and treatment.

Results: 111 patients were identified, and grouped into three age ranges: infant: 0-3 years (2), youth: 4-12 years (13), and adolescent: 13-18 years (96). The most common mechanism of injury was motor vehicle accident (64%) followed by sports (11%) and all-terrain vehicle accidents (7%). Isolated fractures were identified in all infant patients (100%), and accounted for the majority of injures in youth (85%) and adolescents (84%). Multiple sub-axial cervical spine injuries were present in 1 infant (50%), 2 youths (15%) and 34 adolescents (35%). Other non-contiguous injuries in the thoracic or lumbar spine were seen in one infant (50%), 5 youths (38%), and 46 adolescents (48%). Fifty-three (48%) of patients had an associated non-spine injury: there were 19 chest/abdominal injuries, 19 head injuries, and 31 musculoskeletal injuries. Neurologic deficits were noted in one infant (50%), two youths (15%), and 17 adolescents (18%). Four patients died (1 youth, 3 adolescents). Most patients were treated non-operatively. One infant was treated in a cervical collar (c-collar) and with observation. All 13 (100%) youth patients were treated in a c-collar. Of adolescents, 66 (69%) were treated in a c-collar or with observation, 4 (4%) were treated with halo-vest immobilization, 24 (25%) underwent operative intervention, and 2 (2%) with combined halo-vest and surgical treatment.

Conclusion: In this largest consecutive series in the literature, isolated fractures account for the majority of sub-axial cervical spine injuries in pediatric patients. One-third of patients present with multiple sub-axial injuries, and half have additional non-contiguous injuries in the thoracic or lumbar spine. Neurologic deficits and associated non-spine injuries are common. Most patients were treated with a c-collar, but adolescent patients were more likely to require surgical intervention. Adolescent patients were also more likely to sustain multiple spine injuries, both contiguous and non-contiguous.

Significance: Pediatric sub-axial cervical spine injuries are an indicator of severe trauma and associated injuries are common. An awareness of these injury patterns as well as a high index of suspicion for secondary injuries must be maintained in evaluating and treating children with sub-axial spine injuries.

See pages 17 - 62 for financial disclosure information.

Safety of Pedicle Screws for Pediatric Patients Younger Than 10 Years Old: Analysis of 5024 Pedicle Screws

Takahito Fujimori, MD, MSc; Burt Yaszay, MD; Carrie Bartley, MA; Tracey Bastrom, MA; ***Peter O. Newton, MD***
Rady Children's Hospital, San Diego, CA

Purpose: To examine the safety of pedicle screw placement and surgery-related complication rates in young children.

Methods: Radiographic and clinical data were collected on patients treated with pedicle screws at a single institution. Patients were divided into 3 groups based on age (0-5yrs old, 5-10yrs old, 10-15yrs old). Patient demographics, screw adjustment, and complication data were collected for each group. Outcomes were analyzed utilizing ANOVA ($p<0.05$).

Results: In total, 5054 pedicle screws were analyzed: 176 in the 0-5 year old group (31 patients), 659 in the 5-10 year old group (68 patients), and 4219 in the 10-15 year old group (234 patients). Mean follow up was 3.1±1.8 years. There were 7 pedicle screw-associated complications (4 asymptomatic, 3 required revision surgery). Overall pedicle screw-associated complication rates were 2.1% per patient and 0.1% per screw. There were no neurological complications associated with misplacement of a pedicle screw. The pedicle screw-associated complication rates per patient and per screw were not significantly different between groups ($p>0.05$). The 5-10 year old group had a significantly higher overall surgical related complication rate (34%) than the 0-5 year old (7%) and the 10-15 year old groups (6%) ($p=0.005$), likely due to the "growth friendly" constructs more commonly used in this age group as opposed to short fusions (0-5 yo) and longer fusions (10-15 yo) for the other two groups.

Conclusions: Complication rates associated with pedicle screws were low in all age groups and pedicle screws can be used for infantile or juvenile patients with anticipated screw related complication rates that are nearly the same as for adolescent patients.

Significance: The pedicle screw-associated complication rate per screw was 0.6% in the 0-5 years-old group, 0.3% in the 5-10 years-old group, and 0.09% in the 10-15 years-old group. Pedicle screws can be used safely for infantile or juvenile patients.

Age Group	0-5 yo 31 cases	5-10 yo 68 cases	10-15 yo 234 cases
Number of pedicle screws	176	659	4219
Avg. number of pedicle screws/case	5.7	9.7	18.0
Pedicle screw-associated complications (n/%)	1 (3.2%)	2 (2.9%)	4 (1.7%)
Revision surgery for a pedicle screw-associated complication (n/%)	1(3.2%)	1 (1.5%)	1 (0.4%)
Pedicle screws with complication (n/%)	1 (0.6%)	2 (0.3%)	4 (0.09%)

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Evolution of the Surgical Correction of Scoliosis in Patients with Duchenne Muscular Dystrophy

Brian Scannell, MD*; Burt Yaszay, MD; Carrie Bartley, MA;*
Peter O. Newton, MD; Scott J. Mubarak, MD
Rady Children's Hospital, San Diego, CA

Purpose: The purpose of this study was to evaluate outcomes related to spinal deformity correction surgery in Duchenne Muscular Dystrophy (DMD) comparing Luque versus pedicle screw constructs.

Methods: This was a retrospective study of all operatively treated scoliosis in DMD patients at one institution over 30 years. Patients were included if they had at least 2 years of follow-up. Patients were divided into two groups: Luque or Pedicle Screws (PS) constructs. Primary outcomes included radiographic (including maintenance of correction), peri-operative variables, pulmonary function test (pre- and post-operative), and complications.

Results: There were 47 patient in the Luque Group (from 1982-2004; mean age at surgery-13yo; mean f/u-7yrs) and 13 patients in the PS group (from 2006-2011; mean age at surgery-14yo; mean f/u 4yrs). Patients in the PS group were heavier (65kg vs 53kg, p=0.04) and had higher preoperative coronal Cobb angle (43° vs 31°, p=0.005). There were no differences in the upper instrumented vertebrae between groups, however the lower instrumented vertebra was significantly different (Luque: 45% L5, 49% sacrum, 6% Pelvis vs PS Group: 92% Pelvis, p<0.001). The mean surgical time was longer in the PS group (Luque: 227 min vs PS Group: 332min, p<0.001). No differences were found in blood loss or length of hospital stay between groups. Despite a higher coronal Cobb pre-operatively in the PS group, the PS group demonstrated significantly lower Cobb angle at final radiograph (Luque: 21° vs PS: 12°, p=0.045). The PS group also had less pelvic obliquity at final follow-up (Luque: 5° vs PS: 2°, p=0.04). No differences were observed in pre-operative, first post-operative, or final pulmonary function tests (Forced Vital Capacity and Forced Expiratory Volume). High rates of complications (major and minor) were seen in both groups (Luque: 68%; PS: 54%, p>0.05). Although not significant, there were more implant related complications in the Luque group (Luque: 26% vs PS: 8%). Two patients in the Luque group required revision surgery for broken rods at 1 and 3 years post-operatively. There were no major implant complications in the PS group.

Conclusions: Over a 30 year period of operative treatment of scoliosis in DMD, pedicle screw constructs improve and maintain coronal Cobb angle and pelvic obliquity more than Luque instrumentation. However, both groups continue to have high complication rates.

Significance: The improved alignment and pelvic obliquity in the PS group may help long-term with sitting and other activities of daily living in patients with DMD. PS constructs may prevent early implant failures and revision surgery in a DMD patient with declining pulmonary function.

See pages 17 - 62 for financial disclosure information.

Picc Lines Inserted the Day Before Surgery Decrease Time from Induction of Anesthesia to Incision for Spinal Deformity Surgery and Safely Provides Central Venous Access During Surgery: A Pilot Study

Anne Stuedemann, RN, MSN, CPNP*; Vikram N. Chakravarthy, MSIII; Richard M. Schwend, MD, FAAP; Valorie K. Thomas, RN, PNP-BC; Tammy Sue Lightner, MHA, RN, CPN*
Children's Mercy Hospitals & Clinics, Kansas City, MO

Purpose: Investigate whether a percutaneous inserted central catheter (PICC) placed the day prior to spine surgery will decrease the time from induction of anesthesia to surgical incision, thus increasing patient safety and decreasing overall cost.

Methods: Retrospective IRB controlled non randomized comparison study reviewing clinical records of all children between the ages 10 to 17 years old with adolescent idiopathic scoliosis (AIS) and neuromuscular scoliosis (NMS) between December 2007 and April 1, 2012. The control group had the central venous catheter (CVC) placed by the anesthesiologist after induction of anesthesia. The experimental group had a PICC placed the day before surgery under local anesthesia by a vascular access team.

Results: There were 51 neuromuscular patients; 8 had PICC lines placed the day before surgery as an out-patient, 29 had central venous catheters placed in the operating room on the day of the surgery and 2 patients had both a PICC and a CVC placed. The mean time from induction to incision for the CVC group was 116 minutes; PICC group was 102 minutes (estimated cost savings of $2022.30 per patient). There were 90 patients with AIS; 35 had PICC lines placed the day before surgery as an out-patient, 39 had central venous catheters placed in the operating room on the day of the surgery and 16 patients had either both a PICC and a CVC placed or neither. The median time from induction to incision for the CVC group was 93 minutes; PICC group was 86 minutes (estimated cost savings of $753.70 per patient). There were no severe complications of PICC use.

Conclusion: When planning vascular access for a pediatric spinal deformity case; central access the day before surgery can decrease time from induction to incision, therefore decreasing time under anesthesia and costs, while increasing patient safety.

Significance: A PICC inserted the day before spinal deformity surgery can decrease the time from induction to incision; leading to increased patient safety and cost control in the operating room. This pilot study justifies a larger prospective study of cost, safety and efficacy of PICC lines in spinal deformity surgery.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Perioperative Use of Adjunctive Medication for Pain Management Improves Outcomes After Posterior Spinal Fusion for AIS

***Suken A. Shah, MD**; Karen Sacks, CRNP; Dinesh K. Choudhry, MD; Kenneth J. Rogers, PhD, ATC*
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

Purpose: Adjunctive medications (gabapentinoids) have opioid-sparing effects in adult surgical patients, but there have been few reported studies in the pediatric population. Our purpose was to assess the efficacy of gabapentin and pregabalin use in the perioperative period in pediatric patients with idiopathic scoliosis undergoing spinal fusion.

Methods: 132 consecutive patients who underwent posterior spinal fusion (PSF) by a single surgeon for idiopathic scoliosis (AIS) were prospectively assigned to one of three postoperative pain management regimens in this cohort study (Group 1- morphine PCA, Group 2 - morphine PCA and gabapentin, or Group 3 - morphine PCA and pregabalin). Postoperatively, opioid use was calculated in mg/kg/time intervals. Pain scores and opioid side effects were recorded. Physical therapy goals and length of stay were assessed.

Results: 132 (44 morphine PCA, 44 morphine PCA and gabapentin, and 44 morphine PCA and pregabalin) did not differ in demographics, operative blood loss, surgical time, or in the radiographic measurements of coronal and sagittal plane curve corrections. Inpatient visual analog pain scores did not differ significantly between groups. Morphine consumption (mg/kg/h ± SD) was significantly lower in the gabapentin and pregabalin groups on the first postoperative day (0.042 ± 0.014 Group 1 vs. 0.027 ± 0.011 Group 2 vs. 0.028 ± 0.008; $p<0.001$). Also, a greater percentage of patients receiving gabapentin and pregabalin were converted to oral pain medications on the first postoperative day (0% Group 1 vs. 25% Group 2 vs. 45% Group 3; $p=0.005$). There were no significant differences in opioid-related side effects or length of stay (mean 4.85 days). There was a trend showing that a greater number of patients who received gabapentin tolerated ambulation with a physical therapist on the first postoperative day, but this was not statistically significant (26% Group 1, 50% Group 2, 52% Group 3; $p=0.058$). There were no adverse effects noted with the use of the adjunctive medications.

Conclusions: Perioperative gabapentin and pregabalin reduced morphine consumption and facilitated transition to oral pain medication on the first postoperative day after spinal fusion surgery for AIS. There was also a tendency towards early ambulation. We could not demonstrate differences in pain scores or opioid-related side effects with the numbers available. Although the results of the adjunctive medications between the two groups were essentially equivalent, pregabalin is 44 times more expensive then gabapentin (total therapy cost $96.46 vs. $2.19).

Significance: Perioperative gabapentin and pregabalin are effective adjuncts to improve pain control and increase mobility in the early stages of recovery in pediatric patients undergoing spinal fusion for idiopathic scoliosis.

See pages 17 - 62 for financial disclosure information.

A Multicenter Retrospective Cohort Analysis of Infection Characteristics and Rates with VEPTR Surgery: 2007 to Present

Sumeet Garg, MD*; Micaela Cyr, BA; Michael P. Glotzbecker, MD; Patrick Carry; John Taylor Smith, MD; Jeffrey R. Sawyer, MD; Joshua Pahys, MD; Scott J. Luhmann, MD; John (Jack) M. Flynn, MD; Ron El-Hawary, MD; Michael G. Vitale, MD, MPH; Tricia St. Hilaire, MPH; The Children's Spine Study Group*
University of Colorado, Children's Hospital Colorado Orthopedics Institute, Aurora, CO

Purpose: VEPTR surgery has been reported to have infection rates up to 24% in previous small case series. This study describes clinical characteristics and infection rates in modern VEPTR surgery.

Methods: A retrospective query was done on a prospectively collected database of patients having initial VEPTR implantation from 2007-present who developed infection requiring operative debridement. Clinical details were collected from 8 sites, which resulted in 55 infection events and 38 patients (22 male, 16 female) with average follow up of 4.1 years (range 1.7-6.3). These 8 sites implanted VEPTR in 307 total patients during the studied time period. Data collected included underlying diagnosis, pre-operative major Cobb angle, construct type, clinical symptoms, and microbiology. The distribution of infection rates across all the study sites was compared. The exact p-value was estimated by Monte Carlo simulation (SAS 9.3).

Results: From 2007-present, 12% (38/307) of patients implanted with VEPTR developed infection requiring operative debridement. There were significantly different infection rates among the 8 sites, ranging from 1.9% to 37.5% (p=0.0080). The infection cohort experienced an average of 1.5 infection events (range 1-5) and had an average of 2.5 operations per year including operative procedures for infection (range 0-7). The average time to infection ranged from 8-236 days after the infecting procedure. These 55 infection events occurred after all types of VEPTR surgery procedures (18 initial implants; 27 expansions; 10 revisions/exchanges). There was a wide range of clinical symptoms in the infection cohort, the most common being wound drainage and dehiscence (41/55 infection events, 71%). The majority of infections were due to gram-positive bacteria (80%, 44/55), the most prevalent being *Methicillin-sensitive Staphylococcus aureus* (45%, 25/55). There were 20 patients (53%, 20/38) with either partial or complete implant removal to resolve infection however only 3/55 (6%) of these resulted in abandonment of VEPTR treatment. The most common diagnoses for infected patients were neuromuscular (47%, 18/38) and congenital (34%, 13/38).

Conclusions: Since 2007 at the 8 study sites, 12% of patients with VEPTR implanted developed infection. There were significant differences in infection rates between sites. Most cases of infection present with wound breakdown.

Significance: Approximately 1/10 patients starting VEPTR treatment develop an infection requiring operative treatment. There is variability in infection rates from site to site, indicating need for guided efforts to standardize best practices for infection control in VEPTR surgery.

Children's Spine Study Group received support from DePuy Synthes Spine for this study.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

No Advantage by Regional Anesthetic Technique for Pain Control After Anterior Cruciate Ligament Reconstruction in Youth: A Randomized Controlled Trial

Sean Flack, MBChB; Viviana Bompadre, PhD; ***Gregory A. Schmale, MD***
University of Washington School of Medicine and Seattle Children's Hospital, Seattle, WA

Purpose: To determine the optimal postoperative pain management regimen for youth undergoing anterior cruciate ligament (ACL) reconstruction.

Methods: This was a prospective, single-blinded, randomized trial comparing lumbar plexus catheter (LPC) to femoral nerve catheter and a single-injection femoral nerve block performed just prior to ACL reconstruction. Our hypothesis was that the LPC would provide superior analgesia and quality of recovery when compared to the other two techniques. Patients in all three groups underwent an additional single-shot sciatic nerve block. Block concentrations were relatively low to preserve motor function (0.2 % ropivicaine with epinephrine). Fifty-two patients ages 11-21 undergoing ACL reconstruction enrolled and were randomized to one of three groups, with information on post-operative pain, narcotic use, and opioid side affects collected by a blinded interviewer.

Results: Though a pre-study power analysis suggested 114 patients necessary for an 80% power to detect a difference between groups, enrollment was halted at 52 patients because of a perceived clear advantage to patients in one of the groups. However, careful analysis of collected data by the blinded interviewer revealed that there were no advantages to any one technique with the current enrollment at 24, 48 and 72 hours post-operatively, when comparing maximum pain (p=0.16 at 24 hours, p=0.41 at 48 hours, p=0.28 at 72 hours); average pain scores (p=0.26 at 24 hours, p=0.57 at 48 hours, p=0.37 at 72 hours); narcotic usage (p=0.07 at 24 hours, p=0.99 at 48 hours, p=0.75 at 72 hours); and opioid side effects (p=0.284). A post-hoc power analysis suggested that an enrollment of more than 170 patients would be necessary to find a difference between groups.

Conclusion: Though there are advantages to regional anesthetics over pure narcotic-based pain control after ACL reconstruction in youth, no advantages could be found here to any one regional technique when comparing lumbar plexus catheter, femoral catheter, and single-shot femoral block, where patients in each group also received single-shot sciatic blocks. The absence of significant differences between groups may have resulted in part from the low block concentrations utilized.

Significance: Given the high costs of operating room time, regional techniques that are more efficient, such as a single shot femoral injection, here found to be no less effective in pain control, in the need for adjunct narcotic usage, nor produce more side effects than catheter based techniques should be considered a preferred alternative for patients undergoing ACL reconstruction. Higher numbers of patients or higher concentrations of the injected anesthetic might, however, reveal subtle advantages to catheter-based techniques not evidenced here.

See pages 17 - 62 for financial disclosure information.

High Satisfaction Yet Decreased Activity Four Years After Transphyseal ACL Reconstruction

Gregory A. Schmale, MD*; Christopher Y. Kweon, MD; Viviana Bompadre, PhD*
University of Washington School of Medicine and Seattle Children's Hospital, Seattle, WA

Purpose: Long-term rates for return to and maintenance of pre-injury activity following transphyseal ACL reconstruction in young athletes are unclear. Our goals: 1) Determine the rate of maintenance of pre-injury level of sport following transphyseal ACL reconstruction; 2) Correlate patient satisfaction and function to return to sport; 3) Identify factors contributing to failure to return to prior activity level.

Methods: Twenty-nine patients who underwent transphyseal ACL reconstruction using soft tissue grafts passed through open physes and followed to skeletal maturity returned for interviews and exams.

Results: At an average follow-up of four years, the mean satisfaction score was 9.1 (range 4 to 10), the mean Lysholm score was 92 (range 61 to100), the mean Tegner activity score dropped from 7.6 pre-injury to 6.8 (p=0.003), and only 12 of 29 (41%) patients returned to and maintained their pre-injury level of sport. Four revision reconstructions and seven minor operations were performed for a reoperation rate of 11/29 (38%). Eight of 29 patients (28%) sustained contralateral ACL ruptures. Patients who were satisfied had a better (earlier letter in the alphabet) IKDC overall score (r_s=-0.59, p<0.001). Satisfaction was also highly correlated with the Tegner Activity score (r= 0.60, p=0.002) and return to prior level of sports (r=0.44; p=0.02). Having a contralateral ACL tear in the period since the index ACL surgery was not predictive of lower Tegner Activity score (r= -0.08, p=0.70), however only one of four patients undergoing revision reconstruction of their index ACL procedure returned to their prior level of sports. Reasons given for decreased activity levels ranged from loss of interest, loss of relative skill, and in at least one patient, a loss of confidence in the knee's stability.

Conclusions: Despite high satisfaction and function, less than 50% of patients maintained their pre-injury level of play four years after transphyseal ACL reconstruction. Contributing factors include decreased self- and independently-assessed knee function and changes in lifestyle with increasing age.

Significance: Though transphyseal ACL reconstruction can result in restoration of near normal knee function and return to prior activity levels, sports providers should be aware that many teens choose not to continue to participate as intensely in sports four years after ACL injury and reconstructive surgery.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Validation of a Dedicated Pediatric Shoulder Outcome Questionnaire

Eric W. Edmonds, MD*; Tracey P. Bastrom, MA; Joanna H. Roocroft, MA; Valerie A. Young-Calandra, RN; Andrew T. Pennock, MD*
Rady Children's Hospital, San Diego, CA

Purpose: Many health-related quality of life outcome tools for shoulder pathology have been validated for adults; such as, the Disabilities of the Arm, Shoulder, and Hand (DASH) or QuickDASH. The purpose of this study was to examine the reliability and convergent validity of a shoulder outcome tool designed specifically for the pediatric/adolescent population.

Methods: Patients presenting for treatment of shoulder-related complaints were asked to participate. Packets given to each family included: the newly developed shoulder survey, the QuickDASH (including the sports and work modules), and the single assessment numeric evaluation (SANE). The new shoulder survey consists of 13 questions that assess (in child friendly language) symptoms, limitations, need for compensatory mechanisms, and emotional distress related to shoulder dysfunction. Responses are on a 0-5 or 0-10 scale with a score calculation based on percentage of total possible points (100% indicates no/minimal impact on quality of life from shoulder dysfunction). The direction of the responses was varied amongst the questions to allow for identification of response sets. Cronbach's alpha coefficient was utilized to determine internal consistency reliability of the items in the new shoulder questionnaire. Pearson's correlation coefficient was utilized to establish convergent validity with existing tools.

Results: A total of 132 families agreed to participate. Five children were missing responses to at least 6 (46%) questions and were excluded, resulting in 127 patients for analysis. Overall reliability of the shoulder survey was good, with Cronbach alpha = 0.86. Analysis of domains indicated maximum reliability with a Symptom/Limitation domain (Cronbach alpha = 0.77) and a Compensatory Mechanism/Emotion domain (Cronbach alpha = 0.70). Total score averaged 59.7±17.9% in this cohort (range 18.75-100%). Significant correlations for total and domain shoulder survey scores were observed with the QuickDASH score (r =-0.65 to -0.79), sports module score (r =-0.61 to -0.65), work module score (r =-0.64 to -0.73), and SANE scores (r =-0.49 to -0.61).

Conclusion: This 13 question pediatric/adolescent-friendly shoulder survey shows excellent reliability and good convergent validity. The lack of perfect correlation with the QuickDASH score and even lower magnitude correlation with the sports module and work module indicate that while the tools are measuring a similar construct, there is adequate divergence to justify utilization of this pediatric outcome tool.

Significance: Utilization of a reliable shoulder specific outcome tool specifically designed and validated in a pediatric/adolescent population may provide more sensitive and specific information related to the impact of treatment in this younger cohort.

See pages 17 - 62 for financial disclosure information.

Return to Play and Clinical Outcomes after All-Inside, Anterior Cruciate Ligament Reconstruction in Skeletally Immature Athletes

Danyal H. Nawabi, MD, FRCS (Orth); Moira M. McCarthy, MD; ***Daniel W. Green, MD****; Frank A. Cordasco, MD*
Hospital for Special Surgery, New York, NY

Introduction: Anterior cruciate ligament (ACL) injuries in skeletally immature patients are on the rise because of increased participation in cutting sports such as soccer, lacrosse and football. Operative management of these injuries is being increasingly favored due to the risk of progressive intra-articular damage with non-operative treatment. Multiple ACL reconstruction techniques have been described but the optimal method has not been established. The purpose of this study was to evaluate the results of an all-inside, physeal-sparing ACL reconstruction technique in skeletally immature athletes, with a focus on return to play.

Methods: Twenty-five skeletally immature athletes (mean chronologic age 12.6 yrs, [range 10-15]) were prospectively evaluated following an all-inside ACL reconstruction utilizing hamstring autograft. The mean bone age (Greulich and Pyle method) was 13.5 years. There were 8 females and 17 males. Seventeen patients had an all-epiphyseal (AE) ACL reconstruction and 8 patients had a partial transphyseal (PTP) ACL reconstruction, which spared the femoral physis but crossed the tibial physis. The PTP option was reserved for patients with minimal proximal tibial growth remaining. Fourteen athletes were involved in recreational sport and 11 participated competitively. Lacrosse (36%) and Soccer (32%) were the two most common sports associated with ACL injury in our cohort. At last followup, all athletes were evaluated with a physical examination, KT-1000 arthrometry, isokinetic testing, validated outcome scores including the International Knee Documentation Committee score (IKDC), the Lysholm score and Marx activity rating scale. A comprehensive, return to sport performance analysis was also performed for each patient.

Results: At a mean follow-up of 14.2 months (range 9-24), the mean IKDC score was 92.9 ± 7, the mean Lysholm score was 97.7 ± 5 and the mean Marx activity rating scale score was 12.4 ± 3. Lachman and pivot shift testing was negative in all patients. The mean side-to-side difference in the KT-1000 arthrometry was 1 ± 0.7 mm, with the maximum difference in the cohort being 2 mm. Isokinetic testing showed a mean deficit of 7% in extension torque and 14% in flexion torque at a repetition speed of 180 degrees per second. No angular deformities were noted and the mean radiographic leg length discrepancy was 1.4 ± 4.5 mm. One athlete had a traumatic graft disruption at 12 months and underwent revision ACL reconstruction and one athlete sustained a contralateral ACL rupture at 11 months. At the current time, 10 athletes have been cleared to return to unrestricted sporting activity at a mean duration from surgery of 12.5 ± 1.3 months.

Conclusions: An all-inside, physeal-sparing ACL reconstruction technique using hamstring autograft demonstrates excellent subjective and objective clinical outcomes in skeletally immature athletes without growth disturbance. With the institution of a comprehensive return to sport performance analysis, the duration of safe return to unrestricted sport is 12.5 months from surgery.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Status of the Patellofemoral Articular Cartilage in Recurrent Patellar Instability

Nandan Prasad, BA; June C. O'Donnell; ***Scott J. Luhmann, MD***
Washington University School of Medicine, St. Louis, MO

Purpose: To quantify the frequency, severity, and location of patellofemoral articular cartilage changes in recurrent patellar instability treated surgically.

Methods: A single-surgeon patellofemoral surgical database was queried to identify all knees with recurrent patellar instability between 3/2000 and 6/2012 (n=214). Only knees which underwent knee arthroscopy during the surgical treatment were included (n=148). Patellar and femoral articular cartilage condition was assessed arthroscopically, with damage quantified by direct measurement, Outerbridge (OB) grade and location.

Results: There were 148 knees in 130 patients which satisfied the inclusion criteria. Mean age was 16.0 years (11.5 to 22.3 years). There were 93 females and 37 males. Diagnoses were: dislocations 122 (82.4%) knees and subluxations 26 knees. Preoperatively 28 knees (18.9%) had patellofemoral (P-F) crepitation. Statistical analysis demonstrated preoperative P-F crepitation was correlated with medial patellar facet lesions ($p=0.0022$) and were 3.6 times more likely to have medial patellar facet lesions. The presence of crepitation was correlated with the higher OB patellar grades ($p<0.0001$) and larger patellar lesion size ($p=0.0021$). At the time of arthroscopy 89 knees (60.5%) had patellar articular cartilage damage with a mean OB grade of 1.3 (0 to 4) and mean size of 93.2 sq. mm (0 to 750). The locations of patellar damage were medial facet 47%, apex 42%, lateral facet 4%, inferior pole 4%, unspecified 2%. Males were more likely to have medial patellar facet lesions ($p=0.0412$), with higher OB grade ($p=0.0561$) and patellar lesion size ($p=0.0211$) than females. The femoral articular cartilage damage was identified in 29 knees (19.7%). Mean OB grade was 0.44 (0 to 4) and mean size of the damage was 33.5 sq. mm (0-702). In 89.7% (26/29) of femoral lesions there was concomitant damage to the patella, only 3 knees (10.3%) had isolated femoral lesions. Patellar dislocators were more likely to have apical patellar lesions ($p=0.0149$), with loose bodies ($p=0.0436$) and higher-graded femoral ($p=0.0005$) and patellar lesion size ($p=0.0005$).

Conclusion: P-F articular damage was present in 68.5% of knees, with the patella involved in 96.8% of the damage knees and femoral side 31.5%. The articular surface changes at the P-F joint, documented in this study, are very concerning and bode poorly for long-term, painless function of the knee. In light of these changes preventative measures, such as earlier patellar reconstruction, should be considered.

Significance: This study documented a high frequency of significant patellofemoral joint articular cartilage damage in patients with recurrent patellar instability.

See pages 17 - 62 for financial disclosure information.

Arthroscopic Lateral Retinacular Release in Adolescents with Medial Patellofemoral Ligament-Centered Pain

Andrew J. Blackman, MD; June C. O'Donnell; ***Scott J. Luhmann, MD***
Washington University School of Medicine, St. Louis, MO

Purpose: The purpose of the current study is to evaluate the utility of arthroscopic lateral retinacular release (ALRR) in the treatment of MPFL-centered pain in adolescents.

Methods: A single-surgeon database was queried to identify all patients undergoing ALRR for isolated MPFL pain. Inclusion criteria were: minimum 12 months follow-up and ALRR performed for pain (not patellar instability). All patients had persistent MPFL-centered pain despite participating in a structured, supervised nonsurgical protocol prior to surgery. Primary outcomes included IKDC subjective score and need for further surgery, typically tibial tubercle osteotomy (TTO), to address persistent anterior knee symptoms.

Results: 88 knees in 71 patients (66 female, 5 male) whose average age was 15.7 years (8.4-20.2) were included. Average follow-up was 59 months (12-138). There were no post-operative complications noted. 17 knees (19.3%) subsequently underwent TTO for persistent symptoms. Average preoperative IKDC score was 41.9 (range 18.4 - 67.8) while average postoperative IKDC score was 77.2 (range 11.5 - 98.9), $p<0.05$. Mean improvement was 35.2 +/- 21.1 points for a mean 84% improvement from baseline IKDC score. Average IKDC scores were similar at <60 months postop (80.4 ± 14.4) and >60 months postop (78.3 ± 21.9), $p>0.05$. All patients experienced improvement in IKDC score during follow-up <60 months, however two patients that had marked initial improvements ultimately had worse IKDC scores at final follow-up. The remainder had improvement in IKDC score at final follow-up. Of patients who completed mailed questionnaires, 22/24 (91.6%) had high satisfaction scores and 21/23 (91.3%) would have the surgery again. Patients who ultimately required TTO were younger than patients who did not (14.8 ±1.5 vs 15.9 ± 2.1, $p<0.05$) and had lower preoperative Blackburne-Peel ratios (0.95 ± 0.25 vs 1.11 ± 0.24, $p<0.05$). Postoperative IKDC scores were worse in patients with a preoperative sulcus angle <134 than those with sulcus angle ≥134 (69.9 ± 22.1 vs 82.0 ±12.5, $p<0.05$).

Conclusion: Our experience suggests that ALRR is an effective and safe treatment for adolescents with MPFL-centered anterior knee pain. There was a high degree of patient satisfaction and clinical improvements persisted through longer-term follow-up. Identification of the ideal patient for this procedure remains a challenge, but several factors were associated with worse results, including younger age, lower preoperative Blackburne-Peel ratio, and smaller preoperative sulcus angle. Caution should be exercised in these patients.

Significance: ALRR is a low-morbidity procedure in patients with MPFL-centered pain and can improve score by 84% from baseline values.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Increased Posterior Tibial Slope and Its Association with Acl Rupture in the Pediatric Population

*Michael P. O'Malley, MD; **Matthew D. Milewski, MD**; Matthew J. Solomito, MS; Andrew S. Erwteman, MD; Carl W. Nissen, MD*
Elite Sports Medicine, Connecticut Children's Medical Center, Framington, CT

Purpose: Particular interest has been placed in identifying risk factors for sports related injuries in younger populations. In regards to the relationship between posterior sagittal slope of the tibia as a potential risk factor for ACL injury in the pediatric population, studies at this time remain limited.The purpose of our study is to investigate this relationship between posterior tibial slope and ACL rupture in the pediatric population. Our null hypothesis states that an increased posterior tibial slope does not serve as a contributing risk factor for ACL rupture in pediatric patients with open physes.

Methods: A retrospective case-control study was performed at an academic pediatric sports medicine center comparing a target population of skeletally immature patients with an ACL rupture with an age-matched control group. Posterior tibial slope was then measured on plain lateral radiographs in both groups by blinded readers, at two separate time intervals, utilizing a previously examined and accepted technique.

Results: Thirty two patients were included in the ACL rupture with open physes group (average age 13 years old, range 9-17) and compared to 32 patients in the control group (average age 13 years old, range 9-16). These groups were also similar in regards to male:female and left:right distribution. The mean posterior tibial slope in the ACL injured population was 10.0° ± 3° versus 8.5° ± 3° in the control group. Statistical significance was seen in comparing slope measurements between the ACL injury and control groups in two of the three readers (Readers 1 and 3) at both time points (Reader 1: $p = 0.0348$, $p = 0.0051$; Reader 3: $p = 0.0009$, $p = .0059$). Intra-rater proved superior with values correlating with moderate-to-good reliability (Reader 1 ICC = 0.7387, Reader 2 ICC = 0.8853, Reader 3 ICC = 0.5316), while inter-rater values corresponded with fair-to-moderate reliability (Measure 1 ICC = 0.4657, Measure 2 ICC = 0.5146). The average female posterior tibial slope was 9.5° (range of 3-14°) and similar to the posterior tibial slope for males, which was 9.8° (range of 2-16°).

Conclusion: The authors reject the null hypothesis and these results uphold that an increased posterior tibial slope serves as a possible risk factor for ACL rupture in a skeletally immature population.

See pages 17 - 62 for financial disclosure information.

Outcomes of Dynamic Splinting in Patients with Stiffness After Knee Surgery

J. Lee Pace, MD; Adam Y. Nasreddine, BS, MA; David Zurakowski PhD;
Michael Kalani Simoni, BA; Mininder S. Kocher, MD, MPH
Boston Children's Hospital, Boston, MA

Purpose: The purpose of this study was to investigate the outcomes of dynamic splinting of the arthrofibrotic knee in the pediatric population in terms of increased range of motion (ROM) and reducing the need for surgical intervention.

Methods: Seventy-four patients (33 females) with postoperative arthrofibrosis requiring a dynamic splint (DS) were retrospectively reviewed. Median age was 13 years (4-18). Median follow-up was 17 months (interquartile range 10-28). Demographics, type of index surgery, knee ROM (pre and post), length of treatment and occurrence of lysis of adhesions (LOA) surgery were evaluated. An extension deficit (ED) was defined as ≥ 10° and flexion deficit (FD) was defined as <130°. An improvement was defined as an increase of ≥10° in flexion, extension or both. Wilcoxon signed ranks test was used to assess median improvement in range of motion. Patients were classified into 4 surgical groups and multivariable logistic regression was applied to identify predictors of need for LOA surgery

Results: 57 patients with FD showed median improvement of 30° (95%CI: 0-90, $p<0.001$) and 51 patients with ED showed median improvement of 7° (95%CI: 0-60, $p<0.001$). In the present study, dynamic splinting was associated with ROM improvement in 84% and spared the need for surgery in 58% of all patients. There were 23 patients with FD only, 17 with ED only and 34 with combined deficits. Multivariate analysis of the ACL with meniscus repair subgroup revealed that each one-month delay in DS treatment was associated with a 5-fold increased risk of undergoing a LOA ($p=0.007$). Thirty-six (63%) patients with FD avoided need for surgery and twenty-six (51%) patients with ED avoided surgery.

Conclusion: Our data suggests that dynamic splinting may be an effective method to increase knee ROM and reduce the need for LOA in this pediatric population.

Significance: Knee arthrofibrosis in the pediatric population has received little attention and only recently has its incidence after ACL reconstruction or tibial spine fracture been reported. No studies have evaluated the role of various treatment modalities for this condition in the pediatric age group. This study reports on the effective use of dynamic splinting of the arthrofibrotic knee in the pediatric population in terms of increase in range of motion and avoidance of surgical intervention.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Adolescent Supracondylar Humerus Fractures:
Multi-Center Study of Management and Outcomes

Brian P. Scannell, MD*; Kelly L. Vanderhave, MD; Bryan J. Loeffler, MD; Steven L. Frick, MD; Brian K. Brighton, MD; R. Glenn Gaston, MD;*
Virginia F. Casey, MD; Kyle J. Jeray, MD; Lisa K. Cannada, MD; Robert Hymes, MD
Carolinas Medical Center, Charlotte, NC

Purpose: Supracondylar humerus fractures in adolescents are uncommon injuries. These injuries in younger children have been extensively studied, but studies and guidance for treatment in adolescents is lacking. This study compares treatment and outcome of supracondylar humerus fractures (SCHF) in adolescents undergoing closed or mini-open reduction, percutaneous pin fixation and casting (PP Group) versus open reduction and plate fixation (ORIF Group).

Methods: A multicenter, retrospective review at four institutions was performed on patients age 10-17yo with displaced SCHFs from 2005-2012. Medical records were used to collect demographic data. The operative report was used to determine approach, method of fixation, and postoperative plan. Radiographs were reviewed to determine time to healing and alignment. Clinical outcomes measures included time until functional (30-130°) elbow motion was documented, ulnar nerve dysfunction and need for secondary surgery.

Results: 71 patients with displaced SCHFs were identified. Nine of 71 (12%) were open injuries. There were 35 patients (49%) in the ORIF Group and 36 (51%) patients in the PP Group. There were 41 extra-articular and 30 intra-articular fractures. Of the intra-articular fractures, there were 24 patients in the ORIF group and 6 in the PP Group. The mean follow-up for all patients was 9 months.

When comparing the PP and ORIF Groups, there was no difference in coronal/sagittal alignment. All fractures united. Physical therapy was utilized in 82% of the ORIF Group versus 25% of the PP Group ($p<0.001$). Functional elbow motion was achieved at 3 months with no difference between groups. Postoperative ulnar nerve symptoms were more common in the ORIF Group (11% vs. 6%, $p=.04$). 23% of ORIF patients had additional surgery compared to 8% in the PP Group ($p<0.001$). Of the intra-articular fractures, 30% required additional surgery. The most common secondary procedure in the ORIF Group was manipulation under anesthesia (4 procedures) and removal of implants (5 procedures).

Conclusions: Excellent clinical/radiographic outcomes can be achieved with either PP or ORIF in adolescent SCHFs. Fracture union is predictable and alignment is restored by both PP and ORIF. Functional elbow motion takes months to achieve no matter which type of fixation is utilized. ORIF was associated with higher rates of ulnar nerve dysfunction and secondary surgery.

Significance: Surgeons more commonly utilized open reduction and plate fixation in intra-articular fractures. This type of fracture fixation may be appropriate for intra-articular fractures. However, it is associated with higher rates of ulnar nerve dysfunction and secondary procedures.

See pages 17 - 62 for financial disclosure information.

Iatrogenic Nerve Injuries in the Treatment of Supracondylar Humerus Fractures: Are We Really Just Missing Nerve Injuries on Preoperative Examination?

*Elizabeth Joiner, BS; **David L. Skaggs, MD**; Alexandre Arkader, MD; Lindsay M. Andras, MD; Nina R. Lightdale-Miric, MD; J. Lee Pace, MD; Deirdre D. Ryan, MD*
Children's Hospital Los Angeles, Los Angeles, CA

Purpose: Recent studies report the rate of iatrogenic nerve injury in operatively treated supracondylar fractures is 3-4%. A reliable neurologic examination can be difficult to obtain in a young child in pain. The purpose of this study was to prospectively study nerve injuries in patients with surgically managed supracondylar humerus fractures using a standardized pre-operative neurological examination. We hypothesized that nerve injuries may be missed pre-operatively, noted post-operatively in a more compliant patient, and then falsely considered an iatrogenic injury.

Methods: A prospective study was conducted on patients who presented between April 2011 and April 2013 with a SCH fracture that were managed surgically. A neurologic examination was performed pre-operatively, post-operatively, and at follow-up visits by a fellowship trained attending pediatric orthopaedic surgeon. Only patients in whom the attending surgeon felt a reliable neurovascular examination was obtained were included in this study.

Results: Of 100 patients with an extension-type SCH fracture, 16% had a nerve injury recognized on pre-operative exam and 3% had a new nerve injury on post-operative exam. The Gartland type (p=0.421), type of reduction (open versus closed; p=0.720), and number of lateral-entry (p=0.898) or medial-entry (p=0.938) pins used were not associated with patients who had a new nerve injury found post-operatively. The rate of a pre-operative nerve injury was associated with fracture type: Type II 7% (2/28), Type III 19% (9/58) and Type IV 36% (5/14) (p= 0.058). Pre-operatively nerve injuries were noted at the following rates: Median 12% (12/100) (including 8 anterior interosseous nerve injuries), Radial 8% (8/100), Ulnar 3% (3/100).

Conclusions: In this prospective study, in patients who were able to comply with a pre-operative neurologic exam done by an attending pediatric orthopaedic surgeon, the rate of iatrogenic nerve injury following operative treatment of supracondylar humerus fractures is 3%. This is similar to existing rates reported in the literature. We conclude that this finding is true, and not a result of inadequate pre-operative neurologic examinations.

Significance: This study adds to the current evidence that the rate of iatrogenic nerve injury following operative treatment of supracondylar humerus fractures is about 3%.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

It's Always Sunny in the Operating Room: Weather Affects Operative Pediatric Orthopaedic Volume

Christina J. Gutowski, MD, MPH; Kushagra Verma, MD; Eleanor Lewin, MD; Peter G. Gabos, MD; ***Suken A. Shah, MD***
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

Purpose: The purpose of this study was to investigate the relationship between weather patterns and pediatric orthopaedic trauma volume at one institution.

Methods: A retrospective review was performed of all non-elective (semi-emergent) operative orthopaedic cases that had been added onto the operating room schedule at our pediatric Level 1 trauma institution between March and June of 2012. Ninety-nine patients met all inclusion criteria, and these patients' date of injury, date of admission, and injury type were recorded. The National Weather Service Forecast Database was accessed, and the amount of precipitation and extent of cloud-cover were also recorded. The numbers of injuries sustained per day, as well as the number of admissions per day, were compared to the weather pattern for each day.

Results: The majority of days studied had fairly clear skies (cloud-coverage score of 3 or less.) There is an inverse relationship between the amount of cloud coverage and the incidence of operative orthopaedic injuries that occur per day (R^2=0.69). There is a statistically significant difference in daily injury rate between sunny days without precipitation (1.69 injuries/day) and days with precipitation (0.77 injuries/day, p=0.015). There is also a negative association between daily admission rate for operative orthopaedic injuries and cloud coverage (R=0.82), with a statistically significant difference in daily admission rate between clear days compared to rainy days.

Conclusion: Daily weather patterns help to dictate the incidence of pediatric orthopaedic trauma. Clear days without precipitation were associated with a four-fold increase in operative injuries as compared to cloudy days with precipitation.

Significance: These data have significant implications on an institutional level in terms of emergency room and operating room staffing. Recent trends in healthcare have demanded improved hospital and operating room efficiency and reduced costs. This study allows an institution to better estimate the expected daily traumatic patient volume, to allow for more efficient staffing in the operating room, scheduling and triage logistics in the emergency room that facilitates care that is safer and more timely, and an opportunity to best anticipate the demands of the hospital on a daily basis.

See pages 17 - 62 for financial disclosure information.

Exposed versus Buried Intramedullary Implants for Pediatric Forearm Fractures: A Comparison of Complications

Brian A. Kelly, MD; Patricia Miller, MS; Benjamin J. Shore, MD, MPH, FRCSC; Peter M. Waters, MD; ***Donald S. Bae, MD***
Boston Children's Hospital, Boston, MA

Purpose: The purpose of this study was to compare the rate of complications between buried and exposed intramedullary implants after fixation of pediatric forearm fractures.

Methods: A retrospective comparative cohort study of 339 children treated with intramedullary fixation for displaced forearm fractures between 2004 and 2009 was performed. Implants were left exposed in 128 patients (37.8%) and buried in 208 patients (61.4%); 3 patients had buried and exposed hardware (0.9%). Data on demographics, injury, surgical technique, and complications was analyzed.

Results: The buried implant group was older (mean 10.3 years vs. 8.5 years; $p<0.001$), heavier (mean 38.6kg vs. 31.9kg; $p<0.001$) and had fewer open injuries (23% vs. 41%; $p<0.001$) than the exposed implant group. The buried group had their implants removed later than the exposed group (median 3.5 months vs. 1.2 months; $p<0.001$). There was no difference between time to removal for patients with refracture and those without (median 1.3 months vs. 2.0 months; $p=0.78$). 36.2% of exposed implants were successfully removed in the office. Complications were seen in 56 patients (16.5%). There were 16 patients (4.7%) with refracture and 12 patients (3.5%) with infection. The buried and exposed implant groups did not differ significantly with respect to refracture (3.1% vs. 7.0%; $p=0.20$), infection (3.5% vs. 2.3%; $p=0.66$) or overall complications (14.5% vs. 17.2%; $p=0.87$). There was also no difference between groups with respect to loss of reduction, non or delayed-union, loss of motion, or hypertrophic granuloma, or tendon rupture. Buried implants were also associated with penetration through the skin (3.9%). Injury to the dominant arm and need for open reduction were significant predictors of complication (OR=1.01; 95 %CI = (1.001-1.012); $p=0.02$, and OR=0.51; 95%CI = (0.264-0.974); $p=0.04$, respectively).

Conclusions: There were no significant differences seen in number of infections, refractures, or overall complications based on whether implants were left exposed or buried beneath the skin after surgery.

Significance: Leaving intramedullary implants exposed may be a safe strategy in the operative treatment of forearm fractures in pediatric patients. This technique has the additional benefit of potential removal in the office, saving the patient the risk of anesthesia, as well as conferring potential cost benefits.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Short Leg Casting for Isolated Tibial Shaft Fractures in Children

Megan H.M. Kuba, MD; Drew Brown, IV, MD; Nicholas Scarcella, MD;
Byron Hideo Izuka, MD
Kapi'olani Medical Center for Women and Children, Honolulu, HI

Purpose: An isolated spiral/oblique fracture of the tibial shaft, or so-called "Toddler's fracture", is a common injury in young children which typically presents with minimal or no displacement. The popular orthopedic literature currently indicates the use of a long leg cast as the "gold standard" for care and immobilization of this injury. A long leg cast is more uncomfortable, more difficult to ambulate in, more difficult to care for, results in more joint stiffness and muscular atrophy and in some instances may preclude school attendance. We hypothesize that treatment of Toddler's fractures with a short leg cast will be as effective as treatment with a long leg cast.

Methods: A retrospective review of patients' charts and radiographs obtained from a single surgeons practice from 2008-2011 was performed. Inclusion criteria were isolated, spiral fractures of the tibial shaft in patients 13 years of age and younger. Exclusion criteria were multiple fractures (including those of the fibula), displaced fractures requiring reduction or evidence of any underlying metabolic bone disease.

Results: 49 patients were included in this study with an average age of 4.9 years of age. Patients were treated for an average of 39.5 days in a short leg cast. 3/49 patients required a cast change due to various patient factors. We found that 49/49 (100%) of the patients achieved union at an average of 1.2 months with no loss of alignment occurring during cast treatment. No cast related complication occurred.

Conclusion: Long leg casting has historically been the recommended treatment for isolated spiral/oblique fractures of the tibial shaft in children. We found that the use of a short leg cast is a safe and effective alternative which allows these fractures to heal without displacement.

Significance: treatment with a short leg cast has the following advantages over a long leg cast:
- increased ease of and decreased time of application of the cast
- decreased cost of casting supplies
- increased patient comfort
- increased ease of activities of daily living
- increased ease of cast care
- decreased post-immobilization joint stiffness and muscular atrophy

As such, short leg cast treatment of Toddler's fractures realizes the pivotal goals of improving outcomes while decreasing healthcare costs and improving patient satisfaction.

See pages 17 - 62 for financial disclosure information.

Displaced Medial Epicondyle Fractures in Children: Comparative Effectiveness of Operative versus Non-Operative Treatment

Emily Mayer, BS; Emily A. Eismann, MS; ***Charles T. Mehlman, DO***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose: Medial epicondyle fractures have traditionally been managed non-operatively. However, due to the reported risk of elbow instability, ulnar nerve palsy, and permanent limitation of elbow range of motion, there has been a recent increase in operative treatment. The purpose of this study was to compare the functional outcomes of pediatric patients treated operatively and non-operatively for acute, displaced medial epicondyle fractures.

Methods: This study included chart review of radiographic records, demographic data, and surgical data (when applicable) and data regarding functional outcomes of patients who sustained a displaced medial epicondyle fracture between 2000 and 2011. Inclusion criteria were age less than 18 years and a minimum of one year follow-up. All injury films were examined, and medial epicondyle displacement recorded. Patients were contacted by phone and invited to complete the QuickDASH (Disabilities of the Arm, Shoulder, and Hand), a standardized, validated questionnaire, in addition to a few study-specific questions regarding their functional outcomes. If patients were unable to be reached by phone, the clinical data from their most recent follow-up was obtained, and their range-of-motion, pain, symptoms, and limitations were recorded.

Results: Of 56 patients (mean age: 11 years, range: 4-17) with displaced medial epicondyle fractures, 41 were treated operatively and 15 non-operatively. Operatively treated patients were older (p=0.036), had greater fracture displacement (p=0.011), and shorter immobilization (p=0.014) than non-operatively treated patients. The two groups did not differ in range of motion, pain, or QuickDASH scores at most recent follow-up (p>0.05). Fracture-dislocation occurred in 41% (17/41) operative and 33% (5/15) non-operative patients. Patients with fracture-dislocation were more likely to have long-term functional disability, regardless of age, displacement, or treatment (p=0.040). Complications occurred in 53% (8/15) of non-operative patients and included one arthofibrosis, two ulnar neuropathies, three refractures, and three nonunions. Seven non-operative patients advanced to operative treatment within three years, and five had residual functional limitations.

Conclusion: Our findings demonstrate a high complication rate (53%) of non-operative treatment in pediatric patients with displaced medial epicondyle fractures. Clinicians should be vigilant when treating dislocated fractures and fractures with intra-articular fragments.

Significance: Non-operative treatment is recommended for displaced fractures without dislocation. Based on high complication rates, operative management may be safer for more complex fractures.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Functional Outcomes Following Operative Treatment of Tibial Tubercle Fractures

*Grant D. Hogue, MD; **Anthony I. Riccio, MD**; Corey S. Gill, MD; DeRaan Collins, BS; Lori A. Karol, MD; Robert L. Wimberly, MD*
Children's Medical Center-Texas Scottish Rite Hospital for Children, Dallas, TX

Purpose: To evaluate the functional results of surgically managed tibial tubercle fractures in adolescent patients.

Methods: A retrospective review of all patients treated surgically for unilateral tibial tubercle fractures at a single institution from 2007-2011 was performed. Fractures were classified using the Ogden system. Knee extension torque strength was assessed using a Biodex© dynamometer, knee range of motion was recorded, and thigh circumference was measured. All testing was performed on each patient's involved and uninvolved extremity. Torque deficit was calculated using the subject's unaffected limb as a control. The Pediatric-International Knee Documentation Committee Subjective Knee Form (IKDC), Tegner-Lysholm Knee Scoring Scale, and Visual Analog Pain Scale (VAS) were completed. Post-operative protocols were reviewed to include the use of physical therapy and protected weight-bearing. Functional parameters were compared between the involved and uninvolved extremities using the Student's t-test. Regression analysis was performed to identify any relationships between peri-operative factors, functional parameters and subjective outcomes.

Results: 15 of 42 patients completed biometric testing and 14/15 completed all outcome surveys. Average age at injury was 14.2 years and average follow-up was 3.1 years (1.2-6.1). No statistical difference in extension torque or range of motion was identified between the involved and uninjured sides. A 1.5 cm decrease in thigh circumference at 15cm above the patella and a 1.1cm decrease at 50% the length of the thigh was noted ($p<0.05$). No difference in outcome based upon body mass index, postoperative weight bearing status, Ogden classification, or postoperative physical therapy was noted. The mean VAS for affected limbs was 14.2/100 and for unaffected limbs was 5.2/100 ($p=0.0273$). The Tegner-Lysholm Scale revealed 9 excellent results, 2 good, 3 fair, and 1 poor (average 87.8/100). Results of the Pediatric-IKDC were 0 excellent, 9 good, 2 fair, and 3 poor results (average 78/100). Linear regression analysis suggested a relationship between greater extension torque deficit, higher VAS scores and lower pediatric-IKDC scores.

Conclusion: Patients can expect a decrease in thigh circumference after fracture union and clinical recovery. Analysis suggests that a decrease in quadriceps strength increases the likelihood of pain in the affected knee and poorer results as determined by validated outcome measures. Despite promising objective results, clinical outcomes measured by subjective validated surveys are not all excellent.

Significance: Apparent surgical success does not ensure excellent clinical outcomes.

See pages 17 - 62 for financial disclosure information.

The Outcome of Surgical Treatment of Multidirectionally Unstable (Type IV) Pediatric Supracondylar Humerus Fractures

Mauricio Silva, MD*; Shannon Cooper, BS; Angela Cha, CPNP*
Orthopaedic Institute for Children, Los Angeles, CA

Purpose: The outcome of multidirectionally unstable supracondylar humerus fractures (SCHF), commonly classified as type IV SCHF, has been rarely described.

Methods: We retrospectively analyzed the clinical and radiographic data on 114 completely displaced SCHF in children. This data was collected prospectively over a 6 year period (2007-2013), as part of an IRB-approved study on pediatric elbow fractures. For inclusion, all patients required a minimum follow-up of 6 weeks. We compared the outcome of type IV SCHF (n=10, **Group 1**) to that of type III SCHF (n=104, **Group 2**) by assessing the need for open reduction, length of operative time, recovery of range of motion (ROM) (as compared to the normal, contra-lateral side), and rate of complications.

Results: The mean follow-up for patients in **Groups 1** and **2** was 35 weeks, each (p=0.5). There were no significant differences in age or gender between the two groups. The multidirectional instability was confirmed intra-operatively in all cases in **Group 1**. An open reduction was required in 20% of patients in **Group 1** (2 patients), as compared to 2% of patients in **Group 2** (2 patients) (p=0.04). Surgical times were longer (by an average of 21 minutes) for patients in **Group 1** (69 minutes) as compared to patients in **Group 2** (48 minutes) (p=0.001). An acceptable reduction was achieved in all cases. No immediate post-operative complications were observed in either group. The relative ROM at the latest follow-up was similar in both groups (99% of the normal, contra-lateral elbow in **Group 1** vs. 97% in **Group 2**, p=0.3). The overall rate of complications was 10% in **Group 1** and 7% in **Group 2** (p=0.5). One patient in **Group 1** developed an avascular necrosis of the trochlea. In **Group 2**, five patients (4.8%) developed avascular necrosis of the trochlea, one (1%) had a superficial infection and one (1%) had a mild loss in carrying angle.

Conclusion: Multidirectionally unstable SCHF (type IV), a relatively rare subset of pediatric elbow fractures, appear to have an increased level of difficulty (as demonstrated by a higher need for open reduction and prolonged surgical times). Despite the difficulty, comparable outcomes can be expected in the long-term.

Significance: There is very limited information in the literature regarding the outcome of type IV SCHF. Awareness of the possibility of such injury is critical to ensure adequate outcomes.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

The Effectiveness of Cast Wedging for the Treatment of Pediatric Fractures

Jaffer M. Kattan, BA; Michael P. Leathers, MD; Justin H. Barad, MD; ***Mauricio Silva, MD***
Orthopaedic Institute for Children, Los Angeles, CA

Purpose: The purpose of this retrospective study is to present the results of cast wedging on a relatively large cohort of pediatric patients with tibial and radial shaft fractures. Our hypothesis is that cast wedging is an effective technique in the closed management of tibial and radial shaft fractures after re-displacement.

Methods: We conducted an IRB-approved, retrospective review of radiographic and clinical outcomes of 249 patients that underwent cast wedges after re-angulation of a previously manipulated tibial or radial shaft fracture. The cast was wedged if follow-up radiographs demonstrated $\geq$5° or $\geq$10° of angulation in any plain for tibia and radius fractures, respectively. The final angulation of the fracture was considered as the primary outcome. For radius fractures, the final forearm range of motion was considered as secondary outcome. For tibia fractures, satisfactory outcomes were defined as $\leq$5° of coronal angulation, $\leq$10° of sagittal angulation, no evidence of complications, and no need for surgical fixation; for radius fractures, were defined as no evidence of complications, no need for surgical fixation, a combined range of pronation-supination of $\geq$120° and, in patients $\leq$9 years of age, $\leq$15° of coronal or sagittal angulation and $\leq$45° of malrotation; for older patients, $\leq$10° of coronal or sagittal angulation and $\leq$30° of malrotation.

Results: For tibia fractures, wedging of the cast resulted in small but significant improvements in coronal and sagittal alignment: post-wedge radiographs demonstrated a mean improvement in coronal alignment of 3.4° (95% CI: 2.7° to 4.0°, $p<0.00001$), and a mean improvement in sagittal alignment of 0.6° (95% CI: 0.07° to 1.2°, $p=0.03$). For radius fractures, wedging of the cast resulted in significant improvement in coronal and sagittal alignment: post-wedge radiographs demonstrated a mean improvement in coronal alignment of 4.2° (95% CI: 3.5° to 4.9°, $p<0.00001$), and a mean improvement in sagittal alignment of 4.7° (95% CI: 3.9° to 5.4°, $p<0.00001$). Satisfactory outcomes were obtained in 96% of tibial fractures and 94% of radius fractures. No complications associated with the use of cast wedging were seen.
Conclusions: The results of the present study suggest that cast wedging is a simple, safe and effective tool for the treatment of angulated fractures of the shaft of the tibia and radius in children.

Significance: There is limited data available in the literature regarding the efficacy of cast wedging for correction of alignment during the closed treatment of pediatric fractures, and this study adds to the current knowledge.

See pages 17 - 62 for financial disclosure information.

Prevalence and Remodeling of Reversed Radial Bowing Following Radial Shaft Fractures in Children

Erik Olsen; Emily A. Eismann, MS; ***Kevin J. Little, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose: Treatment of diaphyseal radius fractures is problematic given their inherent instability. The remodeling potential in children allows for acceptance of slight malunions; however, malunions with a reversal of the radial bow, or apex volar angulation, can progress to volar distal radioulnar joint instability. The purpose of this study was to determine the prevalence and remodeling potential of reversed radial bow malunion in children with radius fractures.

Methods: This IRB-approved, retrospective study reviewed the radiographs and clinical history of 187 consecutive patients with fractures of the proximal- and middle-third radial diaphysis with or without a concomitant ulna fracture between January 2006 and October 2012. Patients with closed distal radius physis, previous forearm fractures, pathologic fractures, distal radial metaphyseal fractures, or treatment with percutaneous or internal fixation were excluded. Angulation was measured on anteroposterior (AP) and lateral radiographs using PACS software. Patients were classified based on whether they had greater than 10^{o} of apex volar angulation on lateral radiographs and apex ulnar angulation on AP radiographs taken at fracture healing (6-8 weeks after reduction). Mann-Whitney tests compared final angulation between patients with and without apex volar and ulnar angulation at fracture healing.

Results: Of 187 patients, 60 (32%) had apex volar angulation and 32 (17%) had apex ulnar angulation at fracture healing. Follow-up greater than one year (range: 1-4 years) was available for 25 patients (13 males, 12 females; age range: 3-14 years). Of the 9 patients with apex volar angulation, 8 (89%) showed lateral plane remodeling at a median rate of -0.21 degrees per month. Significant apex volar angulation remained at final follow-up ($p=0.004$), with $>10^{o}$ in 3 patients (33%, two age 11 females, one age 3 male). All 5 patients with apex ulnar angulation showed AP plane remodeling at a median rate of -0.33 degrees per month. Significant apex ulnar angulation remained at final follow-up ($p=0.002$), with $>10^{o}$ in 2 patients (40%, age 6 male, age 14 male). Greater initial angulation predicted greater angular deformity at final follow-up in lateral ($r=0.88$, $p<0.001$) and AP ($r=0.90$, $p<0.001$) planes, regardless of age or gender.

Conclusion: Reverse radial bowing is a common outcome of fractures following closed treatment. The reverse radial bow progressively remodels toward normal alignment, but residual radiographic deformity frequently persists.

Significance: Clinicians should be aware of the 32% likelihood of reverse radial bowing following closed treatment of radius diaphyseal fractures and that one-third do not sufficiently remodel in children.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Increased Fracture Risk in Children with Attention Deficit Hyperactivity Disorder: A Nationwide Matched Cohort Study

Chii Jeng Lin, MD*; Nai-Wen Guo; Ming-Tung Huang, MD; Cheng-Li Lin, MD; Tsung-Hsueh Lu, PhD; Fu-Wen Liang, PhD; Min-Fnag Tsai; Shi-Liang Wu, MD*
National Cheng Kung University, TAIWAN

Purpose: The objective of this matched cohort study is to analyze the nationwide database of fracture risk among children aged 4-17 years with or without attention deficit hyperactivity disorder (ADHD, ICD-9-CD codes 314).

Methods: The Longitudinal Health Insurance Database (LHID 2000) were used to analyze DRF (ICD-9-CM 813.4) of children from National Health Insurance (NHI) that covered 96.1% of Taiwanese population (N=21.4 million). A total of 7,200 ADHD children aged between 4 and 17 years whose diagnosis had been confirmed in at least three out-patient clinics between January 1, 2000 and December 31, 2009 were included while a cohort of 36,000 children without ADHD matched with age, gender and urbanization was recruited for analysis.

Results: The incidence rate of fractures in ADHD children was 21.0 (95% CI=19.4-22.7) per 1,000 person-years, significantly ($p<0.001$) higher than 15.0 (95% CI=14.4-15.6) in non-ADHDs. After adjusting by age, gender, urbanization level and geographic region, the statistically significant ($p<0.001$) hazard ratios (HR) of fracture for ADHD children when compared with non-ADHD children included 1.62 in girls and 1.38 in boys, 1.53 in skull, neck and trunk (ICD-9-CM 800-809), 1.28 in upper extremity (ICD-9-CM 810-819) and 1.84 in lower extremity (ICD-9-CM 820-829). The HR also significantly ($p<0.001$) increased in all age groups, including 1.35 in 4-6, 1.37 in 7-9 and 1.54 in 10-17 years.

Conclusion: The risk of fracture increased significant in children with ADHD in each gender, all age groups and all body areas. Yet, ADHD girls had higher fracture risk than ADHD boys while the lower extremity fractures were the most risky body area. Based on this study, ADHD should be listed among risk factors of children's fractures that the parents, teachers, caregivers of ADHD children and pediatric orthopedists should be aware of.

Significance: Nationwide matched cohort analysis revealed that ADHD should be considered as the risk factor of children's fracture.

See pages 17 - 62 for financial disclosure information.

The Epidemiology of Pediatric Supracondylar Fracture Fixation: A Population-Based Study

Amir Khoshbin, MD; Timothy S. Leroux, MD; David Wasserstein, MD, MSc; Jesse I. Wolfstadt, MD; Peggy W. Law, MSc; Nizar Mahomed, MD;
James G. Wright, MD, MPH, FRCSC
Hospital for Sick Children, Toronto, Ontario, CANADA

Purpose: The epidemiology of pediatric supracondylar fracture (SCF) fixation has not been evaluated at a population level. In this study, we determined: 1) the incidence density rate (IDR) of SCF fixation, and 2) the rate and risk factors for re-operation.

Methods: Using administrative databases, all patients who underwent SCF fixation [closed reduction percutaneous pinning (CRPP) or open reduction (OR)] in Ontario between April 2002 and March 2010 were identified. Exclusion criteria included: 1) age (>12 years), 2) prior or concurrent non-SCF elbow fracture, and/or 3) previous humeral osteotomy. The overall IDR of SCF fixation and for subgroups of age, sex, and season were calculated. A multivariate regression (immediate and short-term re-operation) and a Cox proportional hazards model (long-term re-operation) were used to identify patient, injury, and provider factors that influenced re-operation risk, and reported as odds ratios or hazard ratios (HR) with 95% confidence intervals (CI), respectively.

Results: A total of 3,235 patients with a median age of 6.0 years [interquartile range (IQR): 3.0] underwent SCF fixation. The median follow-up was 6.0 years (IQR: 3.7). The majority underwent a CRPP (78.7%) after hours (75.6%). The overall IDR was 20.7/100,000 person-years (py), but varied significantly by season and age. Re-operation was uncommon in the immediate (1.0%), short-term (1.4%), and long-term (0.3%) follow-up period. As compared to CRPP, patients who underwent OR were more likely to undergo early nerve exploration [Odds Ratio: 7.8 (CI: 3.0-20.6)] and re-operation in the long term [HR: 3.0 (CI: 1.0-8.7)]. Increased surgeon volume of SCF fixation was protective against repeat fixation [Odds Ratio: 0.9 (CI: 0.9-1.0)], and re-operation in the long-term [HR: 0.9 (CI: 0.8-1.0)].

Conclusion: While SCF fixation is common, the rate of re-operation is low – particularly when performed by higher volume surgeons. The high rate of OR (21.3%) noted may be reflective of a limitation in our database to differentiate between actual reductions as opposed to other procedures such as ulnar nerve localization. No differences existed between the sexes and higher volume of fixations occurred during the summer months.

Significance: This is the first population-based study to investigate re-operations following SCF fixation. OR increased the risk of re-operation, while time of surgery did not.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Outcomes of Rigid Intramedullary Nail Fixation in Paediatric Femoral Fractures

Timothy P. Carey, MD, FRCSC*; Christopher Del Balso, BSc, MSc, MBBS;*
Debra Bartley, MD, FRCSC; Megan S. Cashin, MD, FRCSC;
Abdel-Rahman Lawendy, MD, MSc, FRCSC
Children's Hospital, London Health Sciences Centre, London, Ontario, CANADA

Purpose: Femoral shaft fractures are a significant cause of morbidity in the paediatric population. Rigid intramedullary (IM) nail fixation is the preferred treatment in adults, offering advantages of length and rotational control as well as early weight-bearing. In the skeletally immature, the potential risk of femoral head avascular necrosis (AVN) has called into question the safety of rigid IM nailing. The goal of the present study was to determine complications associated with rigid IM nailing of traumatic diaphyseal femur fractures in the skeletally immature by reviewing cases at a single trauma centre.

Methods: A retrospective review of 107 traumatic paediatric diaphyseal femur fractures treated with rigid IM nail fixation from November 1, 2004 to December 31, 2012. Mean age was 13 years 11 months (range = 10 years 3 months to 15 years 9 months). Mean follow-up was 17 months (range = 6 months 4 days to 59 months 25 days). Fracture and surgical details as well as complications including infection, deep venous thromboembolism (DVT), malunion, nonunion, re-fracture, reoperation, heterotopic ossification (HO), leg length discrepancy (LLD) and AVN were recorded.

Results: Fifty-three fractures in 52 skeletally immature patients met inclusion criteria. Twenty-eight fractures involved motor vehicle collisions. Four fractures were open. All rigid IM nails were anterograde with a greater trochanteric (GT) start point. Eighteen patients experienced post-operative pain and/or hardware irritation. Twenty-two patients underwent reoperation (8 nail removals, 14 locking screw removals). No infection, DVT, malunion, nonunion, re-fracture, significant LLD or AVN were recorded. Two cases of HO were observed, one requiring surgical excision.

Conclusion: The present investigation sought to determine complications associated with rigid IM nailing of traumatic diaphyseal femur fractures in the skeletally immature. No infection, DVT, malunion, nonunion, re-fracture, significant LLD or AVN were observed suggesting that this treatment can be both safe and efficacious.

Significance: To date, this is the largest series reporting results of rigid IM nailing of diaphyseal femur fractures through a greater trochanteric start point in skeletally immature patients. No cases of AVN were observed, challenging the existing perceived risk of AVN with rigid IM nailing through the GT in the skeletally immature.

See pages 17 - 62 for financial disclosure information.

The High Risk of Infection with Delayed Treatment of Pediatric Seymour's Fractures

Bryan A. Reyes, MD; ***Christine Ann Ho, MD***
Children's Medical Center-Texas Scottish Rite Hospital for Children, Dallas, TX

Purpose: The purpose of this study is to describe treatment methods and complication rates of all Seymour's fractures (open Salter-Harris I/II fractures of the distal phalanx with associated nailbed laceration) treated at or referred to a pediatric level one trauma center over a ten year time period.

Methods: All patients treated in the pediatric hand clinic at our institution with an ICD-9 diagnosis of 816.02 or 816.12 (closed or open fracture of distal phalanx or phalanges of hand, respectively) between August 2002 and December 2012 were identified. All charts and radiographs were retrospectively reviewed. 47 patients treated for 48 Seymour's fractures were identified. Patients were divided into groups based on timing and quality of treatment. 'Appropriate' treatment was defined as irrigation and debridement, fracture reduction, nailbed repair, and antibiotics. 'Partial' treatment was defined as any type of incomplete treatment. 'Acute' treatment was defined as management within 48 hours of the injury, and 'Delayed' as presenting for treatment past 48 hours from time of injury. Statistical comparisons were performed using Fisher's exact test.

Results: Average patient age was 8.7 years (range 1-15 years), with 35 males and 12 females. Most common mechanism of injury was sports (32%, 15/47), followed by closed in door/window (30%, 14/47). 57% (27/47) were treated in an acute, appropriate manner, 15% (7/47) received acute, partial treatment, and 28% (13/47) received delayed treatment. 1 patient initially treated at an outside hospital had inadequate documentation to determine appropriateness of treatment but had no complications. There were 9 complications: 3 superficial infections, 5 osteomyelitis, and 1 malunion. With respect to infectious complications, only 1 (superficial infection) occurred in the acutely, appropriately treated group (infection rate 3.7%, 1/27), 1 (osteomyelitis) occurred in the acutely, partially treated group (14%, 1/7) and 6 (1 superficial, 4 osteomyelitis) occurred in the delayed treatment group, (46%, 6/13), ($p < 0.003$ all infections; $p < 0.007$ osteomyelitis).

Conclusion: Timing and quality of treatment of Seymour's fractures significantly influences infectious complication rates, as patients with delayed treatment had a 12-fold risk of infection compared to those treated early and appropriately.

Significance: This study, the largest reported cohort of Seymour's fractures, highlights the importance of timely, appropriate treatment of this outwardly benign fracture to reduce the risk of infection.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Indirect Shoulder Magnetic Resonance Arthrography: A Technique for Identifying Labral Pathology in Young Patients

Andrew J. Razzano, Jr., DO; Melanie A. Morscher; Richard P. Steiner, PhD; Azam A. Eghbal, MD; ***Kerwyn C. Jones, MD***
Akron Children's Hospital, Akron, OH

Purpose: Direct magnetic resonance arthrography (D-MRI) is the preferred imaging technique for detecting shoulder labral pathology. Indirect magnetic resonance arthrography (I-MRI) has been presented in the adult literature as an alternative to D-MRI, but its use in a pediatric population has not been widely reported. The purpose of this study is to compare the sensitivity of I-MRI to historical D-MRI for detecting shoulder labral pathology in young patients.

Methods: An IRB approved retrospective review identified 68 cases of shoulder I-MRI preformed at a single pediatric institution from 2010 to 2011. Cases were included if subsequent shoulder arthroscopy findings were available for review, leaving 37 cases in the study. A specific I-MRI protocol was consistently followed in all cases which included a review of I-MRI images by the in-house pediatric radiologist. For the purpose of this study, the I-MRI images were reviewed a second time for labral pathology by a single pediatric radiologist blinded to surgical findings. Labral pathology was defined as a labral tear or fraying. Operative images were reviewed by an independent orthopedic surgeon. The I-MRI findings (original and from second radiologist) were compared to the arthroscopic findings. Statistics were used to determine the sensitivity and exact binomial 95% lower bound for detecting shoulder labral pathology.

Results: Of the 37 cases included in the study, 32 had labral pathology on arthroscopic examination. Compared to arthroscopic findings, the sensitivity of I-MRI for detecting labral pathology in young patients was 94% (100% for the second radiologist). The exact binomial lower bound was calculated at 82%.

Conclusion: In this series, the sensitivity of I-MRI for detecting labral pathology was 94% (100% for a second radiologist) which is comparable to the historical range reported for D-MRI of 88-100%, the current gold standard. In the pediatric population, there are several advantages to I-MRI, most notably the elimination of direct injection into the joint, no radiation exposure, and decreased cost. Although detection of rotator cuff pathology (RCP) was not the focus of our study, clinicians need to be aware that there is an increased risk of false positive radiographic reads for RCP with I-MRI. This is primarily due to enhancement of vascular structures.

Significance: Indirect MR arthrography may be a less invasive, cost effective alternative to direct MR arthrography for detecting shoulder labral pathology in young patients with comparable sensitivity (94%).

See pages 17 - 62 for financial disclosure information.

Developmental Anatomy of the Distal Radial Epiphysis in Children

Pooya Hosseinzadeh, MD*; Douglas Olson, MD; Ashley Jaglowicz; Ryan Eads, BS; Scott A. Riley, MD*
Lexington Shriners Hospital for Children, Lexington, KY

Purpose: The radiographic anatomy of the distal radius is well defined in adults and aids in treatment decision making. The volar tilt and radial inclination are the two most commonly used radiographic measurements in adults. Radiographic anatomy of the distal radius is not well defined in children. We studied radiographic parameters of the distal radius epiphysis in children. Our hypothesis was that these values in children are different than adults and vary in children based on age.

Methods: Wrist radiographs of children ages 8-16 taken at our facility from 2009 to 2013 were reviewed. Radiographs showing trauma to the distal radius or those lacking proper lateral views were excluded. The volar tilt, radial inclination, and radial epiphyseal height were measured for each patient. Skeletal age was determined using Greulich and Pyle atlas for each radiograph. A regression analysis was performed to determine the statistical significance of radiographic measurements (volar tilt, radial inclination, and radial epiphyseal height) with regard to chronologic age and skeletal age.

Results: 372 patients (215 males and 157 females) were included in the study. Normal values of volar tilt (11.4±3.6degrees), radial inclination (22.1±3.9 degrees), and radial epiphyseal height (11.4 ±2.7mm) were defined for each age group. Regression analysis showed that volar tilt increased significantly by increase in age ($P < 0.001$). Volar tilt values correlated both with skeletal age ($R = 0.5$) and chronological age ($R=0.4$). Radial inclination and radial epiphyseal height both showed significant increase with increase in age ($P<0.001$). Radial inclination values correlated both with skeletal age($R=0.6$) and chronological age ($R=0.6$). Radial epiphyseal height also showed strong correlation with skeletal ($R=0.8$) and chronological age ($R=0.8$).

Conclusion: We have identified the baseline average radiographic values for volar tilt, radial inclination, and radial epiphyseal height based on patient's age. These values change with the development of the distal radial epiphysis.

Significance: These normal radiographic values can be used by clinicians while planning corrective surgeries.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

Significance of the Lateral Humeral Line for Evaluating Radiocapitellar Alignment in Children

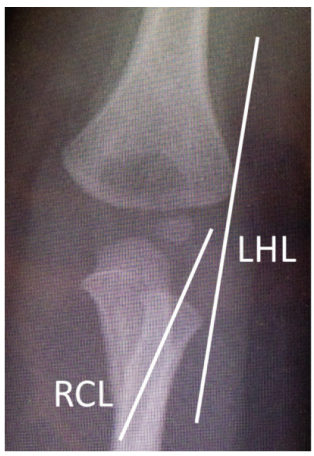
Christopher D. Souder, MD*; Joanna H. Roocroft, MA; Eric W. Edmonds, MD*
Rady Children's Hospital, San Diego, CA

Purpose: The radiocapitellar line (RCL) was originally described for evaluation of the alignment of the radiocapitellar joint on lateral images of the elbow. Although, many authors have translated the utilization of RCL into coronal imaging, previous study has not been performed to confirm validity. The purpose of this paper was to identify an accurate way of evaluating pediatric radiocapitellar alignment in the coronal plane.

Methods: Thirty-nine anteroposterior (AP) radiographs of thirty-seven children were evaluated to determine the position of the radiocapitellar joint in the coronal plane. Thirty-two patients in the cohort had acceptable magnetic resonance imaging (MRI) studies available for comparison. The lateral humeral line (LHL), consisting of a line along the lateral edge of the ossified condyle of the distal humerus parallel to the axis of the humeral shaft, was studied as it related to the lateral edge of the proximal radius. Three children with a confirmed diagnosis of a Bado III, lateral displaced radius, Monteggia fracture were also evaluated.

Results: On AP radiographs, the LHL passed along the edge of or lateral to the lateral cortex of the radial neck in thirty-seven of thirty-nine elbows. The LHL also passed lateral to the radial neck in thirty-one of thirty-two patients evaluated by MRI. A single patient was found to have a LHL through the radial neck on both plain radiograph and MR imaging. In addition, the RCL was seen passing through the capitellum in all patients at a mean of the lateral 31% (range 0-64%) on AP radiographs. All but one RCL intersected the capitellum on MR imaging with all passing through the lateral third (range 0-34%, mean 20.3%). For all three children with a Bado III Monteggia fracture, the LCL crossed the radial neck and the RCL did not intersect the capitellum.

Conclusion: The RCL consistently intersected the lateral portion of the ossified capitellum in children without injury. The LHL can be used as an adjunct to evaluate the AP radiograph in regards to the alignment of the radiocapitellar joint with proximal radius consistently lying medial to this lateral humeral line (Figure, RCL not bisecting capitellum, but intact LHL suggesting no evidence of lateral subluxation).



Significance: The frequently stated concept that the radiocapitellar line passes through the center of the capitellum is rarely found to be true, but the lateral humeral line can be used to aide assessment of questionable injuries to the radiocapitellar joint on AP images.

See pages 17 - 62 for financial disclosure information.

Lower Extremity Anomalies in Patients with Ulnar Longitudinal Deficiency

Pooya Hosseinzadeh, MD; Stanford T. Israelsen, MD; Scott A. Riley, MD; ***Janet Walker, MD***
Lexington Shriners Hospital for Children, Lexington, KY

Purpose: Ulnar longitudinal deficiency (ULD) is a congenital abnormality that involves underdevelopment of the ulnar side of the upper extremity. There is clinically noted association between ulnar longitudinal deficiency and congenital lower extremity anomalies especially fibular deficiency. Clinical decision making for treatment of these patients depends on the functional status of the other extremities. There is limited data in the literature about lower extremity abnormalities in this group of patients. This retrospective study reports the incidence and severity of lower extremity anomalies.

Methods: Retrospective chart review of patients with the diagnosis of ULD treated at our hospital was performed. Radiographs were reviewed and the upper extremity anomaly was classified based on modified Ogdon classification (0: finger deficiencies, I: ulnar hypoplasia, II: partial ulnar absence, III: complete absence of ulna). The lower extremity involvement was studied and graded based on Achterman classification for fibular deficiency (1: fibula present, 2: fibula absent).

Results: Thirty seven upper extremities in twenty nine patients were identified. Average age of patients was 7.5 years with 23 males and 6 females in the study (M/F=3.7). Ogden III was the most common type in our population (38%) followed by type 0 (32%). Twelve patients had associated fibular deficiency (41%) and two patients had associated proximal focal femoral deficiency (7%). Of the twelve patients with fibular deficiency, seven cases (58%) were classified as Achterman 2. Nine of patients with fibular deficiency were in the Ogden 0 group, two in Ogden I and one patient in Ogden II group. Highest association was found between Ogden 0 and fibular deficiency with 75% of the patients with Ogden 0 had associated fibular deficiency followed by 29% of patients with Ogden I. Although Ogden III was the most common type in our population, none of the patients in that group had associated fibular deficiency.

Conclusion: Fibular deficiency is a common finding in patients with Ulnar Longitudinal deficiency (41%). This association is highest with milder forms of ULD. In patients that the deficiency is limited to hands (Ogden 0) 75% had associated fibular deficiency. This association is weakest in severe forms of ULD with none of our patients in Ogden III group found to have fibular deficiency.

Significance: This study shows the prevalence of lower extremity involvement and its association with the severity of upper extremity involvement in patients with ULD.

♦ Indicates those faculty presentations in which the FDA has not cleared the drug and/or medical device for the use described (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.

THE ALFRED R. SHANDS JR. CIRCLE

The Alfred R. Shands Jr. Circle is OREF's highest-level recognition society. Established in 1994, the Shands Circle was created to recognize those individuals who contribute a minimum of $20,000 in cash or securities or a minimum of $50,000 using life insurance, will or trust, or to the OREF endowment. POSNA thanks its members who have joined the Shands Circle.

Drs. Behrooz Akbarnia and Nasrin Owsia
Margaret R. Albanese, MD
Dr. and Mrs. Stephen A. Albanese
Michael C. Albert, MD
Benjamin A. Alman, MD
Dave and Linda Aronsson
Dr. Marc and Mrs. Ellie Asher
Dr. and Mrs. George S. Bassett
Dr. and Mrs. James H. Beaty
Randal R. Betz, MD
Laurel C. Blakemore, MD
Dr. and Mrs. Oheneba Boachie-Adjei
Jennette L. Boakes and Mr. David Rives
Gary T. Brock, MD
(In honor of Denis S. Drummond, MD)
Dr. and Mrs. Robert W. Bruce Jr.
Dr. and Mrs. Robert B. Cady
Robert M. Campbell Jr., MD
S. Terrance Canale, MD
Dr. Hank and Mrs. Jill Chambers
Dr. and Mrs. Henry R. Cowell
Alvin H. Crawford, MD
John P. Dormans, MD, FACS
Denis S. Drummond, MD
Drs. John B. and S. Jean Emans
Dr. Howard and Mrs. Phyllis Epps
Dr. Robert Bucholz and
Dr. Marybeth Ezaki
Frances Farley, MD and Darryl Snabes
David S. Feldman, MD
John M. Flynn, MD
Dr. Steven and Mrs. Lisa Frick
Keith R. Gabriel, MD
Theodore J. Ganley, MD
Drs. Mark and Paulette Gebhardt
Dr. and Mrs. Walter B. Greene
Dr. and Mrs. Lawrence L. Haber
Dr. Richard and Mrs. Sherril Haynes
William L. Hennrikus Jr., MD
Mr. John C. Herklotz
Dale and Stevie Hoekstra
Drs. Alexandra Page and John Houkom
Dr. and Mrs. John D. Hsu
Dr. and Mrs. Kamal N. Ibrahim
Lawrence I. Karlin, MD
James R. Kasser, MD
Robert M. Kay, MD
John T. Killian, MD
Young-Jo Kim, MD, PhD
Andrew G. King, MD
Dr. and Mrs. Howard A. King
Jan E. Klamar, MD
Dr. L. Andrew and Mrs. Leigh E. Koman
Ken N. Kuo, MD
(In memory of Angela S. M. Kuo)
Hubert Labelle, MD
Arabella I. Leet, MD*
Dr. Lawrence G. and
Mrs. Elizabeth A. Lenke
R. Merv Letts, MD
Baron S. Lonner, MD
Dr. John E. and Mrs. Ann K. Lonstein
Dr. and Mrs. Herbert J. Louis
Dr. G. Dean and Mrs. Marilyn MacEwen
Steven M. Mardjetko, MD
Sharon K. Mayberry, MD
Richard E. McCarthy, MD
James J. McCarthy, MD
Dr. Newton C. and Mrs. Mary McCollough
Dr. Gregory and Mrs. Madelyn Mencio
Dr. Todd A. Milbrandt and
Ms. Mary Beth Magyar
Dr. Scott and Mrs. Sandy Mubarak
Dr. Peter and Mrs. Cathy Newton

Dr. Ken Noonan and
Mrs. Carrie Askew Noonan
James W. Ogilvie, MD
Norman Y. Otsuka, MD
Hamlet A. Peterson, MD
Drs. William and Linda Phillips
Kristin A. Pierz, MD
Dr. and Mrs. Charles T. Price
Ellen M. Raney, MD
Dr. and Mrs. Karl E. Rathjen
Juan A. Realyvasquez, MD
Kent A. Reinker, MD
Dr. and Mrs. B. Stephens Richards
Dr. James and Mrs. Elizabeth Roach
Dr. and Mrs. Sanjeev Sabharwal
James O. Sanders, MD
John F. Sarwark, MD
Dr. and Mrs. Perry L. Schoenecker
Dr. Richard M. and
Mrs. Colleen G. Schwend
Dr. and Mrs. Suken A. Shah
Jay Shapiro, MD
Kevin G. Shea, MD
Dr. and Mrs. Harry L. Shufflebarger
David L. Skaggs, MD
Dr. and Mrs. Chadwick F. Smith
Brian D. Snyder, MD, PhD
Dr. Kit M. Song and Kwi Y. Lee
Dr. Paul and Mrs. Amy Sponseller
Howard H. Steel, MD
David B. Stevens, MD
Dr. Peter M. and Mrs. Gayle M. Stevens*
Peter F. Sturm and Judith Serling-Sturm
Dr. and Mrs. Daniel J. Sucato
Dr. George H. and
Mrs. Janice L. Thompson
Vernon T. Tolo, MD
Laura Lowe Tosi, MD
Dr. and Mrs. Michael G. Vitale
Eric J. Wall, MD
William C. Warner Jr., MD
Peter M. Waters, MD
Dr. and Mrs. Stuart L. Weinstein
David S. Weisman, MD
Lawrence Wells, MD
Dr. R. Baxter and Mrs. Susan Willis

Bold=New Members
*=Deceased

POSNA 2013 POSNA DIRECT FUND

Established in 2011, the POSNA Direct Fund helps POSNA accomplish a variety of educational, research and patient care efforts. POSNA thanks those who have generously supported POSNA Direct as of March 1, 2014.

BRONZE LEVEL
David D. Aronsson, MD
Marc A. Asher, MD
Douglas G. Avella, MD
Laurel C. Blakemore, MD
Patrick John Cahill, MD
Robert B. Carrigan, MD
Jack Chun Y. Cheng, MD
Robert Hyun Cho, MD
Guram M. Chochiev, MD
Henry Richard Cowell, MD
Liebe S. Diamond, MD
Howard R. Epps, MD
Chi Kuang Frank Feng, MD
Michael R. Ferrick, MD
Sumeet Garg, MD
Michael J. Goldberg, MD
Walter B. Greene, MD
Thomas J. Grogan, MD
Alan R. Gurd, MD
Geoffrey F. Haft, MD
Matthew F. Halsey, MD
Christina K. Hardesty, MD
Daniel Hedequist, MD
Robert N. Hensinger, MD
Byron Hideo Izuka, MD
Kevin Horowitz, MD
Michael T. Hresko, MD
Kamal N. Ibrahim, MD
Shannon McClure Kelly, MD
A. Noelle Larson, MD
Laura M. Lemke, MD
R. Mervyn Letts, MD
M. Lucas Murnaghan, MD
Kevin M. Neal, MD
Jon Edward Oda, MD
Stephanie A. Otis-Petersen, MD
Shafique P. Pirani, MD
Joseph Rosenblatt, DO
Mark J. Sangimino, MD

BRONZE LEVEL, ***cont'd***
Jeffrey R. Sawyer, MD
Thomas L. Schmidt, MD
Jonathan G. Schoenecker, MD
Richard M. Schwend, MD
Suken A. Shah, MD
Brian A. Shaw, MD
M. Wade Shrader, MD
Brian G. Smith, MD
Anthony A. Stans, MD
Teri Stech
Alan K. Stotts, MD
Drew E. Warnick, MD
Dennis S. Weiner, MD
David A. Yngve, MD
Ira Zaltz, MD
Lewis E. Zionts, MD

SILVER LEVEL
Donald S. Bae, MD
Mark A. Barry, MD
Henry D. Bratt, MD
Henry G. Chambers, MD
Matthew Dobbs, MD
Frances A. Farley, MD
Steven L. Frick, MD
Robert D. Galpin, MD
Gaia Georgopoulos, MD
William L. Hennrikus Jr, MD
Lori Karol, MD
Derek M. Kelly, MD
Ronald Lewis, MD
M&M Orthopaedics, Ltd
Neil J. Macy, MD
Robert R. Madigan, MD
John J. McKeon, MD
Thomas G. McPartland, MD
Jeffrey L. Mikutis, DO
Kristan A. Pierz, MD
Peter D. Pizzutillo, MD

POSNA 2013 POSNA DIRECT FUND, (cont.)

SILVER LEVEL, *cont'd*
Karl E. Rathjen, MD
Christopher W Reilly, MD
James W. Roach, MD
Wudbhav N. Sankar, MD
Jay Shapiro, MD
Ernest L. Sink, MD
Paul D. Sponseller, MD
Stephen B. Sundberg, MD
Nicholas Waanders, MD
Carl R. Weinert, Jr., MD
Lawrence Wells, MD
R. Baxter Willis, MD

GOLD LEVEL
Robert B. Cady, MD
Mark A. Erickson, MD
John (Jack) M. Flynn, MD
Robert M. Kay, MD
Ken N. Kuo, MD
Gregory A. Mencio, MD
Peter O. Newton, MD
Shriners Hospitals for Children
Peter M. Waters, MD

POSNA 2013 OREF ENDOWMENT DONORS

Michael C. Albert, MD
Gary T. Brock, MD
Frances A. Farley, MD
Lawrence L. Haber, MD
Dale V. Hoekstra, MD
Lawrence I. Karlin, MD
Arabella I. Leet, MD*
Todd A. Milbrandt, MD, MS
Thomas F. Novacheck, MD
Norman Y. Otsuka, MD
Kristan A. Pierz, MD
Sanjeev Sabharwal, MD
Suken A. Shah, MD
Kevin G. Shea, MD
Kit M. Song, MD
Peter F. Sturm, MD

*=Deceased

Joshua M. Abzug, MD
Stephen A. Albanese, MD
Jay C. Albright, MD
Maurice Albright, MD
James Aronson, MD
Marc A. Asher, MD
R. Tracy Ballock, MD
Heather L. Bergeson, MD
John S. Blanco, MD
Tamir Bloom, MD
Jennette L. Boakes, MD
J. Andrew Bowe, MD
T. Desmond Brown, MD
Robert W. Bucholz, MD
Steven L. Buckley, MD
Matthew J. Bueche, MD
Michelle S. Caird, MD
Frank M. Chang, MD
Peter C. Cook, MD
Mark C. Dales, MD
Eliana D. Delgado, MD
Mohammad Diab, MD
Matthew B. Dobbs, MD
Emily Dodwell, MD
Nathan Donaldson, DO
Shevaun M. Doyle, MD
David M. Drvaric, MD
Robert C. Durkin, MD
Michael G. Ehrlich, MD
Mark A. Erickson, MD
Frances A. Farley, MD
Robert D. Fitch, MD
Sumeet Garg, MD
Mark C. Gebhardt, MD
Gaia Georgopoulos, MD
Joseph A. Gerardi, DO
J. Eric Gordon, MD
Daniel W. Green, MD
Walter B. Greene, MD
Brian E. Grottkau, MD
Nancy A. Hadley-Miller, MD
Geoffrey F. Haft, MD
Matthew Halanski, MD
Christina K. Hardesty, MD
Travis C. Heare, MD
Daniel J. Hedequist, MD
William L. Hennrikus Jr., MD
John E. Herzenberg, MD, FRCSC
Benton E. Heyworth, MD
Daniel G. Hoernschemeyer, MD
John D. Hsu, MD
Michelle A. James, MD
James G. Jarvis, MD
Charles E. Johnston II, MD
Lawrence I. Karlin, MD
James R. Kasser, MD
Danielle A. Katz, MD
Young-Jo Kim, MD, PhD
Mininder S. Kocher, MD, MPH
Andrea S. Kramer, MD
Dennis E. Kramer, MD
Ken N. Kuo, MD
Robert K. Lark, MD, MS
Mengnai Li, MD
John P. Lubicky, MD
Scott Luhmann, MD
Susan T. Mahan, MD
Travis H. Matheney, MD
Patricia C. McKeever, MD
Gregory J. Melkonian, MD
Gregory A. Mencio, MD
Michael B. Millis, MD
Siobhan Murphy-Zane, MD
Peter O. Newton, MD
Kenneth J. Noonan, MD
Eduardo Novais, MD
Donna M. Pacicca, MD
Kathryn E. Palomino, MD
Nirav K. Pandya, MD
William A. Phillips, MD, BS
Ellen M. Raney, MD
Karl E. Rathjen, MD
Gleeson Rebello, MBBS
Kent A. Reinker, MD
Jason Rhodes, MD
B. Stephens Richards III, MD

Leon Root, MD
Samuel R. Rosenfeld, MD
Benjamin D. Roye, MD
David P. Roye Jr., MD
Sanjeev Sabharwal, MD
Laurel H. Saliman, MD
James O. Sanders, MD
David M. Scher, MD
Susan A. Scherl, MD
Jonathan R. Schiller, MD
Perry L. Schoenecker, MD
Richard M. Schwend, MD
Brian A. Shaw, MD
Harry L. Shufflebarger, MD
Mindy J. Siegel, MD
Ernest L. Sink, MD
Patricia M. Solga, MD
Samantha A. Spencer, MD
Vishwas R. Talwalkar, MD
Erica D. Taylor, MD
Jeffrey D. Thomson, MD
Vernon T. Tolo, MD
Martin A. Torch, MD
Laura L. Tosi, MD
William P. Tully, MD
Michael G. Vitale, MD
Janet Walker, MD
Peter M. Waters, MD
David S. Weisman, MD
Dennis Wenger, MD
George W. Westin Jr., MD
Roger F. Widmann, MD
Kathryn D. Wiesman, MD
Yi-Meng Yen, MD
Ira Zaltz, MD
Seymour Zimbler, MD