POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 ANNUAL MEETING

WELCOME

POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

UPCOMING MEETINGS

12th Annual International Pediatric Orthopaedic Symposium
December 8 – 12, 2015 – Orlando, Florida
Presented by POSNA and AAOS

POSNA Specialty Day
March 5, 2016 – Orlando, Florida

POSNA 2016 Annual Meeting and Pre-Course
April 27 – 30, 2016
JW Marriott – Indianapolis, Indiana

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PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

Acknowledgments

The Pediatric Orthopaedic Society of North America gratefully acknowledges the following for their generous financial support during 2015

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

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Pega Medical*

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Biomet Trauma*
Ellipse Technologies, Inc.
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Mazor Robotics*
Wright Medical

THANK YOU

*Provided financial support for the 2015 Annual Meeting

WELCOME

On behalf of our local host, Tim Schrader and our Program Committee, we invite you to join us in Atlanta for the 2015 POSNA Annual Meeting. Many POSNA volunteers and staff have been working hard to make our experience in Atlanta a memorable one. The meeting opens on Wednesday morning with the Pre-Course entitled, “Treatment of Fractures in Kids: The Next Generation’s Perspective.” Management of pediatric trauma is becoming a larger part of most of our practices. Tony Stans has enlisted both younger and more established POSNA trauma experts to encourage the discussion of new, innovative techniques and controversies in treating fractures in children. The scientific sessions begin Wednesday afternoon. Ernie Sink and his Program Committee have assembled some of the highest rated abstracts into an outstanding session on quality and value, followed by one on infection and tumors.

The opening ceremony on Wednesday evening allows us to recognize our industry sponsors and the outstanding achievement of several of our members. The Awards Committee has selected the following individuals: Humanitarian Award, Elizabeth Szalay and Special Effort and Excellence Award, Jeffrey Sawyer. The Distinguished Achievement Award recipient, Colin Moseley, will be introduced on Thursday. Lisa Borders, Vice President of Global Community Connections at Coca Cola, will be our Steele lecturer, giving us an insider’s view to Coke’s history and its influence on Atlanta’s culture.

The Presidential Guest lecturer on Friday morning will be Neil Green, well-known to members as a pediatric orthopaedic leader, educator, and innovator. Neil’s lecture entitled, “From Then till Now: How Pediatric Orthopaedic Treatment Has Evolved” promises to be an interesting perspective of changes in our field during his career. Lunchtime breakout sessions on Thursday will include symposia on Practice Management (Current Scope of Pediatric Fracture Management), COUR (Building Capacity through Education in Resource Limited Areas), Research (Study Design and POSNA Supported Research Highlights), and NP/PA (Innovations in Pediatric Orthopaedic Surgery). There will be an optional ICD-10 Workshop on Thursday afternoon offered by KarenZupko & Associates, Inc. The First Annual Arabella Leet Young Members Forum, sponsored by a generous grant from Shriners Hospital, will be held on Thursday as well.

Clinical and Basic Science Award papers will be read on Friday morning. POSNA Subspecialty Day will continue in its Friday afternoon time slot. Five concurrent sessions (Hip, Spine, Sports, Hand/Upper Extremity and Neuromuscular/Lower Extremity) will feature concurrent free paper and symposia formats.

The social schedule includes a welcome reception in the Marriott immediately following Opening Ceremonies on Wednesday evening. In response to member feedback from past annual meetings, we will again leave Thursday afternoon open to allow an afternoon for recreation, community building, and exploration of our host city. 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, and have provided you with information on a large number of local attractions that might interest you on Thursday afternoon. There are a number of exciting venues including the Centennial Olympic Park, World of Coca-Cola, the College Football Hall of Fame, CNN, Atlanta Botanical Gardens, Turner Field, The Fox Theatre, and the Fernbank Museum of Natural History within safe, walking distances from the Marriott. We hope that you will get out with friends, spouses, and fellow members and enjoy the city of Atlanta. Thursday evening, per tradition, will again be reserved for fellowship reunions and other gatherings with friends and colleagues. This year we have purchased a block of seats at Turner Field for the Braves game against the Cincinnati Reds, and they are going fast. Our closing reception on Friday evening will be at the Georgia Aquarium, with a cocktail reception (during which, guests can tour the aquarium) followed by dinner and dancing.

After such a cold winter in most of North America, this will be a great opportunity to enjoy some warm weather and fine southern hospitality. We hope to see you in Atlanta for POSNA 2015.

POSNA

PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 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.

MISSION STATEMENT

To improve the care of children with musculoskeletal disorders through education, research, and advocacy.

PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

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GENERAL MEETING INFORMATION

LEARNING OBJECTIVES

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

Objective 1: Identify and define at least three recent advances in the treatment of pediatric patients with orthopaedic injuries and/or deformities.

Objective 2: Analyze the relative value of specific practices in pediatric orthopaedic care.

Objective 3: Implement new or different surgical techniques in their practices to increase effectiveness and safety of operative and non-operative procedures.

Objective 4: Demonstrate care for patients with a better knowledge of the natural history and basic science of pediatric othopaedic pathology.

ACCREDITATION

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership 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.

CONTINUING MEDICAL EDUCATION

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **23** ***AMA PRA Category 1 Credits™***. Physicians should claim only the 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:

n = Nothing to disclose,
1 = Royalties from a company or supplier,
2 = Speakers bureau/paid presentations for a company or supplier,
3A = Paid employee for a company or supplier,
3B = Paid consultant for a company or supplier,
3C = 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

LANGUAGE

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

POSNA ANTITRUST POLICY

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 other groups 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 committee 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.

The “Do Not’s” and “Do’s” presented below highlight only the most basic antitrust principles. POSNA members and others participating in POSNA meetings should consult with the General Counsel in all cases involving specific questions, interpretations or advice regarding antitrust matters.

Do Nots

1. Do not, in fact or appearance, discuss or exchange information regarding:
    a. Individual company prices, price changes, price differentials, mark-ups, discounts, allowances, credit terms, etc. or any other data that may bear on price, such as costs, production, capacity, inventories, sales, etc.
    b. Raising, lowering or “stabilizing” orthopaedic prices or fees;
    c. What constitutes a fair profit or margin level;
    d. The availability of products or services; or
    e. The allocation of markets, territories or patients.

2. Do not suggest or imply that POSNA members should or should not deal with certain other persons or companies.

3. Do not foster unfair practices regarding advertising, standardization, certification or accreditation.

4. Do not discuss or exchange information regarding the above matters during social gatherings, incidental to POSNA-sponsored meetings.

5. Do not make oral or written statements on important issues on behalf of POSNA without appropriate authority to do so.

Do

1. Do adhere to prepared agenda for all POSNA meetings. It is generally permissible for agendas to include discussions of such varied topics as professional economic trends, advances and problems in relevant technology or research, various aspects of the science and art of management, and relationships with local, state or federal governments.

2. Do object whenever meeting summaries do not accurately reflect the matters that occurred.

3. Do consult with General Counsel on all antitrust questions relating to discussions at POSNA meetings.

4. Do object to and do not participate in any discussions or meeting activities that you believe violate the antitrust laws; dissociate yourself from any such discussions or activities and leave any meeting in which they continue.

SPECIAL GUIDELINES FOR COLLECTING AND DISTRIBUTING INFORMATION

The collection and distribution of information regarding business practices is a traditional function of associations and is well-recognized under the law as appropriate, legal and consistent with the antitrust laws. However, if conducted improperly, such information gathering and distributing activities might be viewed as facilitating an express or implied agreement among association members to adhere to the same business practices. For this reason, special general guidelines have developed over time regarding association's reporting on information collected from and disseminated to members. Any exceptions to these general guidelines should be made only after discussion with General Counsel. These general guidelines include:

1. Member participation in a statistical reporting program is voluntary. A statistical reporting program should be conducted without coercion or penalty. Non-members should be allowed to participate in a statistical reporting program if eligible; however, if a fee is involved, non-members may be charged a reasonably higher fee than members.

2. Information should be collected via a written instrument that clearly sets forth what is being requested.

3. The data that is collected should be about past transactions or activities; particularly if the survey deals with prices and price terms (including charges, costs, wages, benefits, discounts, etc,), it should be historic, i.e., more than three months old.

4. The data should be collected by either POSNA or an independent third party not connected with any one member.

5. Data on individual orthopaedic surgeons should be kept confidential.

6. There should be a sufficient number of participants to prevent specific responses or data from being attributable to any one respondent. As a general rule, there should be at least five respondents reporting data upon which any statistic or item is based, and no individual's data should represent more than 25% on a weighted average of that statistic or item.

7. Composite/aggregate data should be available to all participants – both members and non-members. The data may be categorized, e.g., geographically, and ranges and averages may be used. No member should be given access to the raw data. Disclosure of individual data could serve to promote uniformity and reduce competition.

8. As a general rule, there should be no discussion or agreement as to how members and non-members should adjust, plan or carry out their practices based on the results of the survey. Each member should analyze the data and make business decisions independently.

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.

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PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 PRE-COURSE

TREATMENT OF FRACTURES IN KIDS: THE NEXT GENERATION'S PERSPECTIVE

Chair: Anthony A. Stans, MD
Wednesday, April 29, 2015
8:00 AM – 12:30 PM
Marriott Marquis, Atlanta, Georgia

DESCRIPTION

Trauma remains the most common category of disorders treated by pediatric orthopaedic surgeons. A majority of recent orthopaedic residency graduates report that greater than 40% of their practice involves treating orthopaedic trauma. Surgical treatment of supracondylar humerus fracture is the most numerous procedure performed by pediatric orthopedic surgeons submitting case lists to the American Board of Orthopaedic Surgery when applying for certification. Fracture management techniques continue to evolve, emphasizing less invasive surgery and intervention. Young pediatric orthopaedic surgeons often lead practice innovation but may not have the academic prominence or reputation to provide a platform for impactful physician education.

"Treatment of Fractures in Kids: The Next Generation's Perspective" addresses these education gaps by providing the opportunity for young, talented physicians to educate conference attendees on innovative fracture management techniques. Seasoned POSNA experts will moderate sessions sharing their knowledge and insight, and will provide clinical cases to generate vigorous audience and panel interaction during generous time periods set aside for discussion. Keynote speaker James Beaty, MD, will kick-off the Pre-Course, giving attendees his perspective on pediatric fracture management.

LEARNING OBJECTIVES

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

1. Incorporate one new, innovative fracture management strategy into his/her treatment armamentarium.
2. List three steps which can be taken to reduce the risk of cast saw burns.
3. Compare and contrast the advantages and disadvantages of cast immobilization, flexible intramedullary nailing and external fixation for tibia shaft fracture treatment.
4. Identify similarities and differences between flexible intramedullary nail treatment of fractures involving the tibia, humerus and forearm.

ACCREDITATION

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership 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.

2015 PRE-COURSE AGENDA

TREATMENT OF FRACTURES IN KIDS: THE NEXT GENERATION'S PERSPECTIVE

Wed., April 29, 2015 • 8:00 AM – 12:30 PM • Marquis Ballroom

Chair: *Anthony A. Stans, MD*

8:00 AM – 8:05 AM **Opening Welcome**
POSNA President: *Gregory A. Mencio, MD*
Nashville, TN
Chair: *Anthony A. Stans, MD*
Rochester, MN

8:06 AM – 8:16 AM **KEYNOTE SPEAKER**
FRACTURES IN CHILDREN...THE LONG VIEW
James H. Beaty, MD, Memphis, TN

SESSION 1

8:17 AM – 9:08 AM
GENERAL AND ANKLE
Moderator: *Kenneth J. Noonan, MD*
Madison, WI

8:17 AM – 8:23 AM **How to Avoid Cast Saw Complications**
Matthew A. Halanski, MD, Madison, WI

8:24 AM – 8:30 AM **Type I Open Fractures Benefit from Immediate Antibiotics but Not Necessarily Immediate Surgery**
James L. Pace, MD, Los Angeles, CA

8:31 AM – 8:37 AM **Management of Syndesmotic Ankle Injuries in Children and Adolescents**
Benjamin J. Shore, MD, Boston, MA

8:38 AM – 8:44 AM **Tibial Spine Fractures: Open Treatment is Not Just for the Weak**
Todd A. Milbrandt, MD, Rochester, MN

8:45 AM – 9:08 AM MODERATOR TO PRESENT 1 – 2 CASES FOR AUDIENCE AND PANEL DISCUSSION

SESSION 2

9:09 AM – 9:50 AM
TIBIA
Moderator: *Steven L. Frick, MD*
Orlando, FL

9:09 AM – 9:15 AM **Tibia Shaft Fractures in Adolescents: How and When Can They Be Managed Successfully with Cast Treatment?**
Christine Ann Ho, MD, Dallas, TX

9:16 AM – 9:22 AM **Flexible IM Nailing Unstable and/or Open Tibia Shaft Fractures**
Nirav Pandya, MD, Oakland, CA

9:23 AM – 9:29 AM **Managing Unstable Tibia Fractures with Circular External Fixation**
Christopher A. Iobst, MD, Orlando, FL

9:30 AM – 9:50 AM MODERATOR TO PRESENT 1 – 2 CASES FOR AUDIENCE AND PANEL DISCUSSION

9:50 AM – 10:00 AM Break

SESSION 3

10:01 AM – 10:45 AM
FEMORAL SHAFT
Moderator: *Martin J. Herman, MD*
Philadelphia, PA

10:01 AM – 10:07 AM **Bridge Plating Length-Unstable Femoral Shaft Fractures**
Kevin E. Klingele, MD, Columbus, OH

10:08 AM – 10:15 AM **Locked Intramedullary Nailing for Patients Age 12 and Younger: Indications and Technique**
Jeffrey E. Martus, MD, Nashville, TN

10:16 AM – 10:23 AM **Flexible IM Nails in Children: How Young is Too Young?**
Daniel G. Hoernschemeyer, MD, Columbia, MO

10:24 AM – 10:45 AM MODERATOR TO PRESENT 1 – 2 CASES FOR AUDIENCE AND PANEL DISCUSSION

SESSION 4

10:46 AM – 11:30 AM
SHOULDER AND HUMERUS
Moderator: *William L. Hennrikus Jr., MD*
Hershey, PA

10:46 AM – 10:52 AM **Flexible IM Nailing for Humeral Shaft Fractures: Indications and Technique**
Derek M. Kelly, MD, Memphis, TN

10:53 AM – 11:00 AM **Which Proximal Humerus Fractures Should be Pinned?**
Eric C. King, MD, Chicago, IL

11:01 AM – 11:08 AM **Surgical Treatment of Adolescent Clavicle Fractures: Results and Complications**
Amy L. McIntosh, MD, Dallas, TX

11:09 AM – 11:30 AM MODERATOR TO PRESENT 1 – 2 CASES FOR AUDIENCE AND PANEL DISCUSSION

SESSION 5

11:31 AM – 12:25 PM
ELBOW AND FOREARM
Moderator: *Peter M. Waters, MD*
Boston, MA

11:31 AM – 11:37 AM **Medial Epicondyle Fracture Treatment in Future Professional and Olympic Athletes**
J. Todd Lawrence, MD, PhD, Philadelphia, PA

11:38 AM – 11:45 AM **Percutaneous Reduction of Displaced Radial Neck Fractures Achieves Better Results Compared to Fractures Treated by Open Reduction**
Alexandre Arkader, MD, Los Angeles, CA

11:46 AM – 11:53 AM **Successful Strategies for Managing Monteggia Injuries**
Donald S. Bae, MD, Boston, MA

11:54 AM – 12:01 PM **Staying Out of Trouble Performing Intramedullary Nailing of Forearm Fractures**
Lindley B. Wall, MD, St. Louis, MO

12:02 PM – 12:25 PM MODERATOR TO PRESENT 1 – 2 CASES FOR AUDIENCE AND PANEL DISCUSSION

12:26 PM – 12:30 PM **Wrap Up**

POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 OPENING CEREMONY

WEDNESDAY, APRIL 29, 2015

6:30 PM–9:30 PM • Marriott Marquis Hotel • Marquis Ballroom

6:30 PM–6:40 PM	**WELCOME** **POSNA President:** *Gregory A. Mencio, MD* **Local Host:** *Tim Schrader, MD*
6:40 PM–6:50 PM	**Introductions Distinguished Guests** • International Presidents • New Members • Distinguished Achievement Award Recipient • Presidential Guest Speaker • EPOS Traveling Fellows • COUR Visiting Scholars
6:50 PM–6:55 PM	**Presentation of the St. Giles Young Investigator Award** *Donald R. Huene, MD* and *Richard T. Arkwright, MD*
6:55 PM–7:00 PM	**Presentation of the Arthur H. Huene Award** *Donald R. Huene, MD* and *Richard T. Arkwright, MD*
7:00 PM–7:05 PM	**Presentation of Angela S.M. Kuo Memorial Award** *Ken N. Kuo, MD*
7:05 PM–7:10 PM	**Presentation of the Humanitarian Award** *Gregory A. Mencio, MD*
7:10 PM–7:15 PM	**Presentation of the Special Effort and Excellence Award** *Gregory A. Mencio, MD*
7:15 PM–7:30 PM	**Recognition of Industry Sponsors** *Gregory A. Mencio, MD*
7:30 PM	**Introduction Steel Lecturer** *Gregory A. Mencio, MD*
7:35 PM–8:00 PM	**Steel Lecture** ***Lisa Borders,*** *Chair of The Coca-Cola Foundation and Vice President of Global Community Connections at The Coca-Cola Company*
8:00 PM–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
Aarvold, Alexander	n-none	Paper #33
Abbott, Matthew D.	n-none	Paper #32
Abel, Mark F.	8 Gait and Posture	Neuromuscular/Lower Extremity Subspecialty Day #106
Abousamra, Oussama	n-none	Paper #145,150; Spine Subspecialty Day #113
Abzug, Joshua M.	2 Checkpoint Surgical; 3B Axogen; 7 Springer	e-Posters # 7, 74, 85, 113; Paper #2; Hand Subspecialty Day #96; Reviewer
Adapala, Naga Suresh	n-none	Paper #75
Agarwal, Sunil	n-none	e-Poster #24
Ain, Michael C.	1 LANX; 2 Stryker; 3B Stryker; 6 Stryker; 8 Orthopedics; 9 Scoliosis Research Society	e-Poster #111
Aiona, Michael D.	8 CORR; Gait and Posture; JCO; Journal of Bone and Joint Surgery; Journal of Pediatric Orthopaedics; 9 AACPDM	Reviewer
Akbarnia, Behrooz A.	1 DePuy Spine, Nuvasive; K2M; 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	e-Posters #57, 101; Paper #51; Spine Subspecialty #50, 51
Al-Ali, Sami	n-none	Paper #39
Alanay, Ahmet	3B Stryker; 5 DePuy, A Johnson & Johnson Company; 8 European Spine Journal; 9 Scoliosis Research Society	Spine Subspecialty Day #50, 112
Alison, Marianne	Not available at time of printing	e-Poster #99
Allar, Benjamin	n-none	e-Poster #68; Paper #149; Poster #16
Alman, Benjamin	4 ScarX; 9 shrine research advisory board	Paper #3
AlRashid, Mamun	n-none	Paper #16
Alvi, Hasham M.	n-none	e-Poster #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 9.

Name	Disclosure	Presentation Type
Amaral, Terry D.	5 DePuy, A Johnson & Johnson Company; Stryker; Medtronic; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Posters #13, 72; Paper 71
Anadio, Jennifer M.	n-none	e-Poster #24
Anderson, Anthony M.	n-none	Paper #63
Anderson, Megan E.	8 Clinical Orthopaedics and Related Research; 9 Musculoskeletal Tumor Society Education Committee,New England Orthopaedic Society Massachusetts Representative	Paper #16
Andrade, Janice	n-none	e-Poster #71; Paper #34, 38
Andras, Lindsay	4 Eli Lilly; 9 Pediatric Orthopaedic Society of North America	e-Posters #40, 54, 60, 78; Paper #26, 148
Andrisevic, Emily M.	n-none	Paper #148
Aoki, Stephen K.	3B Pivot Medical; Stryker	Poster #13
Archibald-Seiffer, Noah	n-none	e-Poster #38
Arkader, Alexandre	3C Orthopediatrics SAB	e-Poster #36
Armstrong, Douglas G.	9 American Board of Orthopaedic Surgery, Inc.	e-Poster #22
Asemota, Anthony O.	n-none	e-Poster #93
Asghar, Jahangir	3B DePuy, A Johnson & Johnson Company; DePuy, A Johnson & Johnson Company; 9 Scoliosis Research Society	e-Posters #26, 63; Poster #12; Neuromuscular/Lower Extremity Subspecialty Day # 106, Spine Subspecialty Day #114
Ashby, Elizabeth	n-none	Hand Subspecialty Day #90, 91
Ashley, Philip A.	n-none	Hand Subspecialty Day #94
Astone, Kristina	n-none	Paper #61
Asztalos, Ivor B.	n-none	Paper #40
Augsburger, Samuel F.	n-none	e-Poster #52
Autruong, Patrick T.	n-none	Poster #2
Avik, Anna L.	4 Bristol-Myers Squibb	Poster #6
Axelrod, Jed	n-none	Paper #141
Ayan, Saankritya	n-none	e-Poster #13
Badkoobehi, Haleh	n-none	e-Poster #60
Bae, Donald S.	4 CBST; Johnson & Johnson; VVUS; 7 Lippincott Williams & Wilkins; 9 AAOS; ASSH; POSNA	e-Poster #69; Paper #11, 14, 69, 138; Poster #9; Sports Medicine Subspecialty Day #126; Reviewer

Name	Disclosure	Presentation Type
Bagley, Anita	n-none	Paper #148; Hand Subspecialty Day #99
Baird, Glen O.	n-none	Paper #147, 152
Baldwin, Keith D.	3B Synthes Trauma; 4 Pfizer; 7 Journal of Bone and Joint Surgery - American	Paper #22
Barrett, Kody K.	n-none	e-Posters #78, 84; Paper #19
Barsi, James M.	5 Medtronic Sofamor Danek	e-Poster #76
Bartley, Carrie	n-none	Paper #43, 45; Spine Subspecialty Day #114, 118
Bas, Can E.	n-none	e-Poster #64
Basques, Bryce A.	n-none	e-Poster #92; Paper #5
Bastrom, Tracey	n-none	e-Posters #26, 34, 61, 88; Paper # 13, 43, 45, 52, 59, 133, 135; Posters #12, 20; Spine Subspecialty Day #118
Bauer, Jennifer M.	n-none	e-Poster #42
Bayhan, Ilhan A.	n-none	Paper #150; Spine Subspecialty Day #113
Bazzi, Ahmed A.	n-none	e-Poster #111
Bean, Betsey K.	n-none	Paper #147
Beaty, James H.	6 none; 7 Saunders/Mosby-Elsevier; 8 Journal of Bone and Joint Surgery; 9 Orthopaedic Research and Education Foundation	e-Poster #46
Beckwith, Terri	n-none	Hip Subspecialty Day #84
Bedi, Asheesh	3B Smith & Nephew; 4 A3 Surgical ; 8 Journal of Shoulder and Elbow Surgery; 9 American Orthopaedic Society for Sports Medicine	Paper #29; Hip Subspecialty Day #84
Beimesch, Claire F.	n-none	e-Posters #50, 95
Bejarano, Carolina	n-none	Neuromuscular/Lower Extremity Subspecialty Day #101
Bekmez, Senol	n-none	e-Poster #29
Belthur, Mohan V.	n-none	Paper #4
Bencke, Jesper	n-none	Neuromuscular/Lower Extremity Subspecialty Day #105

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Name	Disclosure	Presentation Type
Bernstein, Robert M.	n-none	Spine Subspecialty Day #115
Bernthal, Nicholas	n-none	e-Poster #21
Berry, Chirag A.	n-none	Spine Subspecialty Day #119
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	e-Posters #26, 61; Poster #20
Binkowski, Laura C.	n-none	e-Poster #10
Birch, John G.	1 Orthofix, Inc.; 7 Mosby-Elsevier; 8 Journal of Children's Orthopedics	Paper #63
Bixby, Elise	n-none	e-Poster #70; Paper #61
Black, Sheena R.	n-none	Paper #130
Blakemore, Laurel C.	2 K2M Medical; 3B K2M Medical; 5 K2M; 8 Associate Editor, Spinal Deformity Journal; 9 Scoliosis Research Society	e-Posters #33, 104; Moderator
Blatz, Allison M.	n-none	e-Poster #65
Blum, Laura E.	3A Paragon Medical, Inc.; 4 Paragon Medical, Inc.	Hand Subspecialty Day #94
Blumetti, Francesco C.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Boan, Carla	n-none	Paper #4, 68
Bober, Michael	5 Biomarin;,Enobia; 9 American College of Medical Genetics and Genomics	Paper #150
Bohl, Daniel D.	n-none	e-Poster #92; Paper #5
Bomar, James D.	n-none	Paper #1; e-Poster #82
Bonifas, Anne C.	n-none	e-Poster #28
Bosch, Patrick P.	5 Haemonetics; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #53

Name	Disclosure	Presentation Type
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	Paper #77
Boucharel, Willy	n-none	Hip Subspecialty Day #81
Bowman, Christine	n-none	e-Posters #78, 84
Boye, Gloria N.	n-none	Paper #30
Brennan, Kaitlyn	n-none	e-Poster #58
Brighton, Brian K.	9 Pediatric Orthopaedic Society of North America; American College of Surgeons	e-Posters #85, 87; Paper #24
Bronson, William E.	n-none	e-Poster #12; Paper 147
Brooks, Jaysson T.	n-none	e-Posters 327, 101, 111
Brooks, Maria	5 GenWay Biotech, Inc.; Gilead Scineces, Inc	Paper #44
Broom, Alexander M.	n-none	e-Posters #36, 40, 60, 78, 84
Brown, Kaitlyn	n-none	Spine Subspecialty Day #116
Brubacher, Jacob W.	n-none	Paper #69
Bruce, Robert W.	3C Orthopediatrics; 9 Board of Trustees - Children's Healthcare of Atlanta,Foundation Board - Children's Healthcare of Atlanta	Poster #16
Bueche, Matthew J.	n-none	Presider; Reviewer
Bulat, Evgeny	n-none	Paper #37
Burgess, Jamie K.	n-none	Paper #73
Burket, Jayme C.	n-none	e-Poster # 47
Burns, Camden	n-none	e-Poster #76
Busch, Michael T.	3B Orthopediatrics	Paper # 56, 141; Reviewer
Butler, Leroy	n-none	Paper #159
Butts, Jacob R.	n-none	e-Poster #38
Bylski-Austrow, Donita	3C SpineForm, LLC	e-Poster #28
Cabral, Cristina	n-none	Staff
Cage, Jason M.	n-none	Paper #130

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Name	Disclosure	Presentation Type
Cahill, Patrick J.	2 DePuy, A Johnson & Johnson Company; Ellipse Technologies, Inc.; Globus Medical; Medtronic; 3B DePuy, A Johnson & Johnson Company; Ellipse Technologies, Inc.; Medtronic; 6 DePuy Synthes Spine; Medtronic; 8 Journal of Bone and Joint Surgery - American; Spine Deformity; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Posters #61, 63, 106; Paper # 49; Posters #12, 20;
Caird, Michelle S.	9 Orthopaedic Research and Education Foundation; Pediatric Orthopaedic Society of North America; University of Michigan Medical Center Alumni Society	e-Poster #10; Poster #18
Canizares, Maria F.	n-none	Poster #9
Carender, Christopher N.	n-none	e-Poster #105
Carlson, Cathy S.	3B Pfizer; Synthes	Poster #14; Sports Medicine Subspecialty Day #120
Carollo, James	9 Commission for Motion Laboratory Accreditation, Inc.	e-Poster #12
Carreon, Leah Y.	3A Norton Healthcare; 5 Norton Healthcare; OREF; AOSpine; 6 Travel and accommodations for Study Planning Meetings from Orthopedic Research and Education Fund, Department of Defense and Association for Collaborative Spine Research. Travel and accommodations for required Continuing Education for Institutional Review Board Members, University of Louisville Institutional Review Board. Honoraria for participation in Review Panels of the National Institutes of Health, participation in Global Evidence Advisory Board Medtronic. Medtronic provided funds directly to database company. No funds were paid directly to Individual or Individual's Institution 01/2002 to 09/2009. Nuvasive provides funds directly to database company. No funds are paid directly to Individual or Individual's Institution.; 8 Editorial Advisory Board Spine, The Spine Journal; 9 Scoliosis Research Society; University of Louisville Institutional review Board	Paper #8
Carroll, Rory	n-none	Paper #2

Name	Disclosure	Presentation Type
Carry, Patrick	n-none	e-Posters #15, 20; Papers #28, 67, 143
Carsen, Sasha	n-none	Sports Medicine Subspecialty Day #126
Carter, Cordelia W.	9 Pediatric Orthopaedic Society of North America; AAOS	Poster #8
Carter, Erin M.	n-none	Paper #77
Caskey, Paul M.	8 Journal of Pediatric Orthopedics; 9 Bone and Joint Decade, U.S.A.; Pediatric Orthopaedic Society of North America	e-Poster #12; Paper #147, 152
Cassara, Antonio	n-none	e-Poster #53
Cassese, Todd	n-none	Poster #8
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	Poster #3; Paper #38
Cha, Angela	n-none	Paper #134
Chambers, Henry (Hank) G.	3B Orthopediatrics; 5 Allergan Corporation; Merz Pharmaceutical; 8 Developmental Medicine and Child Neurology; 9 AAOS; American Academy for Cerebral Palsy and Developmental Medicine; Pediatric Orthopaedic Society of North America; Pediatric Research in Sports Medicine PRISM	Paper #52, 59
Chau, Wai Wang	n-none	Paper #47
Cheng, Jack C-Y	8 Journal of Pediatric Orthopedics	e-Poster #4; Paper #42, 47; Poster #17
Cheng, Tegan L.	n-none	Paper #76
Cheung, Kenneth MC	3B Ellipse techonologies; 5 Ellipse technologies; 8 Journal of Orthopaedic Surgery; Spine Deformity; 9 Hong Kong College of Orthopaedic Surgeons; Scoliosis Research Society	Paper #50; Spine Subspecialty Day #112
Chiaia, Theresa A.	n-none	Paper #54
Cho, Robert H.	3B DePuy Spine; Medtronic Sofamor Danek; OrthoPediatrics; 8 Orthopedics	Presider, Reviewer
Cho, Tae-Joon	n-none	Paper 153

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Name	Disclosure	Presentation Type
Choi, InHo	5 Seoul National University Hospital Research Fund SNUH-04-2013-0680	Paper #153
Choi, John S.	n-none	Paper #9
Chou, Andrew Chia Chen	n-none	Paper #23
Chu, Alice	n-none	Paper #155
Chu, Stephanie	n-none	Paper #26
Chu, Winnie Chiu-Wing	n-none	Paper #42; Poster #17
Chua, Matthew C.	n-none	Sports Medicine Subspecialty Day #129
Church, Chris	n-none	e-Poster #49; Paper #145
Clarke, Nicholas	n-none	Paper #33, 38
Clay, Catharine F.	4 Amgen Co	Neuromuscular/Lower Extremity Subspecialty Day #101
Clohisy, John C.	5 Pivot Medical; Smith & Nephew; Zimmer; 7 Wolters Kluwer Health - Lippincott Williams & Wilkins	Paper #29; Hip Subspecialty Day #83
Collins, Deraan	n-none	Hip Subspecialty Day #80
Conner, Kalyn M.	n-none	e-Poster #45
Coombs, Matthew	n-none	e-Poster #28
Cooper, James D.	n-none	e-Poster #53
Cooperman, Daniel R.	n-none	e-Poster #80
Cordasco, Frank A.	1 Arthrex, Inc; CONMED Linvatec; 3B Arthrex, Inc; 7 Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 Journal of Shoulder and Elbow Surgery; 9 AAOS; American Shoulder and Elbow Surgeons; American Orthopaedic Society for Sports Medicine	Paper #54; Sports Medicine Subspecialty Day #123
Cornwall, Roger	n-none	Paper #12
Covell, Donald J.	n-none	Paper #156
Crawford, Alvin H.	8 Journal of Pediatric Orthopedics; 9 J. Robert Gladden Society	e-Poster #24
Crawford, Charles H.	2 Medtronic; Depuy-Synthes; Alphatec Spine; 3B Medtronic; Depuy-Synthes; Alphatec Spine; 9 North American Spine Society; Scoliosis Research Society	Paper #8
Crawford, Haemish A.	2 Biomet; 3B Medtronic Sofamor Danek; 6 Medtronic Sofamor Danek; 9 past president Auckland Medicolegal Society; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Spine Subspecialty Day #115

Name	Disclosure	Presentation Type
Cruz, Aristides I.	n-none	Sports Medicine Subspecialty Day #124
Culotta, Brad A.	n-none	Paper #141
Curtis, Derek	n-none	Neuromuscular/Lower Extremity Subspecialty Day #105; Spine Subspecialty Day #105
Cyr, Micaela	n-none	e-Poster #106; Poster #19
Dabney, Kirk W.	3B DePuy, A Johnson & Johnson Company; Medtronic	Paper #145
Daluiski, Aaron	8 Journal of Hand Surgery - American; 9 American Board of Orthopaedic Surgery, Inc.; American Society for Surgery of the Hand	e-Poster #3
Daniels, Alan H.	3B Osseus; Stryker; 6 Stryker	e-Poster #9
Dannenbaum, Joseph H.	n-none	e-Poster #12
Dare, David M.	n-none	Paper #70; Sports Medicine Subspecialty Day #123
Das, Progga	n-none	e-Poster #58
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 #148
Dawicki, Erin	4 Agios	e-Poster #78; Paper #26
De, Sayan	n-none	Paper #143
De Carvalho, Max F.	n-none	e-Poster #28
De La Rocha, Adriana	n-none	e-Poster #43; Paper #27; Poster #1; Hip Subspecialty Day #80, 87
De Mille, Polly	n-none	Paper #54
Dean, Daniel M.	n-none	e-Poster #31; Paper #144
Dede, Ozgur	n-none	e-Poster #29
Delpizzo, Kathryn	n-none	Poster #7
Demello, Stephanie	n-none	Poster #6
Demirkiran, Gokhan H.	n-none	e-Posters #29, 64; Paper #50; Spine Subspecialty Day #112
Dempsey, Molly	9 Society for Pediatric Radiology Board of Directors, Society for Pediatric Radiology Research and Education Foundation Board of Directors	Paper #73

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Name	Disclosure	Presentation Type
Deng, Min	n-none	Paper #42
Denning, Jaime R.	n-none	Paper #159
Desai, Sameer	n-none	e-Poster # 14; Paper #9; Spine Subspecialty Day #117
Dias, Luciano	n-none	e-Poster #6, 48
Diez-Sebastian, Jesus	n-none	Paper #139
DiFazio, Rachel L.	n-none	Paper #11; Neuromuscular/ Lower Extremity Subspecialty Day #100
Doan, Josh	n-none	e-Posters #32, 82
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; Pediatric Orthopaedic Society of North America	e-Poster #20; Paper #64, 74; Moderator
Doddabasappa, Siddesh N.	n-none	e-Poster #14
Dodwell, Emily	n-none	e-Posters #3, 70; Paper #53, 61; Presider; Reviewer
Donohue, Kyna S.	n-none	Sports Medicine Subspecialty Day #126
Dormans, John P.	7 Elsevier; Mosby; Brooke's Publishing; 8 Journal of Pediatric Orthopedics; 9 SICOT USA; Scoliosis Research Society; SICOT Foundation; World Orthopaedic Concern	e-Poster #57
Doty, Stephen	n-none	Paper #77
Dow, Matthew A.	n-none	e-Poster # 70
Drefus, Lisa	n-none	e-Poster #47
Dua, Karan	n-none	e-Poster #76
Duncan, Stephen T.	3B Mitek; Smith & Nephew	Paper #29
Dunnagan, Rebekah	n-none	e-Poster #97
Dwek, Jerry R.	n-none	e-Poster #91
Dworkin, Aviva G.	n-none	e-Poster #72, Paper #71
Eastwood, Deborah	n-none	Neuromuscular/Lower Extremity Subspecialty Day #108; Paper #39

Name	Disclosure	Presentation Type
Eberson, Craig P.	1 Globus Medical; 2 Stryker Spine,orthofix spine; 3B Orthofix, Inc.; 8 Journal of the American Academy of Orthopaedic Surgeons; 9 Scoliosis Research Society; Pediatric Orthopaedic Society of North America	e-Poster #9
Edmonds, Eric W.	2 Arthrex, Inc; Orthopediatrics; 5 Inion; 9 AAOS; American Orthopaedic Society for Sports Medicine; Pediatric Orthopaedic Society of North America	e-Poster #32; Paper #52, 57, 59, 135
Eisenlohr, John L.	n-none	Paper #159
Eismann, Emily A.	n-none	e-Poster #74, Paper #12, 142, 159
El-Hawary, Ron	3B DePuy, A Johnson & Johnson Company; Halifax Biomedical Inc.; Medtronic; 5 DePuy, A Johnson & Johnson Company; Medtronic; 9 Chest Wall and Spine Deformity Foundation; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #49
Ellermann, Jutta	n-none	Poster #14; Sports Medicine Subspecialty Day #120
Emans, John B.	1 Synthes; 3B Medtronic Sofamor Danek; Synthes; 3C Medtronic Sofamor Danek; Synthes; 8 Journal of Children's Orthopedics	e-Poster #8; Spine Subspecialty Day #111
Engelman, Glenn H.	n-none	e-Poster #20
Erdman, Ashley	n-none	e-Poster #51
Erickson, Mark A.	2 Biomet; 6 Spineform; 9 Pediatric Orthopaedic Society of North America	Paper #67; Spine Subspecialty Day #116; eModerator; Reviewer
Ernat, Justin J.	n-none	e-Posters #30, 66; Paper #137
Escott, Benjamin	n-none	Paper #27
Estes, Ashley R.	n-none	Hip Subscpecialty #85
Ezaki, Marybeth	7 Journal of Bone and Joint Surgery - American; Wolters Kluwer Health - Lippincott Williams & Wilkins	Hand/Upper Extremity Specialty Day #98
Fabricant, Peter D.	n-none	Sports Medicine Subspecialty Day #123, 124, 127

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Name	Disclosure	Presentation Type
Falk, Miranda	n-none	Paper #68
Farhang, Kathleen	n-none	Poster #10
Farley, Frances A.	4 Medtronic; 5 Research or institutional support from companies or suppliers:,The following conflicts were disclosed, Medtronic; DJ Orthopaedics; Johnson & Johnson; Genzyme; Pfizer; Stryker; Wright Medical Technology, Inc.; Zimmer; Synthes,; 8 Journal of Pediatric Orthopedics	e-Poster #10; Poster #18
Farnsworth, Christine L.	n-none	e-Poster #32
Farr, Jennifer	n-none	Paper #34
Farrow, Lutul D.	n-none	e-Poster #109
Fassier, Francois	1 PegaMedical; 8 Journal of Children's Orthopaedics; Journal of Pediatric Orthopedics	Hand/Upper Extremity Specialty Day #90, 91
Faulks, Shawne	n-none	Paper #154
Faust, John R.	n-none	Paper #56
Fedorka, Catherine J.	n-none	e-Poster #89
Feinn, Richard	n-none	Poster #8
Feldman, Lanna	n-none	Paper #14, Poster #9
Felton, Kevin	6 Liberating Technologies, Inc.; 9 Texas Occupational Therapy Association	Paper #41, 72, 154
Ferguson, John A.	2 K2m; 3B Ellipse; K2m; 5 Zimmer	Paper #50; Spine Subspecialty Day #112
Ferguson, Peter	n-none	Paper #3
Ferrero, Emmanuelle	n-none	e-Poster #99
Fields, Kara	2 Pfizer,Takeda,Savient; 3B Takeda,Savient; 8 Arthritis & Rheumatism	e-Poster #91; Poster #7; Hip Subspecialty Day #82
Fields, Katie	n-none	ePoster #91
Fitzgerald, Ryan E.	n-none	e-Poster #75
Flanagan, Ann	n-none	Neuromuscular/Lower Extremity Subspecialty Day #102
Flanagan, Jill C.	n-none	e-Poster #45
Fleissner, Paul R.	2 Exactech, Inc; 3B Exactech, Inc; 5 Exactech, Inc	e-Poster #41; Sports Medicine Subspecialty Day #122
Fletcher, Nicholas D.	2 Biomet; Orthopaediatrics; 3B Biomet; Medtronic Sofamor Danek; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Posters #78, 84, 110; Paper #6; Poster #16
Flores, Erica	n-none	Hip Subspecialty Day #84

Name	Disclosure	Presentation Type
Flynn, John (Jack) M.	1 Biomet; 7 Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 Orthopedics Today; 9 American Board of Orthopaedic Surgery, Inc.; Pediatric Orthopaedic Society of North America; Scoliosis Research Society; AAOS	e-Posters #11, 39, 51; Paper #19, 31, 40, 49, 131; eModerator
Flynn, Tara	n-none	Paper #49
Foley, Joanna E.	n-none	e-Poster #6
Forslund, Johan	n-none	e-Poster #24
Fowers, Cody	n-none	e-Poster #80
Fragala-Pinkham, Maria	3C CRECare consultant on the PEDI-CAT; 5 CRECare; 6 CRECare donated money to the Adaptive Sports Program to Franciscan Hospital for Children where I am employed; 7 CRECare - receive complimentary PEDI-CAT software	e-Poster #49; Paper #149
Franklin, Donald B.	n-none	e-Poster #46
Frantz, Jamie T.	n-none	e-Poster #6
Frick, Steven L.	9 J. Robert Gladden Society; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	e-Poster #87; Paper #10; Hand/Upper Extremity Subspecialty Day #93
Friel, Nicole A.	n-none	Paper #44
Fu, Linda	n-none	Paper #47
Fujino, Marcelo H.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Funk, Shawn S.	n-none	e-Poster #102
Fuzzell, Lindsay	n-none	Neuromuscular/Lower Extremity Subspecialty Day #101
Gabos, Peter G.	3B DePuy, A Johnson & Johnson Company	Paper #13
Galal, Sherif	n-none	Hip Subspecialty Day #89
Ganley, Theodore J.	n-none	e-Posters #38, 108; Poster #13; eModerator
Gans, Itai	n-none	e-Poster #38
Garg, Sumeet	3B DePuy, A Johnson & Johnson Company; Medtronic	e-Posters #11, 62, 106; Paper #49, 67; Poster 19; Spine Subspecialty Day #116

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Name	Disclosure	Presentation Type
Garibay, Erin J.	n-none	e-Poster #44
Garner, Matthew R.	n-none	e-Poster #70
Gausden, Elizabeth	n-none	e-Poster #90
Gebhardt, Mark C.	7 Clinical Orthopaedics and Related Research; Up to Date;; 8 Clinical Orthopaedics and Related Research; 9 International Society of Limb Salvage; Massachusetts Orthopaedic Association; New England Orthopaedic Society	Paper #16
Gecelter, Rachel C.	n-none	e-Poster #72
Gendelberg, David	n-none	e-Poster #22
Georgopoulos, Gaia	n-none	e-Poster #16; Reviewer
Gettys, Franklin	n-none	e-Poster #87
Ghasem, Alexander	n-none	e-Poster #110
Gheen, William T.	n-none	e-Posters #30, 66; Paper #137
Gheorghe, Radu	n-none	Paper #157
Gilbert, Shawn R.	9 AAOS, POSNA	Hip Subspecialty Day #85
Gillespie, Bryce T.	n-none	Paper #138
Gillespie, Catherine W.	n-none	e-Poster #65
Gilmore, Allison	n-none	e-Poster 109
Glavas, Panagiotis	n-none	Sports Medicine Subspecialty Day #125
Glos, David	n-none	e-Poster #28
Glotzbecker, Michael P.	5 Synthes, Via Chest wall and Spinal Deformity Study Group	e-Posters #8, 10, 68; Paper #6, 19, 49; Spine Subspecialty Day #111
Goldstein, Rachel Y.	3B Smith & Nephew	e-Posters #54, 78, 84; Paper #26, 155
Golinvaux, Nicholas	n-none	e-Poster #92; Paper #5
Gomez, Jaime A.	n-none	e-Poster #8; Paper #19
Gomez-Leonardelli, Dominic T.	n-none	Hand/Upper Extremty Specialty Day #92
Goodbody, Christine	n-none	e-Poster #39; Paper #40, 131
Gordon, Andi	n-none	Paper #152
Goulbourne, Kristen-Kaye	n-none	e-Poster #45
Gourineni, Prasad V.	4 G2Healthcare	e-Poster #81; Paper #36
Graf, Adam	n-none	e-Poster #77; Neuromuscular/Lower Extremity Subspecialty Day #101

Name	Disclosure	Presentation Type
Graham, Dionne	n-none	Paper #11
Graham, Susan	n-none	e-Poster #20
Grant, Daniel R.	n-none	Paper #13
Grauer, Jonathan N.	3B Bioventus; Hasrvard Clinical Research Institute; ISTO Technologies; Stryker; 9 AAOS; Cervical Spine Research Society	e-Poster #92; Paper #5
Grayhack, John J.	4 DePuy, A Johnson & Johnson Company; Medtronic Sofamor Danek; Johnson & Johnson; 9 Pediatric Orthopaedic Society of North America	Paper #144
Graziano, Jessica M.	n-none	Paper #54
Green, Daniel W.	1 Arthrex, Inc; Pega Medical; 2 Arthrex, Inc; 7 Current Opinion in Pediatrics; Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 Current Opinion in Pediatrics; 9 AAOS; AAOS; New York County Medical Society; new york state society of orthopedic surgeons; Pediatric Orthopaedic Society of North America	e-Posters #17, 19; Paper #53, 54, 70; Sports Medicine Subspecialty Day #123, 127; Reviewer
Greenler, Alexandria J.	n-none	e-Poster #58
Griffith, James	n-none	Poster #17
Grimard, Guy	3B EMOVI; 4 EMOVI; 9 Quebec Orthopedic Association	Sports Medicine Subspecialty Day #125
Grimm, Nathan L.	n-none	Poster #13
Grzywna, Alexandra M.	n-none	e-Posters #8, 10
Gudmundsson, Paul	n-none	Paper #73
Gunderson, Melissa	n-none	e-Poster #107
Haigler, Richard E.	n-none	Paper #18
Halanski, Matthew A.	5 Biomet, Stryker, Medtronic; 7 MTDS-educational material; 8 Editor Journal of Exercise Sports and Orthopedics; Editorial Board Member Columbia Publishing, Journal of Contemporary Orthopedic Research.; Pediatric section review board for OKU.,Previous reviewer for CORR,Associate contributing editor JBJS Highlights:Spine; Reviewer, FSMA Musculoskeletal Care Series Booklet; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #79; Neuromuscular/ Lower Extremity Subspecialty Day #107

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Name	Disclosure	Presentation Type
Hamdy, Reggie C.	8 BMC Musculoskeletal Disorders; 9 Limb Lengthening Research Society	Hand/Upper Extremity Subspecialty Day #90, 91
Hamershock, Rose	n-none	Paper #11
Hanway, Jeffrey L.	1 Globus Medical	e-Poster #104
Harris, Gerald	n-none	e-Poster #77; Neuromuscular/Lower Extremity Subspecialty Day #102
Harris, Marie	n-none	Paper #11
Hart, Ryan	n-none	Paper #156
Hashemi-Nejad, Aresh	9 British society for children's orthopaedic Surgery	Paper #39
Haskel, Jonathan	n-none	e-Poster #90; Paper #70
Hassani, Sahar	n-none	e-Poster #77; Neuromuscular/Lower Extremity Subspecialty Day #102
Hassanzadeh, Hamid	n-none	e-Poster #56
Hattori, Tadashi	n-none	e-Poster #83
Hayes, Maryann	n-none	Poster #18
Healy, Bitte S.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #103
Heare, Travis C.	n-none	e-Posters #35, 86; Paper #28
Hedden, Douglas M.	8 Journal of Pediatric Orthopedics Ad Hoc Reviewer; 9 Canadian Spine Society,Canadian Paediatric Spine Study Group; Pediatric Orthopaedic Society of North America	e-Poster #18
Hedequist, Daniel J.	9 AAOS; Pediatric Orthopaedic Society of North America	e-Posters #10, 68; Hip Subspecialty Day #86; Spine Subspecialty Day #115; Paper #19
Heffernan, Michael J.	9 Pediatric Orthopaedic Society of North America	e-Poster #54; Hip Subspecialty Day #86
Heflin, John A.	3B Medtronic Sofamor Danek	e-Poster 59; Spine Subspecialty Day #110
Helenius, Ilkka	3A Medtronic; 3B Medtronic; 5 Baxter; Bonalive; Medtronic; 6 Medtronic	Paper #50; Spine Subspecialty Day #112, 115
Henley, John D.	1 Motion Analysis	Paper #145

Name	Disclosure	Presentation Type
Hennrikus, William L.	9 Pediatric Orthopaedic Society of North America; Society of Military Orthopaedic Surgeons	e-Posters #22,85; Paper #62; Poster #11
Hensinger, Robert N.	4 Medtronic; 7 Journal of Pediatric Orthopedics; 8 Journal of Pediatric Orthopedics	Poster #18
Herman, Martin J.	7 Springer, Jaypee Publishing; 8 Journal of Pediatric Orthopedics; 9 AAOS; Pediatric Orthopaedic Society of North America	e-Posters #89, 112, 113; Paper #140
Hernandez-Soria, Alexia	n-none	e-Poster #3
Herrera Soto, Jose A.	1 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 #21, 33
Herzenberg, John E.	3B OrthoPediatrics; 3C Ellipse Technologies, Inc.; Smith & Nephew; Orthofix, Inc.; 5 Ellipse Technologies, Inc.; 6 The following companies supported my institution's non-profit organization, which provides financial assistance to our patients: Stryker; Orthocare Solutions; and Metro Prosthetics. The following companies supported my institution's annual course for orthopedic surgeons: Smith & Nephew; Ellipse Technologies; Stryker; Brainlab; Depuy Synthes; Orthofix; Biomet; KCI; OrthoPediatrics; OHK Medical Devices; and The MHE Coalition.	Paper #151
Herzog, Mackenzie M.	n-none	e-Poster #45; Paper #56, 141
Hesketh, Kim	n-none	Paper #34
Heyworth, Benton E.	9 American Orthopaedic Society for Sports Medicine; Pediatric Orthopaedic Society of North America	Paper #14, 55; Sports Medicine Subspecialty Day #126
Hill, Mary K.	n-none	e-Posters #2, 35; Paper #28
Ho, Brian	n-none	Paper #52
Ho, Christine Ann	7 Wolters Kluwer Health - Lippincott Williams & Wilkins; 9 Pediatric Orthopaedic Society of North America	e-Posters #30, 66; Paper #136, 137; Presider

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Name	Disclosure	Presentation Type
Hogue, Grant D.	n-none	e-Poster #67
Hollenbeck, Steven M.	n-none	Paper #1; Neuromuscular/ Lower Extremity Subspecialty Day #106
Hooe, Benjamin S.	n-none	Paper #66
Hosseini, Pooria	n-none	e-Poster #57
Hosseinzadeh, Pooya	n-none	Paper #156
Houdek, Matthew	n-none	Paper #17
Howard, Andrew W.	n-none	Moderator; Reviewer
Hsu, Anny	3A Hoffmann-La Roche	e-Poster #100
Hui, Anna	n-none	Paper #47
Hui, Steve Cheuk Ngai	n-none	Paper #42
Hung, Alec	n-none	Paper #47
Hurley, Mary E.	n-none	e-Poster #85
Hutchinson, Rachael	n-none	Paper #65
Hydorn, Christopher R	9 Pediatric Orthopaedic Society of North America	Paper #6
Hyman, Joshua E.	5 OMEGA; OREF; SRS; CPIRF; POSNA; 6 OMEGA; 9 American Academy for Cerebral Palsy and Developmental Medicine; American Academy of Pediatrics, Section on Orthopaedic Surgery; La Societe Internationale de Chirurgie Orthopedique et de Traumatologie; Pediatric Orthopaedic Society of North America	e-Poster #85
Ihnow, Stephanie	n-none	e-Poster #103
Ilharreborde, Brice	2 EOS Imaging; Implanet; Zimmer	e-Poster #99
Iobst, Christopher A.	2 Smith & Nephew	Paper #10; Hand/Upper Extremity Specialty Day #93
Irby, Steven	1 Otto Bock	Paper #4
Iriarte, Ivan	3C Merck	Spine Subspecialty Day #110
Ishiguro, Naoki	2 Chugai Pharmaceutical Co Ltd; Abbott; Astellas Pharma Inc; Bristol-Myers Squibb; Daiichi-Sankyo; Eisai Co Ltd; Hisamitsu Pharmaceutical Co Inc; Janssen Pharmaceutical K.K; Kaken Pharmaceutical Co Ltd; Mitsubishi Tanabe Pharmaceutical; Otsuka Pharmaceutical Co Ltd; Pfizer; Taisho Toyama Pharmaceutical Co Ltd; Takeda Pharmaceutical Co Ltd	Paper #89; Neuromuscular/ Lower Extremity Subspecialty Day #109

Name	Disclosure	Presentation Type
Iwata, Koji	n-none	e-Poster #83
Iwinski, Henry J.	n-none	e-Posters #52, 98; Paper #60, 156; Hand/ Upper Extremity Subspecialty Day #94
Jackson, Morgan L.	n-none	Paper #141
Jacobs, John C.	n-none	e-Posters #38, 108; Poster #13
Jain, Amit	n-none	e-Posters #27, 56, 61, 88, 101, 111;Paper #51
Jain, Viral V.	3B Medtronic Sofamor Danek	e-Poster #24
James, Michelle A.	8 Journal of Bone and Joint Surgery - American; 9 American Board of Orthopaedic Surgery, Inc.; Ruth Jackson Orthopaedic Society; Perry Initiative	Hand/Upper Extremity Subspecialty Day #99
Janicki, Joseph A.	4 Pfizer; 9 Pediatric Orthopaedic Society of North America	ePosters #31, 103
Javid, Mahzad	n-none	Paper #58
Jeans, Kelly	n-none	e-Poster #51
Jepsen, Karl J.	8 Journal of Bone and Mineral Research	Paper #77
Jewell, Dylan	Not available at time of printing	Paper #35
Jo, Chan-Hee	n-none	Paper #27, 73; Poster #1
Johnson, Michael H.	n-none	e-Poster #5
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	e-Poster #96
Jones, Gregory	n-none	Paper #44
Jones, Kerwyn	3B Orthopediatrics	e-Poster #85; Presider
Jones, Kristofer	n-none	Sports Subspecialty Day #123
Kaiser, Scott	n-none	e-Poster #55
Kaiser, Sunitha	n-none	e-Poster #55
Kalantre, Sarika	n-none	Paper #71
Kalish, Leslie A.	n-none	Paper #55; e-Poster #69
Kaneko, Hiroshi	n-none	e-Poster #83
Kappa, Jason	n-none	Poster #16
Karg, Jeffrey	n-none	Paper #69

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Name	Disclosure	Presentation Type
Karkenny, Alexa J.	n-none	e-Poster #112
Karlin, Lawrence I.	6 K2M - paid for housing and transportation for research meeting	e-Poster #8
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	e-Posters #51,96; Paper #27, 41, 72, 154; Moderator
Kasser, James R.	7 Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 Journal of Bone and Joint Surgery - American; Journal of Pediatric Orthopedics; 9 American Board of Orthopaedic Surgery, Inc.; Boston Childrens Hospital	Paper #158
Katcher, Arielle	n-none	e-Poster #65
Katzel, Mia J.	n-none	Sports Subspecialty Day #129
Kaufman, Kenton R.	5 American Orthotic and Prosthetic Association; 8 Gait and Posture, Prosthetics and Orthotics International	e-Poster #1
Kawamura, Catia M.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Kedem, Paz	n-none	e-Posters #15, 47
Kelley, Simon	3B Smith & Nephew; 9 International Hip Dysplasia Institute	Paper #33
Kelly, Bryan T.	3C A-3 Surgical; 4 A-3 Surgical	Hip Subpecialty Day #82
Kelly, Derek M.	2 Medtronic; 7 Elsevier Health; 9 Pediatric Orthopaedic Society of North America	e-Poster #46
Kelly, Shannon M.	n-none	e-Poster #104
Kenkre, Tanya	n-none	e-Poster #53; Paper 44
Kestel, Lauryn A.	n-none	e-Poster #15; Hip Subpecialty Day #81
Khamaisy, Saker	n-none	Poster #15
Khandwala, Yash	n-none	Paper #43
Kim, Daniel C.	n-none	Paper #60
Kim, Harry K.	5 Ipsen; 6 Pfizer; Medtronic	Paper #73, 75
Kim, Yeon Soo	n-none	Paper #153
Kim, Yong	n-none	Paper #45
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 #30, 37

Name	Disclosure	Presentation Type
Kinney, Matthew C.	n-none	e-Poster #34
Kitoh, Hiroshi	n-none	e-Poster #83; Paper #78; Neuromuscular/Lower Extremity Subspecialty Day #109
Kleis, Kevin	n-none	e-Poster #32
Knapp, Dennis R.	1 Biomet	Paper #21
Knowlton, Joshua Q.	n-none	e-Poster #5
Kocher, Mininder S.	3B OrthoPediatrics; Smith & Nephew; 4 Fixes 4 Kids; Pivot Medical; 5 Ossur; 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	Paper #55; Sports Subspecialty Day #121, 126
Komatsu, David E.	n-none	e-Poster #76
Kozin, Scott H.	3B checkpoint; 9 American Society for Surgery of the Hand	Hand/Upper Extremity Subspecialty Day #92, 96, 97
Kraemer, William	n-none	Paper #3
Kramer, Dennis E.	n-none	Paper #55
Kristensen, Billy	2 Biomet	Neuromuscular/Lower Extremity Subspecialty Day #105
Krzak, Joseph	3B NeuroCom - a division of Natus	e-Poster #77; Neuromuscular/Lower Extremity Subspecialty Day #102
Kwan, Kenny	n-none	Paper #50; Spine Subspecialty Day #112
Lababidi, Suzanne	n-none	e-Poster #75
Ladenhauf, Hannah-Noemi	n-none	Sports Subspecialty Day #127
Lagreca, Jaren	n-none	Paper #49
Lam, Tsz Ping	5 Pfizer	e-Poster #4; Poster #17; Paper #42, 47
Larouche, Patricia	n-none	e-Poster #71

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Name	Disclosure	Presentation Type
Larson, A. Noelle	9 Scoliosis Research Society	e-Posters #1, 79; Paper #6, 7, 8, 15, 46; Poster #5; Presider
Lauridsen, Hanne Boch	n-none	Neuromuscular/Lower Extremity Subspecialty Day #105
Ledonio, Charles Gerald T.	5 Medtronic	Paper #8, 46
Lee, Dong Yeon	5 Daewoong pharmaceutical	Paper #153
Lee, Mark C.	2 DePuy, A Johnson & Johnson Company; 9 Hartford County Medical Society	e-Poster #44
Lee, R. Jay	n-none	e-Poster #107; Paper #131
Lee, Ryan KL	Not available at time of printing	Poster #17
Lee, Shiela	n-none	Paper #65
Lee, Simon KM	n-none	e-Poster #4
Lehman, Wallace B.	n-none	Paper #155
Leiferman, Ellen	n-none	Paper #79
Lenhart, Rachel L.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #107
Lenke, Lawrence G.	1 Medtronic; 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	e-Poster #54
Lennon, Nancy	n-none	e-Poster #49; Paper #145
Leonard, Sharon	n-none	Neuromuscular/Lower Extremity Subspecialty Day #101
Leung, Joyce Hoi Ying	n-none	Poster #17
Levack, Ashley	n-none	Poster #7
Lewis, Cathy C.	n-none	Poster #18
Li, G. Ying	9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #10; Poster #18
Li, Jacqueline	n-none	e-Poster #71
Lierhaus, Anneliese	n-none	Paper #158
Lightdale - Miric, Nina R.	n-none	e-Poster #74
Lind, Allison A.	n-none	e-Poster #5

Name	Disclosure	Presentation Type
Lindberg, Antoinett W.	3A Oppo Medical	Presider; Reviewer
Linn, Michael S.	n-none	e-Poster #34
Little, David G.	2 Eli Lilly; Amgen Co; 5 Amgen Co; Celgene; N8 Medical; Norvartis; 7 IBMS BoneKey; 8 Journal of Children's Orthopaedics; 9 Orthopaedic Research Society	Paper #76
Little, Kevin J.	9 American Association for Hand Surgery	e-Poster #74
Liu, Raymond W.	6 Orthopediatrics: Royalties paid to my institution; 9 Limb Lengthening Research Society; Pediatric Orthopaedic Society of North America	e-Poster #80, 105, 109; Poster #10; Sports Subspecialty Day #128
Lloyd, Augusta	n-none	Paper #63
Lloyd, Jessica R.	n-none	e-Poster #44
Loftin, Amanda	n-none	e-Poster #21
Londino, Joanne A.	n-none	e-Poster #53
Lonner, Baron	1 DePuy, A Johnson & Johnson Company; 2 DePuy, A Johnson & Johnson Company; K2M; 3B DePuy, A Johnson & Johnson Company; 4 Paradigm Spine; Spine Search; 5 AO Spine; Grant from Depuy Synthes to Setting Scoliosis Straight Foundation; John and Marcella Fox Fund; OREF; 8 SpineUniverse.com; SRS Spine Deformity Journal; 9 Depuy Spine; Scoliosis Research Society; Spine Search	Poster #12
Lopes, Jose Augusto F.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Lord, Elizabeth	n-none	e-Poster #21
Lovecchio, Francis	n-none	e-Poster #103
Lovejoy, John F.	9 Pediatric Orthopaedic Society of North America	e-Poster #104
Lovejoy, Steven A.	n-none	e-Posters #42, 104
Lu, Xuemin	n-none	Hand/Upper Extremity Subspecialty Day #95
Luhmann, Scott J.	1 Globus Medical; 2 Medtronic Sofamor Danek; Stryker; 3B DePuy, A Johnson & Johnson Company; Medtronic Sofamor Danek; Stryker; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #20

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Name	Disclosure	Presentation Type
Luo, T. David	n-none	e-Poster #1; Poster #5
Luther, Herman	n-none	e-Poster #84; Paper #26
Lyman, Stephen	8 American Journal of Orthopedics; HSS Journal; 9 International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine	e-Poster #3; Paper #53
Ma, Julie	n-none	e-Poster #16; Poster #2
Mac, Lisa	n-none	Paper #141
Mackenzie, William G.	2 Biomarin; 3C DePuy, A Johnson & Johnson Company; 9 Medical Advisory Board of the Little People of America	Paper #150
Maguire, Kathleen J.	n-none	Paper #71
Mahadev, Arjandas S.	n-none	Paper #23
Mahan, Susan T.	n-none	Paper #11, 158
Mann, David C.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #107
Marino, Josephine	n-none	Paper #77
Mark, Bryan J.	n-none	e-Poster #20; Paper #143
Marks, Michelle	3B DePuy, A Johnson & Johnson Company; 5 DePuy, A Johnson & Johnson Company; SRS; 9 Scoliosis Research Society; Setting Scoliosis Straight Foundation FKA Harms Study Group Foundation	e-Posters #61, 88; Poster #20
Marquez-Lara, Alejandro	n-none	e-Poster #48
Martin, Benjamin D.	9 United States Bone and Joint Initiative	e-Poster #104
Martin, Daniel	n-none	Paper #55
Martinez, Maximilian	n-none	e-Poster #19
Martus, Jeffrey E.	9 AAOS; Pediatric Orthopaedic Society of North America	e-Posters #42, 102; Paper #66; eModerator; Reviewer
Matheney, Travis H.	9 Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	Paper #37, 38, 149; Poster #16
Matsumoto, Hiroko	6 Biomet; DePuy, A Johnson & Johnson Company; Medtronic; Research Support: Children's Spine Foundation, SRS, POSNA, CPIRF; Stryker; Synthes	e-Posters #11, 100
Matsushita, Masaki	n-none	e-Poster #83; Paper #78; Neuromuscular/Lower Extremity Subspecialty Day #109

Name	Disclosure	Presentation Type
Matthews, Allison	n-none	e-Posters #65, 104
Mayer, Emily	n-none	Paper #142
Mayer, Stephanie W.	n-none	e-Posters #2, 35; Paper #54; Hip Subspecialty Day #82
Mayo, Meredith	n-none	e-Poster #16; Poster #2
Mazda, Keyvan	3B Zimmer	e-Poster #99
McBryde, Callum	2 Smith & Nephew	Paper #35
McCarthy, Alicia	n-none	Paper #13
McCarthy, James J.	3B Synthes; 7 Wolters Kluwer Health - Lippincott Williams & Wilkins; Orthopedics; 9 Limb Lengthening Research Society, Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	Neuromuscular/Lower Extremity Subspecialty Day #107; Program Committee
McCarthy, Moira M.	n-none	Paper #53, 54; Sports Subspecialty Day #123
McCarthy, Richard E.	1 Medtronic; 2 Medtronic; 3B Medtronic; 7 Medtronic	e-Poster #60
McClung, Anna	n-none	e-Posters #23, 94; Paper #48
McCullough, Frances L.	n-none	e-Poster #60
McElroy, Mark J.	n-none	Sports Subspecialty Day #121
McFadden, James	n-none	e-Poster #33
McGraw, Michael	n-none	Sports Subspecialty Day #122
McIntosh, Amy L.	3B Synthes	Paper #7
McKie, Janay	n-none	Paper #63
McKinney, Kaitlin	n-none	Staff
McLawhorn, Alexander S.	n-none	Poster #7
McMulkin, Mark	n-none	Paper #147, 152
Mednick, Rachel E.	n-none	e-Posters #31, 103; Paper #144

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Name	Disclosure	Presentation Type
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-Posters #58, 85; Paper #142; Hip Subspecialty Day #88
Melvani, Roshan T.	n-none	e-Poster #5
Mencio, Gregory A.	8 Saunders/Mosby-Elsevier; 9 Pediatric Orthopaedic Society of North America; Tennessee Orthopaedic Society	e-Posters #42, 102
Menga, Emmanuel N.	n-none	e-Poster #56
Meyer, Carissa L.	n-none	e-Poster #113
Micheli, Lyle J.	3C Carticel scientific board; 5 Genzyme	Paper #55
Mikulec, Kathy	n-none	Paper #76
Milbrandt, Todd A.	9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #98; Paper #12, 156; Hand/Upper Extremity Subspecialty Day #94; Program Committee; eModerator
Miller, Ashley	n-none	e-Poster #74
Miller, Elie	n-none	Hand/Upper Extremity Subspecialty Day #96
Miller, Freeman	1 Motion Analysis Corp; 7 Springer; 8 Gait and Posture, Journal Children's Orthopedics; Journal of Pediatric Orthopedics	e-Poster #49; Paper #145, 150
Miller, Nancy H.	8 Spine; Spine Deformity	e-Poster #20; Paper #143; eModerator; Reviewer
Miller, Patricia	n-none	e-Posters #8, 68; Paper #19, 30, 138, 149, 158; Poster #9; Spine Subspecialty Day #111
Millis, Michael B.	7 Saunders/Mosby-Elsevier; 8 Saunders/Mosby-Elsevier; Springer	e-Posters #37, 78; Paper #26, 30, 37
Mintz, Douglas N.	n-none	e-Poster #70
Mishima, Kenichi	n-none	Paper #78; Neuromuscular/Lower Extremity Subspecialty Day #109

Name	Disclosure	Presentation Type
Miyanji, Firoz	3B DePuy, A Johnson & Johnson Company; 5 DePuy, A Johnson & Johnson Company	ePosters #14, 26, 63, 88; Paper #9; Poster #12; Neuromuscular/Lower Extremity Subspecialty Day #106; Spine Subspecialty Day #114, 117
Mo, Andrew	n-none	e-Poster #93
Modhia, Urvij M.	n-none	e-Poster #88; Paper #51
Mok, Janice	n-none	Paper #9
Morais Filho, Mauro C.	9 Brazilian Society of Pediatric Orthopaedics	Neuromuscular/Lower Extremity Subspecialty Day #104
Moran, Steven L.	1 Integra; 2 Integra; 3B Integra; 4 Conventus, Axogen; 8 Hand	Paper #17
Moreau, Marc J.	n-none	e-Poster#18
Morgan, Jessica	n-none	e-Poster #59
Morris, Andrew	n-none	Hip Subspecialty Day #85
Morris, William Z.	n-none	e-Posters #80, 105
Morscher, Melanie	n-none	e-Poster #75
Mubarak, Scott J.	1 Rhino Pediatric Orthopedic Designs, Inc.; 4 Rhino Pediatric Orthopedic Designs, Inc.; 8 J Children's Ortho Pediatrics	e-Poster #91
Muchow, Ryan D.	n-none	e-Posters #52, 97, 98; Paper 60, 156; Hand/Upper Extremity Subspecialty Day #94
Mueske, Nicole	n-none	Neuromuscular/Lower Extremity Subspecialty Day #103, Sports Medicine Subspecialty Day #129
Mulpuri, Kishore	5 DePuy, A Johnson & Johnson Company; 9 Canadian Orthopaedic Association; International Hip Dysplasia Institute; Pediatric Orthopaedic Society of North America	Papers #33, 34, 38; e-Poster #71
Munch, John	n-none	e-Poster #91
Munns, Craig F.	3B Ultragenyx; 5 Norvartis	Paper #76

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Name	Disclosure	Presentation Type
Murphy-Zane, Margaret S.	8 New England Journal of Medicine; 9 American College of Emergency Physicians; Pediatric Orthopaedic Society of North America; The Society for Academic Emergency Medicine SAEM	e-Poster #73
Muzykewicz, David A.	n-none	e-Poster #91
Nagle, David	n-none	e-Poster #34
Naqvi, Manahil N.	n-none	Paper #16
Nasreddine, Adam	n-none	e-Poster #37
Nault, Marie-Lyne	n-none	Sports Medicine Subspecialty Day
Nawabi, Danyal	n-none	Paper #54
Nduaguba, Afamefuna	n-none	e-Poster #107; Paper #22, 31
Neal, Kevin M.	1 Orthopediatrics; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #157
Neiss, Geraldine	n-none	Paper #13
Nepple, Jeffrey	2 Smith & Nephew; 3B Smith & Nephew	Paper #29; Hip Subspecialty Day #83
Neves, Daniella	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Newton, Peter O.	1 DePuy Synthes Spine, A Johnson & Johnson Company; 2 DePuy Synthes Spine, A Johnson & Johnson Company; 3B Cubist; DePuy Synthes Spine, A Johnson & Johnson Company; Ethicon Endosurgery; 4 ElectroCore; 5 DePuy Synthes Spine via Setting Scoliosis Straight Foundation; EOS Imaging; Orthopediatrics institutional support; 7 Theime Publishing; 9 International Pediatric Orthopedic Think Tank; Pediatric Orthopaedic Society of North America; Scoliosis Research Society; Setting Scoliosis Straight Foundation	e-Posters #26, 61, 88; Paper #43, 45; Poster #12; Neuromuscular/Lower Extremity Subspecialty Day #106; Spine Subspecialty Day #114, 118
Ng, Bobby Kin Wah	n-none	e-Posters #4, 17; Paper #42, 47
Nguyen, Cynthia	n-none	e-Poster #109
Nguyen, Dylan C.	n-none	Hip Subspecialty Day #87
Nguyen, Stacie	n-none	e-Poster #57
Nguyen, Thao	n-none	e-Poster #7
Nigam, Somesh	4 Eli Lilly; Pfizer	e-Poster #38

Name	Disclosure	Presentation Type
Niiler, Timothy	n-none	Paper #145
Nishnianidze, Tristan	n-none	Spine Subspecialty Day #113; Paper #150
Nissi, Mikko J.	n-none	Poster #14; Sports Medicine Subspecialty Day #120
Niswander, Cameron R.	n-none	e-Poster #62; Paper #67; Spine Subspecialty Day #116
Nitikman, Michael	n-none	Paper #9; Spine Subspecialty Day #117
Njoku, Dolores	5 DePuy, A Johnson & Johnson Company; 7 McGraw-Hill Education; 9 American Society of Anesthesiologists Committee on Surgical Anesthesia; Foundation for Anesthesia Education and Research Board Member	e-Poster #93
Nnadi, Colin	8 European Spine Journal; Open Spine Journal	Paper #50; Spine Subspecialty Day #112
Noonan, Ken J.	1 Biomet; Biomet; 3B Biomet; 4 FIXX Orthopaedics; 5 Biomet	Neuromuscular/Lower Extremity Subspecialty Day #107; Reviewer
Nousiainen, Markku	2 Zimmer; 3B Zimmer; 5 Smith & Nephew; Synthes; 9 Canadian Orthopaedic Association, AOTK Computer Navigation North America committee; Orthopaedic Trauma Association	Paper #3
Novacheck, Tom F.	9 Commission on Motion Lab Accreditation	e-Posters #50, 95
Novais, Eduardo N.	n-none	e-Posters #2, 15, 16, 35, 37; Paper #28, 143; Poster #2; Hip Subspecialty Day #81; Reviewer
Novak, Kimberly	n-none	e-Poster #75
Novo, Luis Moraleda	n-none	Paper #139
O'Donnell, June C.	n-none	Paper #20
O'Hara, John N.	1 Finsbury.,I am in receipt of royalties for the Extra Fixation Cup, part of the Adept Resurfacing system	Paper #35
O'Neil, Margaret E.	n-none	e-Poster #49
Odent, Thierry A.	9 Groupe d'étude de la scolioose	Spine Subspecialty Day #115

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Name	Disclosure	Presentation Type
Oeffinger, Donna Jean	n-none	e-Poster #98; Paper #156
Oetgen, Matthew	3B Medtronic; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Posters #65, 104
Oishi, Scott	n-none	Hand/Upper Extremity Subspecialty Day #98
Oliver, Patricia	n-none	Hip Subspecialty Day #81
Ortegren, Jakob	n-none	Paper #25
Ounpuu, Sylvia	8 Gait and Posture; Gait and Posture; 9 American Academy for Cerebral Palsy and Developmental Medicine; Gait and Clinical Movement Analysis Society	Neuromuscular/Lower Extremity Subspecialty Day #103
Pacana, Matthew J.	n-none	Poster #11
Pace, Gregory I.	n-none	Paper #19, 62
Pace, James L.	3B Arthrex, Inc; Ceterix, Inc.; 9 Pediatric Orthopaedic Society of North America	e-Poster #36; Sports Medicine Subspecialty Day #129
Padua, Horacio	n-none	Paper #16
Pahys, Joshua M.	3B DePuy, A Johnson & Johnson Company	Poster #20
Palumbo, Mark A.	3B Stryker; 5 Globus Medical; 9 AAOS	e-Poster #9
Pan, Ting-Jung	n-none	Paper #53
Pan, Zhaoxing	n-none	e-Posters #2, 3, 16; Paper #53; Posters #2, 19, Paper #67
Paredes, Alejandro A.	n-none	Paper #134
Parent, Eric C.	9 Society on Scoliosis Orthopedic and Rehabilitation Treatment	e-Poster #18
Parent, Stefan	3B DePuy Synthes Spine, A Johnson & Johnson Company; Medtronic Sofamor Danek; EOS-Imaging; 4 Spinologics; 5 EOS-Imaging; OREF; Setting scoliosis straight foundation; 9 Scoliosis Research Society, ; Canadian Orthopaedic Association	Poster #12; Spine Subspecialty Day #118
Parikh, Shital N.	7 Saunders/Mosby-Elsevier; 8 Orthopedic Clinics of North America; Orthopedics Today; 9 Pediatric Orthopaedic Society of North America	e-Poster #13
Park, Howard	n-none	e-Poster #40
Park, Paul	n-none	Poster #10
Parker, Sarah	8 American Academy of Pediatrcis, RedBook	e-Poster #86
Parkin, Patricia	n-none	e-Poster #55

Name	Disclosure	Presentation Type
Parry, Joshua A.	n-none	e-Poster #1
Parvaresh, Kevin	n-none	Spine Subspecialty Day #111
Paryavi, Ebrahim	n-none	e-Poster #113
Pashos, Gail	4 GlaxoSmithKline	Paperr #29
Patel, Surekha	n-none	Paper #136
Pawar, Abhijit	n-none	e-Poster #72
Pawasarat, Ian M.	n-none	e-Poster #89
Pawelek, Jeff	n-none	e-Posters #57; Paper #51; Spine Subspecialty Day 111
Peacock, Lauren	n-none	Paper #76
Pennock, Andrew T.	n-none	e-Posters #32, 34, 82; Paper #52, 57, 59, 133, 135
Perez Salazar Marina, Diego	n-none	Poster #3
Perez-Grueso, Francisco S.	3B DePuy, A Johnson & Johnson Company; 5 DePuy, A Johnson & Johnson Company	e-Posters #11, 101
Peterson, Jonathan B.	n-none	e-Poster #82
Phillips, Jonathan H	1 Biomet; 3B OrthoPaediatrics; Synthes; 5 Biomet; 6 Spine Advisory Board OrthoPaediatrics; 7 Springer; 8 Journal of Pediatric Orthopedics; Journal of the Southern Orthopedic Association; 9 OrthoPaediatrics; Scoliosis Research Society	Paper # 21, 49, 140; Spine Subspecialty Day #115
Phillips, Lee G.	n-none	Paper #59; Poster #12
Phillips, Lisa	n-none	Paper #34
Phipps, Matthew	n-none	Paper #75
Pierrie, Sarah	n-none	Paper #24
Pineault, Kevin G.	n-none	Paper#145
Pinkstock, Stephanie	n-none	Paper #12
Pleshko, Nancy	n-none	Paper #77
Podeszwa, David A.	9 Pediatric Orthopaedic Society of North America; AAOS	e-Posters #30, 43, 66; Paper #63, 136, 137; Hip Subspecialty Day #80, 87
Poe-Kochert, Connie	n-none	e-Poster #105
Polly, David W.	9 Scoliosis Research Society	Paper #46
Polousky, John D.	3B Allosource; 4 Organovo	e-Poster #64; Posters #13, 14; Sports Medicine Subspecialty Day #120

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Name	Disclosure	Presentation Type
Preminger, Jonathan	n-none	e-Poster #64
Price, Charles T.	1 Biomet; Halo Innovations, Inc; 4 Institute for Better Bone Health, LLC; 8 Institute for Better Bone Health, LLC; Journal of Pediatric Orthopedics	Paper #33, 38; Moderator; Reviewer
Prusick, Vincent W	n-none	e-Poster #98
Pugh, Linda	n-none	Paper #148
Putnam, Sara	n-none	Paper #29
Pyle, Laura	n-none	e-Poster #73
Qui, Yong	n-none	Paper #42
Raggio, Cathleen L.	2 Biomarin; 5 Amgen Co; 9 Orthopaedic Research Society; Pediatric Orthopaedic Society of North America; Scoliosis Research Society;OIF	Paper #77; eModerator; Reviewer
Ramirez-Lluch, Norman F.	3A Frederic Lee- My father work for a brace/ soft equipment factory in Puerto Rico; 9 Children Spine Study Group- Core Member	Spine Subspecialty Day #110
Ramirez, Rey N.	9 American Society for Surgery of the Hand	Hand/Upper Extremity Specialty Day #92
Ramo, Brandon A.	2 Biomet	Paper #21, 66, 136; Poster 31; Spine Subspecialty Day #116
Rampy, Patricia	n-none	e-Poster #94
Rangel, Scottie	n-none	Staff
Rao, Raj D.	8 Elsevier; Journal of Bone and Joint Surgery - American; Journal of the American Academy of Orthopaedic Surgeons; Spine; 9 Lumbar Spine Research Society; US Food and Drug Administration	Spine Subspecialty Day #119
Rao, Rameshwar	n-none	Poster #18
Rao, Sandesh	n-none	e-Poster #27
Rathjen, Karl E.	3C K2M; 4 Mati Therapeutics; 7 Elsevier; 8 Clinical Orthopaedics and Related Research; Journal of Pediatric Orthopedics; Spine;; 9 Limb Lengthening and Reconstruction Society; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #154
Raymond, Melody	n-none	Staff
Rebolledo, Brian	n-none	Sports Medicine Subspecialty Day #123
Reddy, Anil	n-none	Spine Subspecialty Day #116

Name	Disclosure	Presentation Type
Refsland, Stephen A.	n-none	Hand/Upper Extremity Subspecialty Day #97
Reid, Dorian Y.	n-none	e-Poster #5
Reighard, Fredrick G.	n-none	Paper #43, 45
Reilly, Chris	6 DePuy, A Johnson & Johnson Company; 9 Pediatric Orthopaedic Society of North America	e-Posters #25, 63, 71; Reviewer
Ricciardi, Benjamin	n-none	Hip Subspecialty Day #82
Riccio, Anthony I.	5 Synthes; 9 Pediatric Orthopaedic Society of North America	e-Posters #30, 66; Paper #130, 132, 136, 137
Richard, Heather M.	n-none	Hip Subspecialty Day #87
Richards, B. Stephens	4 Pfizer; 7 Elsevier; 8 Journal of Pediatric Orthopedics; Spine Deformity	Paper #154
Richards, Claire H.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #108
Riley, Patrick M.	n-none	Sports Medicine Subspecialty Day #121
Ritzl, Eva Katharina	9 ACNS American Clinical Neurophysiology Society; ASNM American Society of Neurophysiological Monitoring	e-Poster #93
Roach, James W.	4 Abbott; 8 Spine Deformity Journal	Paper #44
Robbins, Christopher B.	n-none	e-Poster #10
Roberts, Jesse	n-none	e-Poster #86
Robertson, David M.	n-none	e-Poster #62
Rodeo, Scott A.	3B Cytori; Pluristem; Rotation Medical; 4 CAYENNE	Paper #70
Rogers, Kenneth J.	n-none	Paper #13, 150; Spine Subspecialty Day #113
Roocroft, Joanna H.	n-none	Paper #59, 135
Roposch, Andreas	9 European Paediatric Orthopaedic Society	Paper #39
Rosenblatt, Joseph	n-none	e-Poster #89
Ross, James	n-none	Paper #29; Hip Subspecialty Day #83
Roulette, Paulvalery	n-none	e-Poster #87
Roye, Benjamin D.	5 SRS, OMeGA, POSNA	e-Poster #100
Roye, David P.	3B Stryker; 5 CPIRF; CSSG; POSNA; 6 Biomet; DePuy, A Johnson & Johnson Company; Medtronic; OMEGA; Stryker; Synthes; 8 Journal of Bone and Joint Surgery - American	e-Posters # 11, 100

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Name	Disclosure	Presentation Type
Rozario, Nigel	n-none	e-Poster #87
Ruiz, Carlos Vidal	n-none	Poster #3
Runner, Robert	n-none	e-Posters #78, 84
Russell, Conor	4 Titan Pharmaceuticals	e-Poster #112
Ryan, Deirdre D.	n-none	Hand/Upper Extremity Subspecialty Day #93; Neuromuscular/Lower Extremity Subspecialty Day #103
Sabatino, Matthew J.	n-none	Paper #16
Sabharwal, Sanjeev	8 Journal of Bone and Joint Surgery - American; Clinical Orthopaedics and Related Research; 9 Pediatric Orthopaedic Society of North America; Limb Lengthening & Reconstruction Society	e-Poster #19
Safadi, Fayez	n-none	e-Poster #75
Safir, Oleg	3B Intellijoint	Paper #3
Sager, Brian W.	n-none	e-Poster #67
Sala, Debra A.	n-none	Paper #155
Saldana, Roger E.	n-none	Paper #146
Salgueiro-Canetti, Lissette	n-none	Paper #133, 135
Salvati, Eduardo A.	n-none	Sports Medicine Subspecialty Day #127
Samdani, Amer	3B DePuy, A Johnson & Johnson Company; Stryker; Zimmer	e-Posters #26, 61, 63; Paper #49; Poster #12, 20; Spine Subspecialty Day #114
Samuelsson, Hanna	n-none	Paper #32
Sanders, James O.	4 Abbott; Abbvie; GE Healthcare; Hospira; 9 AAOS; POSNA; SRS	Moderator; Reviewer
Sanghrajka, Anish P.	n-none	Paper #65
Sankar, Wudbhav N.	7 Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 Journal of Bone and Joint Surgery - American; Journal of Pediatric Orthopedics; 9 American Board of Orthopaedic Surgery, Inc.; Boston Childrens Hospital	e-Poster #39; Paper #22, 31, 38, 40, 131; Reviewer
Santos, Carlos A.	n-none	Neuromuscular/Lower Extremity Subspecialty Day #104
Sarwahi, Vishal	3B DePuy, A Johnson & Johnson Company; Medtronic; 5 DePuy, A Johnson & Johnson Company	e-Posters #13, 72; Paper 71

Name	Disclosure	Presentation Type
Sawyer, Jeffrey R.	7 Mosby; Wolters Kluwer Health - Lippincott Williams & Wilkins; 9 AAOS; Pediatric Orthopaedic Society of North America; Campbell Foundation	e-Poster #46; Paper #6
Scaduto, Anthony A	8 Orthopedics; Journal of the American Academy of Orthopaedic Surgeons; Journal of Pediatric Orthopedics; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #21
Scannell, Brian	n-none	e-Poster #87; Paper #24
Scher, David M.	8 Springer; 9 Pediatric Orthopaedic Society of North America	e-Poster #47; Poster #15; eModerator; Reviewer
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; Moderator
Schindeler, Aaron	5 N8 Medical; 6 Celgene Ltd; 8 Journal of Tissue Science & Engineering, Editorial Board member	Paper #76
Schlechter, John	2 Arthrex, Inc	e-Poster #32; Poster #6
Schoenecker, Jonathan G.	5 ISIS pharmaceuticals	e-Poster #42; eModerator; Reviewer
Schoenecker, Perry L.	8 Journal of Pediatric Orthopedics;,Journal of Children's Orthopaedics; 9 Pediatric Orthopaedic Society of North America	Paper #29; Hip Subspecialty Day #83
Schoenleber, Scott J.	n-none	Paper #13
Schrader, Tim	9 AAOS	Presider; Reviewer
Schreiber, Sanja	n-none	e-Poster #18
Schroth, Mary	3B Biogen Idec; Roche; 9 Cure SMA Medical Advisory Council	Neuromuscular/Lower Extremity Subspecialty Day #107
Schueler, Beth	9 American Association of Physicists in Medicine	Poster #5
Schulz, Jacob F.	n-none	e-Posters #13, 72
Schwartz, Alexandra K.	2 Synthes; 3A spouse employed by zimmer; Zimmer; 4 spouse employed by zimmer	e-Poster #34
Schwartz, Brandon	n-none	e-Poster #113
Schwartz, Michael H.	8 Gait and Posture	e-Posters #50, 95

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Name	Disclosure	Presentation Type
Schwend, Richard M.	9 POSNA; American Academy of Pediatrics; Project Perfect World; Miracle Feet	Reviewer
Scott, Allison C.	n-none	Paper #18
Scott, Trevor	6 MAX BioPharma Inc.	e-Poster #21
Sebag, Guy	Not available at time of printing	e-Poster #99
Sees, Julieanne P.	n-none	e-Poster #49
Segal, Lee S.	8 Clinical Orthopaedics and Related Research; 9 Pediatric Orthopaedic Society of North America	Paper #4, 68
Seo, Sang Gyo	n-none	Paper #153
Shabtai, Lior	n-none	e-Poster #36; Paper #151
Shah, Mitesh	n-none	Paper #140
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	e-Posters #26, 57, 61, 88; Paper #13, 51; Poster #12; Neuromuscular/Lower Extremity Subspecialty Day #106; Spine Subspecialty Day #113, 114
Shaha, James S.	n-none	Paper #130
Shaha, Steve	n-none	Paper #130
Shahcheraghi, Gholam H.	9 Iranian Paediatric Orthopaedic Association; IranianOrthopaedic Association	Paper #58
Sharkey, Melinda	n-none	Poster #8
Shaughnessy, William J.	8 Journal of the American Academy of Orthopaedic Surgeons	e-Poster #1; Paper #46
Shea, Kevin G.	9 AAOS; American Orthopaedic Society for Sports Medicine; North Pacific Orthopedic Society; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America	e-Posters #13, 39, 108; Poster #14; Sports Medicine Subspecialty Day #120
Sheha, Evan	n-none	Poster #7
Shi, Benlong	n-none	Poster #17
Shieh, Alvin	n-none	Paper #57
Shin, Yong-Woon	n-none	e-Poster #17
Shirley, Eric D.	3A Depomed; 7 Orthobullets.com; 8 Orthobullets.com; 9 Jacksonville Sports Medicine Program; Pediatric Orthopaedic Society of North America	Paper #10, 157; Neuromuscular/Lower Extremity Subspecialty Day #101
Shore, Benjamin J.	9 American Academy for Cerebral Palsy and Developmental Medicine; Pediatric Orthopaedic Society of North America	e-Poster #68; Paper #6, 138, 149; Poster #16

Name	Disclosure	Presentation Type
Shrader, M. Wade	3B Orthopediatrics; 9 AAOS; American Academy for Cerebral Palsy and Developmental Medicine; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #4, 68
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 #26
Siegall, Evan M.	n-none	Paper #56
Sigrist, Emmalynn	n-none	e-Poster #89
Silva, Mauricio	9 World Federation of Hemophilia	Paper #134
Sim, Franklin H.	7 Saunders/Mosby-Elsevier	Paper #17
Simon, Anne-Laure	n-none	e-Poster #1
Sinclair, Mark R.	n-none	e-Poster #5
Singh, Amardeep	n-none	e-Poster #25
Sink, Ernest L.	9 Pediatric Orthopaedic Society of North America	Paper #28; Poster #7; Hip Subspecialty Day #82; Program Committee
Sison-Williamson, Mitell	n-none	Hand/Upper Extremity Subspecialty Day #99
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	e-Posters #11, 40, 54, 60, 84, 101; Paper #19; Spine Subspecialty Day #111
Slough, Jennifer	n-none	Poster #11; e-Poster #22
Smit, Kevin	n-none	e-Poster #43
Smith, Brian G.	9 AAOS; American Academy of Pediatrics Orthopaedic Section	e-Poster #92; Paper #5
Smith, John T.	1 Synthes; Synthes; 3B Ellipse Technologies; Spineguard; Synthes; Synthes; 9 Chest Wall and Spine Deformity Research Foundation	e-Poster #59; Paper #49; Spine Subspecialty Day #110
Smith, Nelson	n-none	e-Poster #73
Smith, Peter A.	n-none	e-Poster #77; Neuromuscular/ Lower Extremity Subspecialty Day #102

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Name	Disclosure	Presentation Type
Smith, Richard A.	n-none	e-Poster #46
Smith-McLallen, Aaron	n-none	e-Poster #38
Snoddy, Mark	n-none	Paper #66
Snowden, Ryan	n-none	e-Poster #98
Snyder, Benjamin M.	n-none	Hip Subspecialty Day #86
Snyder, Brian	9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	Paper #149; Poster #16; Neuromuscular/Lower Extremity Subspecialty Day #100; Moderator; Reviewer
Solomito, Matthew J.	n-none	e-Poster #44
Son-Hing, Jochen P.	8 Wolters Kluwer Health - Lippincott Williams & Wilkins; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #105
Song, Kit	7 Hanley and Belfus; 9 AAOS; POSNA; SRS	Reviewer
Song, Xuyang	n-none	e-Posters #7, 74; Paper #2; Hand/Upper Extremity Subspecialty Day #96
Sonne-Holm, Stig	n-none	Neuromuscular/Lower Extremity Subspecialty Day #105
Sousa, Ted	n-none	e-Poster #36
Southorn, Tom	n-none	Paper #39
Spence, David D.	n-none	e-Poster #46
Spencer, Samantha A.	9 AAOS, Massachusetts Orthopaedic Association, Pediatric Orthopaedic Society of North America	e-Poster #68; Paper #158
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	e-Posters #27, 56, 61, 64, 88, 93, 101, 111; Paper #51, Neuromuscular/Lower Extremity Subspecialty Day #106; Spine Subspecialty Day #114, 115
Spruiell, Murray D.	n-none	e-Poster #86
St. Hilaire, Tricia	n-none	e-Poster #106; Poster #19; Spine Subspecialty Day #110

Name	Disclosure	Presentation Type
Standard, Shawn C.	1 Ellipse Technologies; Pega Medical; 3B Ellipse Technologies; 4 Ellipse Technologies; 6 The following companies supported my institution's non-profit organization, which provides financial assistance to our patients: Stryker; Orthocare Solutions; and Metro Prosthetics. The following companies supported my institution's annual course for orthopedic surgeons: Smith & Nephew; Ellipse Technologies; Stryker; Brainlab; Depuy Synthes; Orthofix; Biomet; KCI; OrthoPediatrics; OHK Medical Devices; and The MHE Coalition	Paper #151
Stanfield, Jacob M.	n-none	Hand/Upper Extremity Subspecialty Day #94
Stans, Anthony A.	9 Pediatric Orthopaedic Society of North America	Paper #7, 17; Poster #5; Spine Subspecialty Day #115; Program Committee
Starr, Adam J.	1 Starrframe, LLC; 2 Smith & Nephew; 8 Journal of Orthopaedic Trauma	e-Poster #67
Stavrakis, Alexandra	n-none	e-Poster #21
Stech, Teri	n-none	Staff
Steinman, Suzanne E.	n-none	Reviewer
Stephens, Byron F.	n-none	e-Poster #46
Stillwagon, Matthew	n-none	Paper #10
Stirton, Jacob	n-none	Paper #60
Stout, Jean L.	9 American Academy for Cerebral Palsy and Developmental Medicine; Commission for Motion Laboratory Accreditation; Gait and Clinical Movement Analysis Society	e-Posters #50, 95
Strupp, Kim M.	n-none	e-Poster #15; Hip Subpecialty Day #81
Study Group, Children's Spine	5 DePuy, A Johnson & Johnson Company	e-Posters #11, 106; Poster #19; Spine Subspecialty Day #110
Study Group, Growing Spine	5 Growing Spine Foundation	e-Posters #11, 40, 57, 60, 64, 101; Paper #51; Poster #19; Spine Subspecialty Day #111

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Name	Disclosure	Presentation Type
Study Group, Harms	5 DePuy, A Johnson & Johnson Company; OREF; SRS	e-Posters #61, 106; Poster #20
Study Group, Minimize Implants Maximize Outcomes	n-none	Paper #8
Study Group, Pediatric Cervical Spine	n-none	Paper #140
Study Group, R-IHDI	4 Institute for Better Bone Health LLC.; 5 Johnson & Johnson; 7 Biomet; Halo Innovations Inc.; 8 Journal of Pediatric Orthopaedics; 9 Canadian Pediatric Orthopaedic Group; Journal of Orthopaedics	Papers #33, 38
Sturm, Peter F.	3B DePuy, A Johnson & Johnson Company,Ortho Pediatrics; 4 Pioneer Surgical; 5 DePuy, A Johnson & Johnson Company; 8 Journal of Children's Orthopaedics; 9 Scoliosis Research Society,POSNA	e-Posters #11, 24, 28, 29
Stutz, Christopher M.	n-none	e-Poster #42
Su, Alvin W.	n-none	Paper # 7, 15
Sucato, Daniel J.	6 Medtronic Sofamor Danek; 7 Saunders/ Mosby-Elsevier; 9 AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Posters #23, 43, 94; Paper #27, 48; Posters #1, 4; Hip Subspecialty Day #80, 84, 87
Suhr, Maureen	n-none	Hip Subspecialty Day #82
Sullivan, Mark P.	n-none	e-Posters #11, 100
Sutton, Fran	n-none	Paper #65
Swaroop, Vineeta T.	7 Up to Date online publication; 9 Pediatric Orthopaedic Society of North America; Submitted on: 09/17/2014	e-Posters #6, 48
Sweeney, Pat	n-none	Paper #144
Switaj, Paul	n-none	Paper #144
Talwalkar, Vishwas R.	n-none	e-Posters #52, 97, 98; Paper 60, 156; Hand/Upper Extremity Subspecialty Day #94; Reviewer
Tam, Elisa MS	n-none	e-Poster #4; Paper #42; Poster #17
Tamai, Junichi	7 Oakstone	Hip Subspecialty Day #88
Tang, Sheng P.	n-none	e-Poster #4
Tanner, Stephanie L.	n-none	Paper #148
Tareen, Naureen G.	n-none	Paper #66
Tate, Victoria V.	n-none	Poster #8

Name	Disclosure	Presentation Type
Terhune, Elizabeth B.	n-none	e-Poster #73
Teurlings, Tyler L.	n-none	e-Poster #33
Thein, Ran	n-none	Poster #15
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	e-Posters #57, 101, 105; Paper #51; Poster #19; Spine Subspecialty Day #111
Thomson, Jeffrey D.	8 Journal of Bone and Joint Surgery - American; 9 Pediatric Orthopaedic Society of North America	Neuromuscular/Lower Extremity Subspecialty Day #103
Thornhill, Beverly	n-none	e-Poster #13
Thoveson, Alec	n-none	Paper #73
Tiderius, Carl J.	n-none	Paper #25, 32
Ting, Beverlie L.	n-none	e-Poster #69
Tis, John	8 Wolters Kluwer Health; 9 Pediatric Orthopaedic Society of North America; Scoliosis Research Society	e-Poster #111
Todd, Dane	n-none	e-Poster #110
Tompkins, Bryan J.	9 Pediatric Orthopaedic Society of North America	e-Poster #12; Paper #147, 152
Tong, Suhong	n-none	e-Poster #106
Toth, Ferenc	n-none	Poster #14; Sports Medicine Subspecialty Day #120
Tran, Dong-Phuong	n-none	e-Posters #23, 94; Paper #48; Spine Subspecialty Day #116
Trasolini, Nicholas A.	n-none	e-Poster #76
Trehan, Samir	n-none	e-Poster #17
Troy, Michael J.	n-none	Paper #19
Trupia, Evan P.	n-none	e-Posters #11, 100
Tsang, Echo	n-none	Poster #17
Tulchin-Francis, Kirsten	9 Gait and Clinical Movement Analysis Society	e-Poster #96; Hip Subspecialty Day #80

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Name	Disclosure	Presentation Type
Upasani, Vidyadhar V.	2 OrthoPediatrics; 3B OrthoPediatrics	e-Poster #82; Paper #133, 135; Spine Subspecialty Day #111
Uppstrom, Tyler J.	n-none	e-Posters #17, 90; Spine Subspecialty Day #111
Valencia, Maria	n-none	Paper #139
Van Bosse, Harold J P	n-none	Paper #146
Van Straaten, Meegan	n-none	e-Poster #1
VandenBerg, Curtis D.	n-none	Paper #67
Vanderhave, Kelly L.	n-none	e-Poster #87; Paper #24
Varghese, Ranjit A.	n-none	e-Posters #50, 71, 95
Venkatesan, Arun	n-none	e-Poster #93
Vessey, Judith A.	4 Johnson & Johnson; Pfizer; Wyeth	Neuromuscular/Lower Extremity Subspecialty Day #100
Vigneswaran, Hari	n-none	e-Poster #9
Virostek, Donald D.	9 American Board for Certification in Orthotics, Prosthetics, and Pedorthics inc.	Paper #41, 72, 154
Vitale, Michael G.	1 Biomet; 3B Biomet; Stryker; Medtronic Sofamor Danek; 5 Biomet; Childrens Spine Foundation; OREF; SRS, POSNA, OSRF; 6 Biomet; DePuy, A Johnson & Johnson Company; FOX, Children's Spine Foundation; Medtronic; OMEGA; Synthes; 9 Childrens Spine Foundation; IPOS; Pediatric Orthopaedic Society of North America	e-Posters #11, 54, 100; Paper #19, 49
Vuillermin, Carley	n-none	Hand/Upper Extremity Subspecialty Day #98
Wagner, Eric R.	n-none	Paper #17
Walker, Janet	n-none	e-Posters #52, 98; Paper #60, 156; Hand/Upper Extremity Subspecialty Day #94
Wallace, Juanita J.	n-none	e-Poster #52
Wang, Dan	n-none	e-Poster #72; Paper #71
Wang, Xiaobin	n-none	Poster #4
Wang, Luning	n-none	Poster #14; Sports Medicine Subspecialty Day #120
Ward, Maeve	n-none	Paper #44
Ward, W. Timothy	n-none	Paper #44

Name	Disclosure	Presentation Type
Warner, William C.	3C Medtronic Sofamor Danek; Medtronic Sofamor Danek; 7 Saunders/Mosby-Elsevier; Saunders/Mosby-Elsevier; 9 Clinical Orthopaedic Society	e-Poster #46
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 #69; Paper #11, 138; Sports Medicine Subspecialty Day #126
Watkins, Summer	n-none	e-Poster #81; Paper #36
Wattenbarger, J. Michael	2 K2M; 9 POSNA; SRS	Presider; Reviewer
Weinberg, Douglas S.	n-none	Poster #10
Weiner, Dennis S.	n-none	e-Poster #75
Weinstock, Peter	n-none	Paper #69
Weiss, Jennifer M.	9 POSNA; Research for Osteochondritis Dissecans of the Knee	Moderator; Reviewer
Welborn, Michelle C.	n-none	e-Poster #59; Spine Subspecialty Day #110
Wells, Joel E.	n-none	Paper #37
Wells, Lawrence	9 Philadelphia Orthopaedic Society	e-Poster #107; Sports Medicine Subspecialty Day #124
Wenger, Daniel	2 Smith & Nephew	Paper #34
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	e-Poster #82; Paper #1; Moderator
Westberry, David E.	n-none	Paper #148
Wheeler, Lesley	n-none	Paper #41, 72; Hand/Upper Extremity Subspecialty Day #98
White, Gregory R.	2 Transgenomic	Paper #68
White, Hank	n-none	e-Poster #52

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Name	Disclosure	Presentation Type
White, Klane W.	2 Shire HGT; Biomarin Pharmaceuticals; Genzyme; 5 Biomarin Pharmaceuticals; 7 UptoDate; 8 Journal of Pediatric Orthopaedics; JAAOS	Presider; Reviewer
Whitesell, Rebecca	n-none	Paper #141
Widmann, Roger F.	8 Springer: Journal of Children's Orthopaedics Editorial Board; 9 Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America: Development Committee	e-Posters #17, 70; Paper #61; Poster #15; Reviewer
Wiemann, John M.	3B Biomet	Paper #21
Wilhite, Jonathan H.	n-none	Paper #21
Williams, Brendan A.	n-none	e-Poster #33
Williams, Justin	n-none	e-Poster #112
Williams, Nicole	2 Biomarin	Paper #38
Willimon, Samuel C.	3B Smith & Nephew Endoscopy	Paper #56, 141
Willits, Rebecca K.	4 GE Healthcare; Norvartis	e-Posters #75
Wilson, Philip L.	7 Elsevier	Paper #132
Wimberly, Robert L.	n-none	e-Posters #33, 60; Paper #130, 132, 136, 137
Witte, Zackery W.	n-none	e-Poster #97
Wren, Tishya	4 Arthrocare; 8 Gait and Posture; 9 Gait and Clinical Movement Analysis Society	Neuromuscular/Lower Extremity Subspecialty Day #103; Sports Medicine Subspecialty Day #129
Wu, Lezhou	n-none	e-Poster #89
Wylie, Erin	n-none	e-Poster #86
Xerogeanes, John W.	1 Arthrex, Inc; Linvatec; 3B Linvatec,Arthrex	e-Poster #110
Xie, Katherine K.	n-none	e-Poster #80; Sports Medicine Subspecialty Day #128
Yahya, Ayesha	n-none	Hip Subspecialty Day #88
Yamaguchi, Ryosuke	n-none	Paper #75
Yang, Mary	n-none	Paper #130
Yasmeh, Pauline	n-none	Neuromuscular/Lower Extremity Subspecialty Day #103

Name	Disclosure	Presentation Type
Yaszay, Burt	1 Orthopediatrics, K2M; 2 DePuy, A Johnson & Johnson Company; K2M; 3B DePuy, A Johnson & Johnson Company; K2M; Nuvasive; 5 DePuy, A Johnson & Johnson Company; Harms Study Group; 8 Spine Deformity; 9 Scoliosis Research Society; POSNA; AAOS	e-Posters #26, 63; Paper #1, 43, 45, 133, 135; Poster #12; Neuromuscular/Lower Extremity Subspecialty Day #106; Spine Subspecialty Day #114, 118
Yaszemski, Michael J.	3B Medtronic; 8 Journal of Biomedical Materials Research-J. Wiley, Inc.; 9 AAOS; Society of Military Orthopaedic Surgeons	Paper #46
Yazici, Muharrem	2 DePuy, A Johnson & Johnson Company; 3B None; 8 Spine Deformity, Journal of Children's Orthopaedics	e-Posters #29, 64; Paper #50; Spine Subspecialty Day #112
Yen, Yi-Meng	3A Agios Pharmaceuticals; 3B Smith & Nephew; Orthopediatrics; Arthrex, Inc; 4 Agios Pharmaceuticals	e-Posters #37, 108; Paper #55
Yeo, Andrea	n-none	Neuromuscular/Lower Extremity Subspecialty Day #108
Yeung, Kar-Hing	n-none	e-Poster #4
Yildirim, Tugrul	n-none	Paper #79
Yoganandan, Narayan	n-none	Spine Subspecialty Day #119
Yoo, Won Joon	8 Clinics in Orthopedic Surgery	Paper #153
Yorgova, Petya	n-none	Spine Subspecialty Day #113
Youlo, Sylvester	n-none	Neuromuscular/Lower Extremity Subspecialty Day #107
Young, Ernest	n-none	e-Poster #79
Young, Megan	n-none	e-Poster #65
Yu, Fiona	n-none	Paper #42
Yu, Jonathon	n-none	Hip Subspecialty Day #85
Yuh, Roger T.	n-none	e-Poster #80
Zalone, Sarah	n-none	e-Poster #97
Zaltz, Ira	3B Pivot Medical; 5 DePuy, A Johnson & Johnson Company	eModerator

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Name	Disclosure	Presentation Type
Zaslow, Tracy	n-none	Sports Medicine Subspecialty Day #129
Zeller, Reinhard	1 Spinevision; 3C Paradigm Spine; 8 Journal of Children's Orthopaedics; Maitrise Orthopedique,Spine Deformity; European Spine Journal; Journal of Pediatric Orthopedics; Spine Deformity; 9 Scoliosis Research Society Historical committee; Scoliosis Research Society	e-Poster #55
Zhang, Hong	n-none	Poster #4
Zhou, Hanbing	n-none	Hip Subspecialty Day #86
Zhu, Xiaomao	n-none	e-Poster #7
Zlotolow, Dan A.	1 Arthrex, Inc; 3B Arthrex, Inc; Osteomed; 5 Arthrex, Inc; 6 Arthrex, Inc; 7 Saunders/Mosby-Elsevier; 9 American Society for Surgery of the Hand	Hand/Upper Extremity Subspecialty Day #92, 96, 97
Zurakowski, David	n-none	Neuromuscular/Lower Extremity Subspecialty Day #100

2015 SCIENTIFIC PROGRAM

WEDNESDAY, APRIL 29, 2015

1:30 PM – 1:39 PM **Introduction and Opening Remarks**

QUALITY, SAFETY, VALUE

Moderator: *James O. Sanders, MD*
eModerator: *John (Jack) M. Flynn, MD*
Presider: *Emily Dodwell, MD*

1:40 PM – 1:44 PM
1 *(page 119)*
Adopting the EMR: Effect on Efficiency, Completeness, Accuracy, Teaching, and Surgeon Satisfaction in an Academic Pediatric Orthopedic Practice
*Steven M. Hollenbeck, MD; James David Bomar, MPH; **Dennis R. Wenger, MD**; Burt Yaszay, MD*
Rady Children's Hospital, San Diego, CA

1:45 PM – 1:49 PM
2 *(page 120)*
Pediatric Orthopaedic Emergency Room Transfers: Are They Warranted?
*Xuyang Song, MS; Rory Carroll, BS; **Joshua M. Abzug, MD***
University of Maryland Department of Orthopaedics, Baltimore, MD

1:50 PM – 1:54 PM
3 *(page 121)*
What is the Role of Faculty in Training Residents?
*Oleg Safir, MD; Markku Nousiainen, MD; Peter Ferguson, MD; William Kraemer, MD; **Benjamin A. Alman, MD, FRCSC***
Duke University, Durham NC

1:55 PM – 2:03 PM Discussion

2:04 PM – 2:08 PM
4 *(page 122)*
Characteristics of Medical Professional Liability Claims in Pediatric Orthopedics
***Mohan V. Belthur, MD**; Steven Irby; Carla Boan, MSc; Lee S. Segal, MD; M. Wade Shrader, MD*
Phoenix Children's Hospital, Phoenix, AZ

♦ 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 9.

See pages 21- 66 for financial disclosure information.

†LOE - Level of Evidence - Please see page 20 for details.

2:09 PM – 2:13 PM
5 *(page 123)*

Which Common Pediatric Orthopaedic Procedures are the Most Dangerous?

Bryce A. Basques, BS; Daniel D. Bohl, MPH; Nicholas S. Golinvaux, BA; ***Brian G. Smith, MD****; Jonathan N. Grauer, MD*

Yale University School of Medicine, New Haven, CT

2:14 PM – 2:18 PM
6 *(page 125)*

Early Career Experience of Pediatric Orthopaedic Fellows: What to Expect and Need for Their Services

Michael P. Glotzbecker, MD*; Benjamin J. Shore, MD, MPH, FRCSC; Nicholas D. Fletcher, MD; A. Noelle Larson, MD; Christopher R. Hydorn MD; Jeffrey R. Sawyer, MD*

Boston Children's Hospital, Boston, MA

2:19 PM – 2:27 PM Discussion

2:28 PM – 2:32 PM
7 *(page 126)*

How Does Patient Radiation Exposure Compare with Low Dose O-Arm vs. Fluoroscopy for Pedicle Screw Placement in Idiopathic Scoliosis?

Alvin W. Su, MD, PhD*; Amy L. McIntosh, MD; Anthony A. Stans, MD; A. Noelle Larson, MD*

Mayo Clinic, Rochester, MN;
Texas Scottish Rite Hospital for Children, Dallas, TX

2:33 PM – 2:37 PM
8 *(page 128)*

Which Malpositioned Pedicle Screws Should Be Revised?

A. Noelle Larson, MD*; Charles Hopkins Crawford III, MD; Charles Gerald T. Ledonio, MD; Leah Yacat Carreon, MD; Minimize Implants Maximize Outcomes Study Group*

University of Minnesota, Minneapolis, MN;
Mayo Clinic, Rochester, MN

2:38 PM – 2:42 PM
9 *(page 130)*

Improving Quality and Safety in Pediatric Spine Surgery: The Team Approach

Firoz Miyanji, MD, FRCSC*; John Choi, BSc; Janice Mok, BSc; Michael Nitikman, BHK; Sameer Desai, BSc*

British Columbia Children's Hospital, Vancouver, BC, CANADA

2:43 PM – 2:51 PM Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

2:52 PM – 2:56 PM
10 *(page 132)*

ABOS Questionnaire as a Framework for QSV Evaluation in Pediatric Supracondylar Humerus Fracture Care
Christopher A. Iobst, MD; *Matthew Stillwagon, BS; Eric D. Shirley, MD; Steven L. Frick, MD*
Nemours Children's Hospital, Orlando, FL

2:57 PM – 3:01 PM
11 *(page 134)*

Implementation of a Standardized Clinical Assessment and Management Plan (SCAMP) for Pediatric Distal Radius Fractures: Effect on Quality and Care
Donald S. Bae, MD; *Rachel L. DiFazio, MS, RN, cPNP; Marie Harris, MPH; Dionne Graham PhD; Rose Hamershock, MA; Susan T. Mahan, MD, MPH; Peter M. Waters, MD*
Boston Children's Hospital, Boston, MA, Institute for Relevant Clinical Data Analytics, Boston, MA

3:02 PM – 3:06 PM
12 *(page 136)*

Does the Use of Midlevel Providers in the Closed Treatment of Pediatric Both Bone Forearm Fractures Increase Malunion Risk?
Stephanie Pinkstock, PA-C; Emily A. Eismann, MS; ***Roger Cornwall, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

3:07 PM – 3:15 PM Discussion

3:16 PM – 3:20 PM
13 *(page 137)*

Are We Giving Our Patients Too Much Pain Medication After Surgery?
Daniel R. Grant, MD; *Scott J. Schoenleber, MD; Alicia McCarthy, CPNP-AC; Kenneth J. Rogers, PhD; Petya Yorgova, MS; Geraldine Neiss, PhD; Peter G. Gabos, MD; Suken A. Shah, MD*
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

3:21 PM – 3:25 PM
14 *(page 139)*

Volume, Charges, and Costs of Operative vs. Non-Operative Management of Diaphyseal Clavicle Fracture in Adolescents at Thirty-Four U.S. Children's Hospitals
Donald S. Bae, MD; Lanna Feldman, MS; ***Benton E. Heyworth, MD***
Boston Children's Hospital, Boston, MA

3:26 PM – 3:30 PM
15 *(page 140)*

Magnetically Controlled Growing Rod Achieves Estimated Cost Savings Compared to Traditional Growth Rods Over Five Years
Alvin W. Su, MD, PhD; *Todd A. Milbrandt, MD, MS; A. Noelle Larson, MD*
Mayo Clinic, Rochester, MN

3:31 PM – 3:39 PM Discussion

3:40 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 9.

INFECTIONS/TUMORS

Moderator: *Andrew W. Howard, MD*
eModerator: *Jonathan G. Schoenecker, MD*
Presider: *Antoinette W. Lindberg, MD*

4:01 PM – 4:05 PM
16 *(page 142)*

Recurrence After Radiofrequency Ablation Treatment of Osteoid Osteomas Over a Decade in a Pediatric Hospital: Rates and Associated Factors
Matthew J. Sabatino, MD; Manahil N. Naqvi, BS; Mamun Al-Rashid, MD; Horacio Padua Jr., MD; Mark C. Gebhardt, MD; ***Megan E. Anderson, MD***
Boston Children's Hospital, Boston, MA

4:06 PM – 4:10 PM
17 *(page 143)*

Long-Term Outcome Following Lower Limb Salvage with Massive Bone Allograft and Intramedullary Free Fibula (Capanna Technique) in Pediatric and Adolescent Patients
Matthew T. Houdek, MD; Eric R. Wagner, MD; ***Anthony A. Stans, MD****; Franklin H. Sim, MD; Steven L. Moran, MD*
Mayo Clinic, Rochester, MN

4:11 PM – 4:15 PM
18 *(page 145)*

Incidence of Intraspinal Exostoses in Multiple Hereditary Exostoses
Allison C. Scott, MD*; Richard E. Haigler, MD*
Shriners Hospital for Children, Houston, TX

4:16 PM – 4:24 PM

Discussion

4:25 PM – 4:29 PM
19 *(page 146)*

Can You Retain Spinal Hardware in Acute Postoperative Infections? A Multicenter Study
Michael P. Glotzbecker, MD*; Jaime A. Gomez, MD; Patricia Miller, MS; Michael J. Troy, BS; David L. Skaggs, MD, MMM; Michael G. Vitale, MD, MPH; John (Jack) M. Flynn, MD; Kody K. Barrett, BA; Gregory I. Pace, BA; Daniel J. Hedequist, MD*
Boston Children's Hospital, Boston, MA

4:30 PM – 4:34 PM
20 *(page 147)*

Cumulative Radiation Exposure with EOS® Imaging Compared to Standard Spine Radiographs
T. David Luo, BS; ***Anthony A. Stans, MD****; Beth A. Schueler, PhD; A. Noelle Larson, MD*
Mayo Clinic, Department of Orthopaedics, Rochester, MN

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

4:35 PM – 4:39 PM **Spinal Infections in AIS and Neuromuscular Scoliosis: Are MRSA Nares' Cultures Predictors of Trouble To Come?**
21 *(page 149)*

Jose A. Herrera-Soto, MD*; John M. Wiemann, MD; Jonathan H. Wilhite, MD; Jonathan H. Phillips, MD; Dennis Raymond Knapp, Jr., MD; Brandon A. Ramo, MD*

Arnold Palmer Hospital for Children, Orlando, FL

4:40 PM – 4:48 PM Discussion

4:49 PM – 4:53 PM **Predictive Factors for Differentiating Between Septic Arthritis and Lyme Disease of the Knee**
22 *(page 150)*

Afamefuna M. Nduaguba, BS; ***Keith D. Baldwin, MD, MSPT, MPH****; Wudbhav N. Sankar, MD*

Children's Hospital of Philadelphia, Philadelphia, PA

4:54 PM – 4:58 PM **The Use of C-Reactive Protein as a Guide to Transition to Oral Antibiotics in the Management of Pediatric Osteoarticular Infections**
23 *(page 152)*

Andrew C. Chou, BS; ***Arjandas S. Mahadev, MBBS, FAMS, FRCS***

KK Women's and Children's Hospital, SINGAPORE

4:59 PM – 5:03 PM **Prevalence and Complications of Musculoskeletal Infections in Adolescents: A Result of Delay in Diagnosis?**
24 *(page 153)*

Sarah N. Pierrie, MD; ***Brian P. Scannell, MD****; Brian K. Brighton, MD; Kelly L. Vanderhave, MD*

Carolinas Healthcare System and Levine Children's Hospital, Charlotte, NC

5:04 PM – 5:12 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 9.

THURSDAY, APRIL 30, 2015

8:00 AM – 8:04 AM **Welcome and Remarks**

HIP

Moderator: *Charles T. Price, MD*
eModerator: *Ira Zaltz, MD*
Presider: *Tim Schrader, MD*

8:05 AM – 8:09 AM
25 *(page 154)*
Remodeling and Longitudinal Growth of the Hip After Unthreaded Fixation of Slipped Capital Femoral Epiphysis
Jakob Ortegren, MD; *Carl Johan Tiderius, MD, PhD*
Skane University Hospital, Lund, SWEDEN

8:10 AM – 8:14 AM
26 *(page 155)*
Slip Progression After In-Situ Screw Fixation of Slipped Capital Femoral Epiphysis
Rachel Y. Goldstein, MD, MPH; *Stephanie Chu, BA; Erin Dawicki, PA-C; Herman Luther; Lindsay Andras, MD; Michael B. Millis, MD*
Children's Hospital Los Angeles, Los Angeles, CA

8:15 AM – 8:19 AM
27 *(page 156)*
Long-Term Health Status After In-Situ Fixation for Slipped Capital Femoral Epiphysis
Benjamin Escott, MBBS, MSc; *Adriana De La Rocha, MSc; Chan-Hee Jo, PhD; Daniel J. Sucato, MD, MSc; Lori A. Karol, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

8:20 AM – 8:28 AM Discussion

8:29 AM – 8:33 AM
28 *(page 157)*
The Modified Dunn Procedure vs. In-Situ Pinning for Treatment of Severe Stable Slipped Capital Femoral Epiphysis
Eduardo N. Novais, MD; *Travis C. Heare, MD; Mary K. Hill, BA; Patrick M. Carry; Ernest L. Sink, MD*
Children's Hospital Colorado-University of Colorado School of Medicine, Aurora, CO

8:34 AM – 8:38 AM
29 *(page 158)*
The False Profile Radiograph: Is it an Accurate and Precise Method of Assessing Anterior Coverage?
Jeffrey J. Nepple, MD; *James Ross, MD; Asheesh Bedi, MD; Sara Putnam, MD; Stephen T. Duncan, MD; Gail Pashos; Perry L. Schoenecker, MD; John C. Clohisy, MD*
Washington University School of Medicine, St. Louis, MO

8:39 AM – 8:43 AM
30 *(page 159)*

Expectations and Satisfaction of Patients of Outcomes After PAO Surgery

Gloria N. Boye, BA; Patricia Miller, MS; Young Jo Kim, MD, PhD; ***Michael B. Millis, MD***

Boston Children's Hospital, Boston, MA

8:44 AM – 8:52 AM Discussion

8:53 AM – 8:57 AM
31 *(page 160)*

Ilfeld Abduction Orthosis is an Effective Second Line Treatment Following Failure of Pavlik Harness for Infants with DDH

Wudbhav N. Sankar, MD*; Afamefuna M. Nduaguba, BS; John (Jack) M. Flynn, MD*

Children's Hospital of Philadelphia, Philadelphia, PA

8:58 AM – 9:02 AM
32 *(page 161)*

The Risk of Avascular Necrosis Following Early Treatment with the Von Rosen Splint for Neonatal Instability of the Hip

Daniel Wenger, MD*; Hanna Samuelsson; Carl Johan Tiderius, MD, PhD*

Lund University, Lund, SWEDEN

9:03 AM – 9:07 AM
33 *(page 162)*

Success with Pavlik Treatment for Dislocated but Irreducible Hips in Infants Aged <6 Months

Alexander Aarvold, BSc(Hons), MBChB, FRCS (Tr&Orth), MD*; Kishore Mulpuri, MBBS, MS (Ortho), MHSc(Epi); Simon Kelley, MBChB, FRCS (Tr&Orth); Nicholas M.P. Clarke, ChM, FRCS, FRCSEd; Jose A. Herrera Soto, MD; Charles T. Price, MD, FAAP; and R-IHDI Study Group*

BC Children's Hospital, Vancouver, BC, CANADA

9:08 AM – 9:16 AM Discussion

9:17 AM – 9:21 AM
34 *(page 163)*

Avascular Necrosis in Children with Cerebral Palsy After Reconstructive Hip Surgery

Kim Hesketh BKIH, MScPT; ***Lisa Phillips, BSc, MD, FRCSC****; Janice Andrade, BSW; Jennifer Farr; Kishore Mulpuri, MBBS, MS(Ortho), MHSc(Epi)*

BC Children's Hospital, Vancouver, BC, CANADA

9:22 AM – 9:26 AM
35 *(page 164)*

The Birmingham Interlocking Pelvic Osteotomy: Controlled Predictable Correction of Acetabular Dysplasia. 15 to 23 Year Survival

John N. O'Hara, FRCS*; Callum McBryde, MD; Dylan Jewell, MD*

Royal Orthopaedic Hospital, & Childrens' Hospital, Birmingham, UK

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9:27 AM – 9:31 AM **36** *(page 165)*	**Prevention and Treatment of Major Complications of Femoral Neck Osteotomies** ***Prasad Gourineni, MD***; *Summer Watkins, NP, RN, MS* *Advocate Children's Hospital, Oakbrook, IL*
9:32 AM – 9:40 AM	Discussion
9:41 AM – 9:45 AM **37** *(page 166)*	**Long-Term Results Following Bernese Periacetabular Osteotomy, Minimum 15-Year Follow-Up** *Joel E. Wells, MD, MPH; Evgeny Bulat, MA; Young Jo Kim, MD, PhD; Michael B. Millis, MD;* ***Travis H. Matheney, MD, MLA*** *Boston Children's Hospital, Boston, MA*
9:46 AM – 9:50 AM **38** *(page 167)*	**Risk Factors for Late Presenting Developmental Dysplasia of the Hip From A Multi-Centre, Prospective Study Group** *Kishore Mulpuri, MBBS, MS(Ortho) MHSc(Epi); Janice Andrade, BSW; Nicole Williams, BMedSc, FRACS(Ortho); Wudbhav N. Sankar, MD;* ***Travis H. Matheney, MD, MLA****; Pablo Castaneda, MD; Nicholas M.P.Clarke, ChM, FRCS, FRCS.Ed; Charles T. Price, MD, FAAP; R-IHDI Study Group* *BC Children's Hospital, Vancouver, BC, CANADA*
9:51 AM – 9:55 AM **39** *(page 169)*	**Factors Affecting the Outcome of Open Reduction Performed Over the Age of 18 Months for Developmental Dysplasia of the Hip** ***Tom Southorn, MBBS, BSc, FRCS****; Sami Al-Ali; Aresh Hashemi-Nejad, FRCS; Deborah Eastwood, FRCS; Andreas Roposch, MD* *Great Ormond Street Hospital for Children, London, UK*
9:56 AM – 10:04 AM	Discussion
10:05 AM – 10:20 AM	**Distinguished Achievement Award**
10:20 AM – 10:35 AM	Break

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

CONCURRENT SESSION I: SPINE

Moderator: *Laurel C. Blakemore, MD*
eModerator: *Mark A. Erickson, MD*
Presider: *Robert H. Cho, MD*

10:35 AM – 10:39 AM **Welcome and Remarks**

10:40 AM – 10:44 AM **It's Not Just the Big Kids: Both High and Low BMI Impact Bracing Success for AIS**
40 *(page 170)*
Christine M. Goodbody, BA; Ivor B. Asztalos, BS; Wudbhav N. Sankar, MD; ***John (Jack) M. Flynn, MD***
Children's Hospital of Philadelphia, Philadelphia, PA

10:45 AM – 10:49 AM **The Effect of Risser Sign on the Likelihood of Failure with Bracing in Adolescent Idiopathic Scoliosis**
41 *(page 171)*
Lori A. Karol, MD*; Donald D. Virostek, CPO; Kevin Felton, CO; Lesley Wheeler, BS*
Texas Scottish Rite Hospital, Dallas, TX

10:50 AM – 10:54 AM **Does Spinal Cord Morphology Predict Curve Progression in Adolescent Idiopathic Scoliosis Treated by Bracing? A Prospective Cohort Study with Magnetic Resonance Imaging**
42 *(page 172)*
Min Deng; Tsz Ping Lam, MBBS, FRCS; Steve C.N. Hui; Fiona W.P. Yu; Elisa M.S. Tam, PhD; Yong Qiu; ***Bobby Kin Wah Ng, MD;*** *Jack C-Y Cheng, MD; Winnie Chiu-Wing Chu*
The Chinese University of Hong Kong, Hong Kong SAR

10:55 AM – 11:03 AM Discussion

11:04 AM – 11:08 AM **♦ New EOS Imaging Protocol Allows a 50-Fold Reduction in Radiation Exposure for Scoliosis Patients**
43 *(page 173)*
Peter O. Newton, MD*; Fredrick G. Reighard, MPH; Carrie E. Bartley, MA; Yash Khandwala MD; Tracey P. Bastrom, MA; Burt Yaszay, MD*
Rady Children's Hospital, San Diego, CA

11:09 AM – 11:13 AM **SRS-22R Scores in Non-Operatively Treated Adolescent Idiopathic Scoliosis Patients with Curves Greater Than Forty Degrees**
44 *(page 175)*
W. Timothy Ward, MD*; James W. Roach, MD; Tanya Kenkre, PhD; Nicole A. Friel, MD; Gregory Jones; Maeve Ward; Maria Brooks, PhD*
University of Pittsburgh Medical Center, Pittsburgh, PA

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11:14 AM – 11:18 AM **A Three-Dimensional Analysis of Apical Lordosis Correction – The Role of the Ponte Osteotomy**
45 *(page 176)*
Yong Kim; *Tracey P. Bastrom, MA; Carrie E. Bartley, MA; Fredrick G. Reighard, MPH; Burt Yaszay, MD; Peter O. Newton, MD*
Rady Children's Hospital, San Diego, CA

11:19 AM – 11:27 AM Discussion

11:28 AM – 11:32 AM **Minimum 20-Year Outcomes for Treatment of Adolescent Idiopathic Scoliosis: Results From a Novel Cohort of U.S. Patients**
46 *(page 177)*
A. Noelle Larson, MD*; David W. Polly Jr., MD; William J. Shaughnessy, MD; Charles G. T. Ledonio, MD; Michael J. Yaszemski, MD, PhD*
Mayo Clinic, Rochester, MN

11:33 AM – 11:37 AM **Use of Tranexamic Acid (TXA) on Reducing Blood Loss During Scoliosis Surgery in Adolescents**
47 *(page 179)*
Bobby Kin Wah Ng, MD*; Wai Wang Chau; Alec Hung, MBBS; Anna Hui; Linda Fu, MBBS; Tsz-Ping Lam, MBBS, FRCS; Jack C-Y Cheng, MD*
The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong SAR

11:38 AM – 11:42 AM **Is MRI Necessary for Adolescent Idiopathic Scoliosis When Patients Present with Curves Over 80 Degrees?**
48 *(page 180)*
Daniel J. Sucato, MD, MS*; Dong-Phuong Tran, MS; Anna McClung, RN*
Texas Scottish Rite Hospital for Children, Dallas, TX

11:43 AM – 11:51 AM Discussion

11:52 AM – 11:56 AM **Patients Without Intraoperative Neuromonitoring (IONM) Alerts During VEPTR Implantation Did Not Sustain Neurologic Injury During Subsequent Routine Expansions: A Retrospective Multi-Center Cohort Study**
49 *(page 181)*
Jaren LaGreca, BA; Tara Flynn, BA; Patrick John Cahill, MD; Amer Samdani, MD; Michael G. Vitale, MD, MPH; Ron El-Hawary, MD, MSc, FRCS(C); John T. Smith, MD; Jonathan H. Phillips, MD; John (Jack) M. Flynn, MD; Michael P. Glotzbecker, MD; ***Sumeet Garg, MD***
Children's Hospital Colorado, Aurora, CO

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11:57 AM – 12:01 PM
50 *(page 182)*

Re-Operation After Magnetically Controlled Growing Rod Implantation: A Review of 26 Patients with Minimum Two-Year Follow-Up
Kenneth M.C. Cheung, MD; Kenny Kwan, FRCS; John Alexander Ferguson, FRACS; Colin Nnadi, MBBS, FRCS; Ahmet Alanay, MD; Muharrem Yazici, MD; Gokhan Halil Demirkiran, MD; Ilkka Helenius, MD; ***Behrooz A. Akbarnia, MD***
Queen Mary Hospital, The University of Hong Kong, Hong Kong SAR

12:02 PM – 12:06 PM
51 *(page 183)*

♦ Can a "No Final Fusion" Produce Equal Results to Final Fusion After Growing Rod Treatment?
Amit Jain, MD; ***Paul D. Sponseller, MD****; Urvij M. Modhia, MBBS, MD; Suken A. Shah, MD; George H. Thompson, MD; Jeff Pawelek; Behrooz A. Akbarnia, MD; Growing Spine Study Group*
Johns Hopkins Bloomberg Children's Center, Baltimore, MD

12:07 PM – 12:15 PM Discussion

CONCURRENT SESSION II: LOWER EXTREMITY/SPORTS

Room: Imperial B

Moderator: *Jennifer M. Weiss, MD*
eModerator: *Theodore J. Ganley, MD*
Presider: *Kerwyn C. Jones, MD*

10:35 AM – 10:39 AM **Welcome and Remarks**

10:40 AM – 10:44 AM
52 *(page 184)*

Risk Factors for ACL Reconstruction Failure in Pediatric and Adolescent Patients: A Review of 913 Cases
Brian P. Ho, BA; Eric W. Edmonds, MD; Henry (Hank) G. Chambers, MD; Tracey Bastrom, MA; ***Andrew T. Pennock, MD***
Rady Children's Hospital, San Diego, CA

10:45 AM – 10:49 AM
53 *(page 185)*

Long-Term Follow-Up of Pediatric ACL Reconstruction in New York State: High Rates of Subsequent ACL Reconstruction
Emily R. Dodwell, MD*; Moira M. McCarthy, MD; Ting-Jung Pan, MPH; Daniel W. Green, MD; Stephen L. Lyman, PhD*
Hospital for Special Surgery, New York, NY

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10:50 AM – 10:54 AM **All-Inside, All-Epiphyseal ACL Reconstruction in Skeletally Immature Athletes: Return to Play, Incidence of Second Surgery and Two-Year Clinical Outcomes**
54 *(page 186)*
Daniel W. Green, MD*; Stephanie W. Mayer, MD; Jessica M. Graziano, DPT, PT; Polly De Mille, RN; Theresa Chiaia DPT; Moira M. McCarthy, MD; Danyal Nawabi, MD, FRCS; Frank A. Cordasco, MD*
Hospital for Special Surgery, New York, NY

10:55 AM – 11:03 AM Discussion

11:04 AM – 11:08 AM **Outcomes Following Operative Treatment of Bucket Handle Meniscus Tears in Children and Adolescents**
55 *(page 188)*
Dennis E. Kramer, MD*; Daniel J. Martin, BS; Mininder S. Kocher, MD, MPH; Leslie A. Kalish, ScD; Yi-Meng Yen, MD, PhD; Lyle J. Micheli, MD; Benton E. Heyworth, MD*
Boston Children's Hospital, Boston, MA

11:09 AM – 11:13 AM **The Critical Age for Arthroscopy in Juvenile OCD of the Knee: Is Arthroscopy Necessary at the Time of Drilling?**
56 *(page 190)*
Evan M. Siegall, MD; John R. Faust, MD; Mackenzie M. Herzog, MPH; Samuel C. Willimon, MD; ***Michael T. Busch, MD***
Children's Healthcare of Atlanta/Children's Orthopaedics of Atlanta, Atlanta, GA

11:14 AM – 11:18 AM **Revisions Meniscus Surgery in Children and Adolescents: The Effect of Skeletal Immaturity**
57 *(page 191)*
Alvin K. Shieh, MS; ***Eric W. Edmonds, MD****; Andrew T. Pennock, MD*
Rady Children's Hospital, San Diego, CA

11:19 AM – 11:27 AM Discussion

11:28 AM – 11:32 AM **Functional Assessment in Tibial Hemimelia (Can We Also Save the Foot in Reconstruction?)**
58 *(page 192)*
Gholam Hossain Shahcheraghi, MD, FRCSC; ***Mahzad Javid, MD***
Namazee Hospital, Shiraz, Fars, IRAN

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11:33 AM – 11:37 AM **Extra-Articular Drilling for Adolescents with Osteochondritis**
59 *(page 193)* **Dissecans of the Talus: A Lost Cause or a Call to Develop Better Treatment?**

Lee G. Phillips, MD*; Joanna H. Roocroft, MA; Tracey P. Bastrom, MA; Andrew T. Pennock, MD; Henry (Hank) G. Chambers, MD; Eric W. Edmonds, MD*

Rady Children's Hospital, San Diego, CA

11:38 AM – 11:42 AM **Patient-Reported Outcomes for Syme vs. Boyd Amputation**
60 *(page 194)* **in Congenital Fibular Deficiency**

Jacob B. Stirton, MD; Daniel Kim, BS; Janet Walker, MD; Henry J. Iwinski, MD; Vishwas R. Talwalkar, MD; ***Ryan D. Muchow, MD***

Lexington Shriners Hospital for Children, Lexington, KY

11:43 AM – 11:51 AM Discussion

11:52 AM – 11:56 AM **Percutaneous Transphyseal Screw Epiphysiodesis:**
61 *(page 195)* **Efficacy and Complications**

Emily Dodwell, MD, MPH*; Elise Bixby, BA; Kristina Astone, MPH; Roger F. Widmann, MD*

Hospital for Special Surgery, New York, NY

11:57 AM – 12:01 PM **Weight Loss Programs Fail in Obese Children with SCFE and**
62 *(page 196)* **Blount's Disease**

Gregory Ian Pace; ***William L. Hennrikus Jr., MD***

Pennsylvania State University College of Medicine, Hershey, PA

12:02 PM – 12:06 PM **Mid and Long-Term Outcomes of Patients Undergoing Femoral**
63 *(page 197)* **Lengthening Using the Ilizarov Technique**

Janay McKie, MD*; David A. Podeszwa, MD; Augusta Lloyd, MS; Anthony M. Anderson, MS; John G. Birch, MD*

Texas Scottish Rite Hospital, Dallas, TX

12:07 PM – 12:15 PM Discussion

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POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY
OF NORTH AMERICA

LUNCHTIME BREAKOUT SESSION

COUR SYMPOSIUM

Thurs., April 30, 2015 • 12:30 PM–3:00 PM • International 5-6

Chair: *Coleen S. Sabatini, MD, MPH*

BUILDING CAPACITY THROUGH EDUCATION IN RESOURCE-LIMITED AREAS

12:30 PM – 12:35 PM	**Welcome** *Kit M. Song, MD* *Coleen S. Sabatini, MD, MPH*
12:35 PM – 12:50 PM	**Context** *David A. Spiegel, MD*
12:50 PM – 1:05 PM	**Developing a Sustainable Outreach and Education Program** *Kaye E. Wilkins, MD*
1:05 PM – 1:20 PM	**Preparing Oneself as an Educator** *Andrew W. Howard, MD*
1:20 PM – 1:35 PM	**Using Technology to Provide Educational Resources Globally** *Lynn T. Staheli, MD*
1:35 PM – 2:10 PM	**Panel Discussion** *Speakers and COUR Scholars*
2:10 PM – 3:00 PM	**COUR Scholar Presentations**

NOTE: *Boxed lunches will be provided only to those registered for the lunchtime breakout sessions*

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POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

LUNCHTIME BREAKOUT SESSION

RESEARCH SYMPOSIUM

Thurs., April 30, 2015 • 12:30 PM–2:00 PM • International 1-3

Co-Chairs: *Firoz Miyanji, MD*
Ron El-Hawary, MD
Stefan Parent, MD
Jay Janicki, MD

12:30 PM – 12:32 PM **Introduction**
Firoz Miyanji, MD

PERIOD 1

STUDY DESIGN – IT ALL DEPENDS ON THE QUESTION
Moderators: *Firoz Miyanji, MD*
Frances A. Farley, MD

12:32 PM – 12:39 PM **The Randomized Control Trial – Is it Feasible, Practical, and in the End How Useful is it Really**
James O. Sanders, MD

12:40 PM – 12:47 PM **Study Groups – The Evolutionary or Revolutionary Fad: What You Can and What You Cannot Learn from Prospective Databases**
Peter O. Newton, MD

12:49 PM – 12:56 PM **Bench to Bedside – Knowledge Translational Research in 2015**
Harry H.W. Kim, MD

12:56 PM – 1:00 PM Discussion

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PERIOD 2 — POSNA SUPPORTED RESEARCH HIGHLIGHTS

Moderators: *Ron El-Hawary, MD, MSc, FRCSC*
Firoz Miyanji, MD

1:02 PM – 1:07 PM
2013 Arthur Huene Memorial Research Award
Evaluation of Outcomes of Hip Interventions for Children with Cerebral Palsy – An International Multi-Centre Prospective Longitudinal Comparative Cohort Study
Unni G. Narayanan, MD

1:08 PM – 1:13 PM
2013 OREF/POSNA Clinical Research Award
Development and Validation of a Pediatric Activity Scale
Mininder S. Kocher, MD

1:14 PM – 1:19 PM
2014 Biomet Spine Research Award
A New Porcine Model for Pediatric Spinal Deformity
Matthew A. Halanski, MD

1:20 PM – 1:25 PM
2013 POSNA Basic Science Research Award
Genome-Wide Approach to Genetic Causes of Congenital Pseudarthrosis of the Tibia (CPT)
Jonathan J. Rios, MD

1:25 PM – 1:30 PM Discussion

1:30 PM – 1:40 PM Break

PERIOD 3 — GRANT DEVELOPMENT STRATEGIES

Moderators: *Ron El-Hawary, MD, MSc, FRCSC*
Jay Janicki, MD

1:41 PM – 1:48 PM
Opportunities After POSNA: What is Out There?
Stefan Parent, MD

1:49 PM – 1:56 PM
How to Navigate NIH
Bryan D. Snyder, MD

1:56 PM – 2:00 PM Discussion

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LUNCHTIME BREAKOUT SESSION

NP/PA SYMPOSIUM

Thurs., April 30, 2015 • 12:30 PM–2:00 PM • International 9-10

Co-Chairs: *Jill Ariagno, MSN, RN, CPNP*
Anne Stuedemann, MSN, RN, CPNP

INNOVATIONS IN PEDIATRIC ORTHOPAEDIC SURGERY

12:30 PM – 12:45 PM	**Presentation I: MAGEC Growing Rods** *Burt Yaszay, MD*
12:45 PM – 1:00 PM	Discussion
1:00 PM – 1:15 PM	**Presentation II: EOS Imaging System** *Nigel J. Price, MD, FAAP, FRCSC*
1:15 PM – 1:30 PM	Discussion
1:30 PM – 1:45 PM	**Presentation III: Advancement of Telemedicine** *Richard M. Schwend, MD, FAAP*
1:45 PM – 2:00 PM	Discussion

NOTE: *Boxed lunches will be provided only to those registered for the lunchtime breakout sessions*

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POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

LUNCHTIME BREAKOUT SESSION

PRACTICE MANAGEMENT SYMPOSIUM

Thurs., April 30, 2015 • 12:30 PM–2:00 PM • International 7-8

Moderator: *Kerwyn C. Jones, MD*

Discussion: *Jeffrey R. Sawyer, MD*
Dennis S. Weiner, MD
William L. Hennrikus Jr., MD
Andrew Gregory, MD

12:30 PM – 12:40 PM **Current Scope of Pediatric Fracture Management in the United States**
Jeffrey R. Sawyer, MD

12:40 PM – 1:40 PM **Point / Counterpoint Panel:**

Model A: Care Provided Only by Pediatric Orthopedic Surgeons
Dennis S. Weiner, MD

Model B: Care Provided by Surgical Practices that Utilize Physician Extenders for Non-Operative Management
William L. Hennrikus Jr., MD

Model C: Care Provided by Surgical Practices that Utilize Primary Care Physician for Non-Operative Management
Andrew Gregory, MD

1:40 PM – 2:00 PM **What Do Our Patients Really Want? "The Patient's Perspective"**
Kerwyn C. Jones, MD

NOTE: *Boxed lunches will be provided only to those registered for the lunchtime breakout sessions*

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POSNA

PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

ICD-10 WORKSHOP

ICD-10 WORKSHOP

Thurs., April 30, 2015 • 2:15 PM–5:15 PM • International 7-8

Margaret M. Maley BSN, MS, KarenZupko & Associates, Inc.;
Jeffrey R. Sawyer, MD

- **Clinical Documentation Improvement (CDI)**
- **Overview of ICD-10 Book**
  - Comparing ICD-9 to ICD-10
- **What About the Chapter on External Causes?**
  - Does it Matter if the Patient was Bit by an Orca or Hit by an Orca?
- **ICD-10 Format and Structure**
  - Other and Other Specified
  - Includes and Excludes Notes
  - X Place Holder
- **Injury, Poisoning and Certain Other Consequences of External Causes**
  - Architecture & Re-Organization of the Injury Chapter
  - The "Injury Guy" Coding Aid to Identify the "Category" of Any Injury
- **Using the 7th Character Extension for Injuries and Fractures**
- **Technology Tips and Demo**
- **Classification of Fractures and Fracture Documentation**
- **Leo C. Far to Master Fracture Documentation**
  - Salter Harris Fractures
  - SCFE
- **Using the Zupko Slim Guide to Orthopaedic ICD-10**
- **Congenital Malformations, Deformations and Chromosomal Abnormalities**
  - Nervous System
  - Musculoskeletal System

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- **Diseases of the Musculoskeletal System**
    - Architecture and Organization of the Musculoskeletal Chapter
    - The “Musculoskeletal Block”
    - Spine
        - Scoliosis
    - Complications
- **REVISED Implementation Guide**
    - Understanding What Technology Can Do For You
    - Knowing What You Should Do Next

POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

YOUNG MEMBERS FORUM

1st ANNUAL ARABELLA LEET YOUNG MEMBERS FORUM

Thurs., April 30, 2015 • 5:00 PM–6:30 PM • International Rooms 1–3

Moderator: *Gregory A. Mencio, MD*

5:00 PM – 5:05 PM	**Welcome**
5:05 PM – 5:25 PM	**Your On-line Presence:** **Projecting Your Best Image On-line, Protecting Your Reputation, Social Media: Use and Abuse** *Bryan J. Tompkins, MD, Spokane, WA*
5:25 PM – 5:45 PM	**Perspectives on Life and Leadership as a Pediatric Orthopaedic Surgeon** **• 12 Points or Steps** **• Becoming and Staying Involved** *Lori A. Karol, MD, Dallas, TX*
5:45 PM – 6:05 PM	**Financial Planning 101** **• Paying Off Loans** **• Saving for College and Retirement** *Michael T. Busch, MD, Atlanta, GA*
6:05 PM – 6:30 PM	Discussion

POSNA extends sincere appreciation to Shriners Hospital for Children for their support of the Arabella Leet Young Members Forum.

♦ 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 9.

FRIDAY, MAY 1, 2015

8:00 AM – 8:04 AM **Welcome and Remarks**

CLINICAL AWARD PAPERS

Moderator: *Dennis R. Wenger, MD*
eModerator: *Todd A. Milbrandt, MD*
Presider: *Matthew J. Bueche, MD*

8:05 AM – 8:09 AM
64 *(page 199)*

Treatment of Congenital Vertical Talus: Comparison of Minimally Invasive vs. Traditional Surgical Technique with Minimum Five-Year Follow-Up
Matthew Dobbs, MD

Washington University School of Medicine, St. Louis, MO

8:10 AM – 8:14 AM Discussion

8:15 AM – 8:19 AM
65 *(page 200)*

The Outcomes of Selective Ultrasound Screening for Developmental Dysplasia of the Hip are No Better Than Clinical Screening Alone: A Cohort Study Using A 40-Year Old Historic Control Group
Fran Sutton, BSc; Shiela Lee;
Rachael Hutchinson, MD, FRCS (Tr&Orth);
Anish P. Sanghrajka, MEd, FRCS (Tr&Orth)

The Norfolk & Norwich University Hospitals,
NHS Foundation Trust, Norwich, Norfolk, UK

8:20 AM – 8:24 AM Discussion

8:25 AM – 8:29 AM
66 *(page 201)*

Intramedullary Nailing of Femur Fractures in Preschool Age Children Does Not Improve Radiographic Outcomes vs. Immediate Spica Casting but Does Increase Intervention
Brandon A. Ramo, MD*; Jeffrey E. Martus, MD, MS;*
Naureen Ghani Tareen, MPH; Benjamin Scott Hooe, BS;
Mark E. Snoddy, MD

Children's Medical Center, Dallas, TX

8:30 AM – 8:34 AM Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

8:35 AM – 8:39 AM
67 *(page 202)*

Antibiotic Compliance Decreases Infection Rate in Pediatric Spine Surgery: A Retrospective Cohort Study
Curtis D. VandenBerg, MD; Cameron R. Niswander, BA; Patrick Carry; Zhaoxing Pan; Mark A. Erickson, MD; ***Sumeet Garg, MD***
Children's Hospital Colorado, Aurora, CO

8:40 AM – 8:44 AM Discussion

8:45 AM – 8:49 AM
68 *(page 203)*

Minimizing Complications in Scoliosis Surgery in Children with Cerebral Palsy
M. Wade Shrader, MD*; Miranda Falk, PA-C; Lee S. Segal, MD; Carla Boan, MSc; Gregory R. White, MD*
Phoenix Children's Hospital, Phoenix, AZ

8:50 AM – 8:54 AM Discussion

8:55 AM – 8:59 AM
69 *(page 205)*

Training Away Pediatric Cast Saw Burns via Simulation: A Novel Simulation Trainer and Curriculum
Jacob W. Brubacher, MD; Jeffrey Karg, MS; Peter Weinstock, MD, PhD; ***Donald S. Bae, MD***
Boston Children's Hospital, Boston, MA

9:00 AM – 9:04 AM Discussion

9:05 AM – 9:09 AM
70 *(page 207)*

Long-Term Clinical Follow-Up of Arthroscopic Treatment of Discoid Lateral Meniscus in Children
Jonathan Haskel, BS; Tyler J. Uppstrom, BA; David M. Dare, MD; Scott A. Rodeo, MD; ***Daniel W. Green, MD***
Hospital for Special Surgery, New York, NY

9:10 AM – 9:14 AM Discussion

9:15 AM – 9:19 AM
71 *(page 208)*

Adolescent Idiopathic Scoliosis Patients Are at Increased Risk for Pulmonary Hypertension Which Reverses After Scoliosis Surgery
Vishal Sarwahi, MD; Aviva G. Dworkin, BS; Dan Wang, MS; Sarika Kalantre, MD; Kathleen Joan Maquire, MD; ***Terry D. Amaral, MD***
Montefiore Medical Center, Bronx, NY

9:20 AM – 9:24 AM Discussion

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9:25 AM – 9:29 AM
72 *(page 209)*
The Effect of Compliance Monitoring on Brace Use and Success in Patients with AIS: A Final Report
Lori A. Karol, MD; *Donald D. Virostek, CPO; Kevin Felton, CO; Lesley Wheeler, BS*
Texas Scottish Rite Hospital, Dallas, TX

9:30 AM – 9:34 AM Discussion

9:35 AM – 9:39 AM
73 *(page 210)*
Assessment of Femoral Head Revascularization in Legg-Calvé-Perthes Disease (LCPD) Using Serial Perfusion MRI
Jamie Kaye Burgess, PhD; Paul Gudmundsson; Alec Thoveson; Molly Dempsey, MD; ChanHee Jo, PhD; ***Harry K.W. Kim, MD, MS***
Center for Excellence in Hip Disorders, Texas Scottish Rite Hospital for Children, University of Texas Southwestern Medical Center, Dallas, TX

9:40 AM – 9:44 AM Discussion

9:45 AM – 10:05 AM Break

BASIC SCIENCE AWARD PAPERS

Moderator: *Brian D. Snyder, MD, PhD*
eModerator: *Nancy H. Miller, MD*
Presider: *J. Michael Wattenbarger, MD*

10:06 AM – 10:11 AM
74 *(page 212)*
Rare Coding Variants in Musculoskeletal Collagen Genes Are Associated with Increased Risk of Adolescent Idiopathic Scoliosis
Matthew B. Dobbs, MD
Washington University School of Medicine, St. Louis, MO

10:12 AM – 10:17 AM
75 *(page 213)*
Factors in the Necrotic Bone Stimulate Osteoclast Formation and Inhibit Osteoblast Differentiation Following Ischemic Osteonecrosis of the Femoral Head
Naga Suresh Adapala, MBBS, PhD; Ryosuke Yamaguchi, MD, PhD; Matthew Phipps, PhD; ***Harry K.W. Kim, MD, MS***
Center for Excellence in Hip Disorders, Texas Scottish Rite Hospital for Children; University of Texas Medical Center, Dallas, TX

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See pages 21- 66 for financial disclosure information.

10:18 AM – 10:23 AM ♦ **Combination Sclerostin Antibody and Zoledronic Acid Treatment Outperforms Either Treatment Alone in a Mouse Model of Osteogenesis Imperfecta**
76 *(page 215)*

David G. Little, FRACS(Orth) PhD*; Lauren Peacock; Kathy Mikulec; Tegan Cheng, BE, BMedSc; Aaron Schindeler, PhD; Craig Munns, FRACP, PhD*

The Children's Hospital at Westmead, Sydney, AUSTRALIA

10:24 AM – 10:32 AM Discussion

10:33 AM – 10:38 AM ♦ **Comparison of RANKL Blockade and Bisphosphonate Therapies in a Growing Mouse Model of OI – Implications of Prolonged Treatment on Bone Health**
77 *(page 217)*

Josephine Marino, MPH; Nancy Pleshko, PhD; Erin M. Carter, MS; Karl J. Jepsen, PhD; Stephen Doty, PhD; Adele L. Boskey, PhD; ***Cathleen L. Raggio, MD***

Hospital for Special Surgery, New York, NY

10:39 AM – 10:44 AM **Meclozine Promotes Longitudinal Bone Growth in Transgenic Achondroplasia Mice with Gain-Of-Function Mutation in FGFR3 Gene**
78 *(page 220)*

Masaki Matsushita, MD*; Hiroshi Kitoh, MD; Kenichi Mishima, MD; Naoki Ishiguro, MD*

Nagoya University Graduate School of Medicine, Nagoya, Aichi, JAPAN

10:45 AM – 10:50 AM **Evaluation of Periosteal Procedures to Increase Growth**
79 *(page 221)*

Matthew A. Halanski, MD*; Tugrul Yildirim, MD; Ellen Leiferman, DVM*

University of Wisconsin, Madison, WI

10:51 AM – 10:59 AM Discussion

11:00 AM – 11:12 AM **Introduction of Presidential Speaker**

11:13 AM – 11:25 AM **Presidential Speaker –** ***Neil E. Green, MD***
"From Then till Now: How Pediatric Orthopaedic Treatment has Evolved"

11:26 AM – 11:29 AM **POSNA Annual Meeting 2016 / Best Paper / Poster / ePoster Awards**

11:30 AM – 12:00 PM **Presidential Transfer**

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2015 SUBSPECIALTY DAY AGENDA

HIP SUBSPECIALTY DAY

Fri., May 1, 2015 • 1:00 PM–5:15 PM • Imperial B

Co-Chairs: *Wudbhav N. Sankar, MD* and *Pablo Castaneda, MD*

PERIOD 1 1:00 PM – 2:19 PM

FREE PAPERS

Moderators: *Wudbhav N. Sankar, MD*
Pablo Castaneda, MD

1:00 PM – 1:04 PM
80 *(page 223)*

Rectus Sparing Approach to Periacetabular Osteotomy in Adolescents Preserves Hip Flexion Strength at Short Term Follow-Up
David A. Podeszwa, MD; *Kirsten Tulchin-Francis, PhD; Adriana De La Rocha, MS; DeRaan Collins, BS; Daniel J. Sucato, MD, MS*
Texas Scottish Rite Hospital for Children, Dallas, TX

1:05 PM – 1:09 PM
81 *(page 224)*

Motor-Evoked Potentials to Monitor the Sciatic Nerve During Periacetabular Osteotomy
Eduardo N. Novais, MD; *Lauryn A. Kestel, BS; Kim M. Strupp, MD; Patricia Oliver, R EEG T, CNIM; Willy Boucharel, MS, DABNM*
Children's Hospital Colorado, Aurora, CO

1:10 PM – 1:14 PM
82 *(page 225)*

Demographics and Early Functional Outcomes of Combined Hip Arthroscopic Labral Repair and Periacetabular Osteotomy
Benjamin F. Ricciardi, MD; Kara G. Fields, MS; ***Stephanie W. Mayer, MD***; *Maureen Suhr, PT; Bryan T. Kelly, MD; Ernest L. Sink, MD*
Hospital for Special Surgery, New York, NY

1:15 PM – 1:24 PM Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

1:25 PM – 1:29 PM
83 *(page 226)*

Three-Dimensional CT Analysis Identifies Distinct Variations in Acetabular Morphology in the Dysplastic Hip
Jeffrey J. Nepple, MD; *James R. Ross, MD; Asheesh Bedi, MD; Perry L. Schoenecker, MD; John C. Clohisy, MD*
Washington University-School of Medicine, St. Louis, MO

1:30 PM – 1:34 PM
84 *(page 228)*

Majority of Patients Who Have Confirmed Normal Physical Exam Upon Initial Referral to the Orthopaedic Provider Have No Evidence of Dysplasia Through 2 Years of Age
Daniel J. Sucato, MD, MS; *Terri Beckwith, MPH, CPH; Erica Flores, RN, BSN, MSN*
Texas Scottish Rite Hospital for Children, Dallas, TX

1:35 PM – 1:39 PM
85 *(page 229)*

Arthroscopic Treatment of Traumatic Hip Dislocations in Children and Adolescents
Shawn R. Gilbert, MD; *Andrew C. Morris, MD; Jonathon C. Yu, BS; Ashley Reed Estes, MD*
University of Alabama at Birmingham, Birmingham, AL

1:40 PM – 1:49 PM
Discussion

1:50 PM – 1:54 PM
86 *(page 230)*

Imaging Overestimates the Screw Tip-Subchondral Bone Distance in Slipped Capital Femoral Epiphysis
Michael Heffernan, MD; *Benjamin M. Snyder, MD; Hanbing Zhou, MD*
University of Massachusetts Medical School, Worcester, MA

1:55 PM – 1:59 PM
87 *(page 231)*

Perioperative Psychological Intervention Contributes to Improved Outcomes of Adolescents Treated With Hip Preservation Surgery
Heather M. Richard, PsyD; ***David A. Podeszwa, MD***; *Dylan C. Nguyen, MA; Adriana De La Rocha, MS; Daniel J. Sucato, MD, MS*
Texas Scottish Rite Hospital for Children, Dallas, TX

2:00 PM – 2:04 PM
88 *(page 233)*

Health-Related Quality of Life Following Staged Containment for Legg-Calve- Perthes Disease
Ayesha Yahya; Charles T. Mehlman, DO, MPH; ***Junichi Tamai, MD***; *Alvin H. Crawford, MD*
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

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2:05 PM – 2:09 PM
89 *(page 234)*
Percutaneous Multi-Planar Subtrochanteric Osteotomy with External Fixation for Developmental Coxa Vara
Sherif Galal, MD, MSc, PHD

Department of Pediatric Orthopedics, Faculty of Medicine, Cairo University, Cairo, EGYPT

2:10 PM – 2:19 PM Discussion

2:20 PM – 2:30 PM Break

PERIOD 2

2:30 PM – 3:45 PM
APPLYING THE LITERATURE: TOP 5 PAPERS THAT HAVE CHANGED MY PRACTICE
Moderators: *Wudbhav N. Sankar, MD*
Pablo Castaneda, MD

2:30 PM – 2:38 PM **FAI**
Daniel J. Sucato, MD

2:38 PM – 2:42 PM **Technique Video on Arthroscopic CAM Resection**
Yi-Meng Yen, MD

2:42 PM – 2:50 PM **Infantile DDH**
Jose A. Herrera-Soto, MD

2:50 PM – 2:54 PM **Technique Slides on Medial Open Reduction**
Ira Zaltz, MD

2:54 PM – 3:00 PM Questions

3:00 PM – 3:08 PM **SCFE**
Ira Zaltz, MD

3:08 PM – 3:12 PM **Technique Video on Anterolateral Open Reduction for Unstable SCFE**
Perry L. Schoenecker, MD

3:12 PM – 3:20 PM **Acute LCPD**
David G. Little, MD

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See pages 21- 66 for financial disclosure information.

3:20 PM – 3:24 PM **Algorithm for Acute LCPD (Early and Late)**
Harry K.W. Kim, MD

3:30 PM – 3:45 PM **Hip Cases**
David G. Little, MD; Jose A. Herrera-Soto, MD; Harry K.W. Kim, MD; Yi-Meng Yen, MD; Ira Zaltz, MD

3:45 PM – 4:00 PM Break

PERIOD 3

4:00 PM – 5:00 PM
SEPTIC HIP AND RELATED TOPICS
Moderators: *Wudbhav N. Sankar, MD*
Pablo Castaneda, MD

4:00 PM – 4:10 PM **Acute Septic Hip and Osteomyelitis**
Travis Matheney, MD

4:10 PM – 4:20 PM **Perihip Infections**
Jonathan G. Schoenecker, MD

4:20 PM – 4:30 PM **Septic Hip Complications**
Fergal P. Monsell, MD

4:30 PM – 5:00 PM **Questions and Septic Hip Cases**
Travis Matheney, MD; Jonathan G. Schoenecker, MD; Fergal P. Monsell, MD

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2015 SUBSPECIALTY DAY AGENDA

HAND SUBSPECIALTY DAY

When to Phone a Friend: Navigating the Pediatric Upper Extremity

Fri., May 1, 2015 • 1:00 PM–5:15 PM • International 5-6

Co-Chairs: *Roger Cornwall, MD* and *Dan A. Zlotolow, MD*

PERIOD 1

1:00 PM – 2:19 PM

FREE PAPERS

Moderators: *Roger Cornwall, MD*
Dan A. Zlotolow, MD

1:00 PM – 1:04 PM
90 *(page 236)*

Long-Term Functional Outcome of Forearm Rodding in Children with Osteogenesis Imperfecta
Elizabeth Ashby, FRCS; *Reggie C. Hamdy, MD, MSc FRCS(C); Francois Fassier, MD, FRCS(C)*
Shriners Hospital, Montreal, QC, CANADA

1:05 PM – 1:09 PM
91 *(page 237)*

Long-Term Functional Outcome of Humeral Rodding in Children With Osteogenesis Imperfecta
Elizabeth Ashby, FRCS; *Reggie C. Hamdy, MD, MSc FRCS(C); Francois Fassier, MD, FRCS(C)*
Shriners Hospital, Montreal, QC, CANADA

1:10 PM – 1:14 PM
92 *(page 238)*

Combined Elbow Release and Humeral Rotational Osteotomy in Arthroygryposis
Rey N. Ramirez, MD; Dominic T. Gomez-Leonardelli, MD; Scott H. Kozin, MD; ***Dan A. Zlotolow, MD***
Shriners Hospital of Philadelphia, Philadelphia, PA

1:15 PM – 1:24 PM — Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

1:25 PM – 1:29 PM
93 *(page 239)*

Multi-Center Evaluation of Pediatric Supracondylar Humerus Fracture Practice Patterns Based on the ABOS Performance Improvement Questionnaire
Christopher A. Iobst, MD*; Steven L. Frick, MD; Deirdre Dunn Ryan, MD*
Nemours Children's Hospital, Orlando, FL

1:30 PM – 1:34 PM
94 *(page 240)*

The Utility of Postoperative Radiographs After Pinning of Pediatric Supracondylar Humerus Fractures
Philip A. Ashley, MD; Jacob M. Stanfield, MD; Ryan D. Muchow, MD; Laura Blum; Henry J. Iwinski, MD; Vishwas R. Talwalkar, MD; Janet Walker, MD; ***Todd A. Milbrandt, MD***
University of Kentucky Department of Orthopaedic Surgery, Lexington, KY

1:35 PM – 1:39 PM
95 *(page 241)*

Annular Ligament Reposition Instead of Reconstruction on the Management of Missed Monteggia Fractures
Xuemin Lu, MD, PhD
Beijing Jishuitan Hospital, Beijing, CH

1:40 PM – 1:49 PM
Discussion

1:50 PM – 1:54 PM
96 *(page 243)*

Tendon Transfers for C5-7 Brachial Plexus Birth Palsy Patients: Is One Tendon Enough?
Xuyang Song; Elie Miller, BS; Dan A. Zlotolow, MD; Scott H. Kozin, MD; ***Joshua M. Abzug, MD***
University of Maryland School of Medicine, Baltimore, MD

1:55 PM – 1:59 PM
97 *(page 244)*

Ulnar Distraction Osteogenesis for Treatment of Ulnar Based Forearm Deformities in Multiple Hereditary Exostoses
Stephen Refsland, MD*; Scott H. Kozin, MD; Dan A. Zlotolow, MD*
Shriners Hospitals for Children, Philadelphia, PA

2:00 PM – 2:04 PM
98 *(page 245)*

Soft-Tissue Release with Bilobed Flap for the Treatment of Severe Wrist Deformity in Radial Deficiency: Does Not Affect Ulna Growth
Carley Vuillermin, MBBS, FRACS*; Lesley Wheeler, BA; Scott Oishi, MD; Marybeth Ezaki, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

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2:05 PM – 2:09 PM **99** *(page 246)*	**Functional Workspace of Normal and Reconstructed Hypoplastic Thumbs** ***Michelle A. James, MD***; *Mitell Sison-Williamson, MS; Anita Bagley, PhD, MPH* *Shriners Hospital for Children Northern California, Sacramento, CA*
2:10 PM – 2:19 PM	Discussion
2:20 PM – 2:30 PM	Break

PERIOD 2

2:30 PM – 3:45 PM

CONGENITAL / ACQUIRED

Moderator: *Dan A. Zlotolow, MD*

HAND

Panel: *Douglas T. Hutchinson, MD; Peter M. Waters, MD; Allan E. Peljovich, MD*

2:30 PM – 2:40 PM	**Trigger Thumb/Finger** *Douglas T. Hutchinson, MD*
2:40 PM – 2:50 PM	**Syndactyly, Polydactyly** *Peter M. Waters, MD*
2:50 PM – 3:00 PM	**Cleft Hand, Symbrachydactyly** *Allan E. Peljovich, MD*
3:00 PM – 3:05 PM	Transition

FOREARM/ELBOW

Panel: *Suzanne E. Steinmann, MD; Scott Oishi, MD; Charles Goldfarb, MD*

3:05 PM – 3:15 PM	**Madelung** *Suzanne E. Steinmann, MD*
3:15 PM – 3:25 PM	**MHE** *Scott Oishi, MD*
3:25 PM – 3:35 PM	**Radial Deficiency** *Charles Goldfarb, MD*

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3:35 PM – 3:45 PM **Arthrogryposis**
Dan A. Zlotolow, MD

3:45 PM – 4:00 PM Break

PERIOD 3

4:00 PM – 5:15 PM
TRAUMA / NERVE
Moderator: *Roger Cornwall, MD*

TRAUMA
Panel: *Donald S. Bae, MD; Robert B. Carrigan, MD; Joshua Ratner, MD; Joshua M. Abzug, MD*

4:00 PM – 4:10 PM **Elbow Malunions, OCD**
Donald S. Bae, MD

4:10 PM – 4:20 PM **Monteggias/Galeazzi/TFCC**
Robert B. Carrigan, MD

4:20 PM – 4:30 PM **Distal Radius Growth Arrest**
Joshua Ratner, MD

4:30 PM – 4:40 PM **Hand Fractures, Tendon Injuries**
Joshua M. Abzug, MD

4:40 PM – 4:45 PM Transition

NERVE
Panel: *Roger Cornwall, MD; Allan E. Peljovich, MD; Peter M. Waters, MD*

4:45 PM – 4:55 PM **Brachial Plexus**
Roger Cornwall, MD

4:55 PM – 5:05 PM **CP/TBI**
Allan E. Peljovich, MD

5:05 PM – 5:15 PM **Peripheral Nerve Injuries**
Peter M. Waters, MD

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2015 SUBSPECIALTY DAY AGENDA

NEUROMUSCULAR/LOWER EXTREMITY SUBSPECIALTY DAY

Fri., May 1, 2015 • 1:00 PM–5:15 PM • International 7-8

Co-Chairs: *Michelle S. Caird, MD* and *Jon R. Davids, MD*

PERIOD 1

1:00 PM – 2:15 PM
Moderators: *Frances A. Farley, MD*
Jon R. Davids, MD

LECTURES

1:00 PM – 1:10 PM **Outcome Assessment in GMFCS IV and V: CP Child Questionnaire**
Unni G. Narayanan, MD

1:10 PM – 1:15 PM Discussion

1:15 PM – 1:25 PM **Hip Surveillance for Children with CP**
Benjamin J. Shore, MD

1:25 PM – 1:30 PM Discussion

MASTER TECHNIQUES

1:30 PM – 1:40 PM **Dega vs. Pemberton Pelvic Osteotomy: How I Choose/Do Them**
Kirk W. Dabney, MD

1:40 PM – 1:45 PM Discussion

1:45 PM – 1:55 PM **Surgical Management of the Equinoplanovalgus Foot in Children with CP**
Jon R. Davids, MD

1:55 PM – 2:00 PM Discussion

2:00 PM – 2:10 PM **Surgery to Improve Gait in Children with Myelodysplasia**
Deidre D. Ryan, MD

2:10 PM – 2:15 PM Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

2:15 PM – 2:30 PM Break

PERIOD 2

2:30 PM – 3:50 PM
FREE PAPERS
Moderators: *Frances A. Farley, MD*
Jon R. Davids, MD

2:30 PM – 2:34 PM
100 *(page 247)*
Health Related Quality of Life and Caregiver Impact Following Orthopaedic Surgery in Children with Severe Cerebral Palsy
Rachel L. DiFazio, PhD, RN, PNP, FAAN; Judith Anne Vessey, PhD, CRNP, MBA, FAAN; David Zurakowski, MS, PhD; ***Brian D. Snyder, MD, PhD***
Boston Children's Hospital, Boston, MA

2:35 PM – 2:39 PM
101 *(page 248)*
Helping Families Make Difficult Choices: Implementation of a Decision Aid for Neuromuscular Scoliosis Surgery
Eric D. Shirley, MD*; Catharine Clay, MA, BSN; Carolina Bejarano, BS; Lindsay Fuzzell, MA; Sharon Leonard, MD*
Nemours Children's Clinic, Jacksonville, FL

2:40 PM – 2:44 PM
102 *(page 249)*
A Long Term Follow-Up of Young Adults with Idiopathic Clubfeet Using Pedobarography: Does Foot Shape Matter?
Peter A. Smith, MD*; Adam Graf, MS; Sahar Hassani, MS; Joseph Krzak, PT, PSC; Ann Flanagan, PT, PCS; Gerald Harris, PhD, PE*
Shriners Hospitals for Children, Chicago, IL

2:45 PM – 2:54 PM Discussion

2:55 PM – 2:59 PM
103 *(page 251)*
Identification of Gait Pathologies in Children with Spina Bifida and the Role of Gait Analysis
Deirdre D. Ryan, MD*; Bitte S. Healy, PT; Sylvia Õunpuu, MS; Jeffrey D. Thomson, MD; Nicole Mueske, MS; Pauline Yasmeh, BA; Tishya Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA

3:00 PM – 3:04 PM
104 *(page 252)*
Recurrence of Knee Flexion Deformity After Hamstrings Surgical Lengthening – Can Semitendinosus Transfer Improve the Results?
Mauro C. Morais Filho, MD*; Marcelo H. Fujino; Daniella Lins Neves; Francesco C. Blumetti, MD; Cátia M. Kawamura, PT; Jose Augusto Fernandes Lopes, MSc; Carlos Alberto dos Santos, MD*
AACD, São Paulo, BRAZIL

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3:05 PM – 3:09 PM **105** *(page 253)*	**The Effect of Selective Motor Branch Block of The Rectus Femoris as Indication for Transfer of the Muscle** ***Stig Sonne-Holm****; Derek J. Curtis; Hanne Boch Lauridsen; Billy Kristensen; Jesper Bencke* *Hvidovre University Hospital, Copenhagen, DENMARK*
3:10 PM – 3:19 PM	Discussion
3:20 PM – 3:24 PM **106** *(page 254)*	**The Pros and Cons of Operating Early vs. Late in the Progression of CP Scoliosis** ***Steven M. Hollenbeck, MD****; Burt Yaszay, MD; Paul D. Sponseller, MD; Suken A. Shah, MD; Jahangir Asghar, MD; Mark F. Abel, MD; Firoz Miyanji, MD; Peter O. Newton, MD* *Rady Children's Hospital, San Diego, CA*
3:25 PM – 3:29 PM **107** *(page 256)*	**Respiratory and Radiographic Effects of Growing Rods in Children with Spinal Muscular Atrophy** *Rachel L. Lenhart, MS; Sylvester Youlo, MD; Mary Schroth, MD; Kenneth J. Noonan, MD; James J. McCarthy, MD; David C. Mann, MD;* ***Matthew A. Halanski, MD*** *University of Wisconsin Hospitals & Clinics, Madison, WI*
3:30 PM – 3:34 PM **108** *(page 257)*	**Rate of Lower Limb Angular Correction in 8-Plate Hemiepiphysiodesis in Children with Varying Skeletal Pathologies** ***Andrea Yeo, FRCS (Tr & Orth)****; Claire Richards, MRCS; Deborah M. Eastwood, FRCS (Tr & Orth)* *Great Ormond Street Hospital, London, UK*
3:35 PM – 3:39 PM **109** *(page 259)*	**Clinical Outcome of the Lower Limb Lengthening Using Culture-Expanded Bone Marow Cells and Platelet Rich Plasma** ***Hiroshi Kitoh, MD****; Kenichi Mishima; Masaki Matsushita, MD; Naoki Ishiguro, MD* *Nagoya University Graduate School of Medicine, Nagoya, Aichi, JAPAN*
3:40 PM – 3:49 PM	Discussion
3:50 PM – 4:00 PM	Break

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See pages 21- 66 for financial disclosure information.

PERIOD 3

4:00 PM – 5:15 PM
Moderators: *Frances A. Farley, MD*
Jon R. Davids, MD

LECTURES

4:00 PM – 4:10 PM	**Techniques for Assessment of Skeletal Maturity (Elbow, Hand, Pelvis, and Calcaneus)** *James O. Sanders, MD*
4:10 PM – 4:15 PM	Discussion
4:15 PM – 4:25 PM	**Lower Extremity Alignment Surgery for Children with Skeletal Dysplasias – Who, What, When, and How** *Klane K. White, MD*
4:25 PM – 4:30 PM	Discussion
4:30 PM – 4:40 PM	**Treatment of Exotic Tarsal Coalitions: Beyond Calcaneonavicular Coalitions** *Samantha A. Spencer, MD*
4:40 PM – 4:45 PM	Discussion

MASTER TECHNIQUES

4:50 PM – 5:00 PM	**Guided Growth: Staples, Plates, and Screws (How I Choose/Do Them)** *Lior Shabtai, MD*
5:00 PM – 5:05 PM	Discussion
5:05 PM – 5:15 PM	**Vitamin D in Pediatric Orthopaedics** *David G. Little, MD*

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POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 SUBSPECIALTY DAY AGENDA

SPINE SUBSPECIALTY DAY

Fri., May 1, 2015 • 1:00 PM–5:15 PM • International 1-3

Co-Chairs: *Firoz Miyanji, MD* and *Burt Yaszay, MD*

PERIOD 1

1:00 PM – 2:15 PM
DEBATES
Moderators: *Firoz Miyanji, MD*
Burt Yaszay, MD

AIS – TREATMENT OF MODERATE CURVES

1:03 PM – 1:08 PM **Tethering is Best**
Peter O. Newton, MD

1:08 PM – 1:13 PM **I Would Staple That**
Randal R. Betz, MD

1:13 PM – 1:18 PM **Bracing is a Tried and True Method**
Lori A. Karol, MD

NONINVASIVE LENGTHENING METHODS FOR THE GROWING SPINE

1:19 PM – 1:26 PM **Pro – The Paradigm Shift Allows Us to Do More Growing Rods**
Behrooz A. Akbarnia, MD

1:26 PM – 1:33 PM **Con – This Doesn't Change a Thing**
James O. Sanders, MD

THE YOUNG SPASTIC PATIENT WITH A LARGE CURVE

1:34 PM – 1:39 PM **This Patient Needs an Early Fusion**
Mark F. Abel, MD

1:39 PM – 1:44 PM **This Patient Would Best be Served by Growing Rods**
David L. Skaggs, MD, MMM

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

1:44 PM – 1:49 PM **Late Treatment Would be the Most Appropriate**
Firoz Miyanji, MD

1:50 PM – 2:15 PM **Debate Case Presentations/ Panel Discussion**
Panel: *Anthony A. Scaduto, MD; Peter F. Sturm, MD; Matthew Oetgen, MD; Michael G. Vitale, MD*

2:15 PM – 2:30 PM Break

PERIOD 2

2:30 PM – 3:50 PM
FREE PAPERS
Moderators: *Patrick J. Cahill, MD*
A. Noelle Larson, MD

2:30 PM – 2:34 PM
110 *(page 260)*
Parallel Proximal Fixation in Rib Based Growing Rod System: A Novel Approach to Deal with Proximal Hook Migration
John Alexander Heflin, MD*; Norman F. Ramirez-Lluch, MD; Michelle Cameron Welborn, MD; Ivan Iriarte, MD, MS; Tricia St. Hilaire, MPH; John T. Smith, MD; Children's Spine Study Group*
Primary Children's Hospital, Salt Lake City, UT

2:35 PM – 2:39 PM
111 *(page 261)*
♦ Age at Initiation and Deformity Magnitude Influence Complication Rates of Surgical Treatment with Dual Growing Rods in Early Onset Scoliosis
Vidyadhar V. Upasani, MD*; Kevin Parvaresh, MD; Jeff Pawelek, BS; Patricia Miller, MS; George H. Thompson, MD; David Lee Skaggs, MD, MMM; John B. Emans, MD; Michael P. Glotzbecker, MD; Growing Spine Study Group*
Rady Children's Hospital, San Diego, CA

2:40 PM – 2:44 PM
112 *(page 263)*
Proximal Junctional Kyphosis Associated with Magnetically Controlled Growing Rod Surgery
Kenneth M.C. Cheung, MD; Kenny Kwan, FRCS; John Alexander Ferguson, FRACS; Colin Nnadi, MBBS, FRCS; Ahmet Alanay, MD; Muharrem Yazici, MD; Gokhan Halil Demirkiran, MD; Ilkka Helenius, MD; ***Behrooz A. Akbarnia, MD***
Queen Mary Hospital, The University of Hong Kong, Hong Kong SAR

2:45 PM – 2:54 PM Discussion

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2:55 PM – 2:59 PM
113 *(page 264)*

Correction of Pelvic Obliquity After Spinopelvic Fixation in Cerebral Palsy Patients: A Comparison Study

Oussama Abousamra, MD; Tristan Nishnianidze Sr, MD, PhD; Kenneth J. Rogers, PhD, ATC; Ilhan Avni Bayhan, MD; Petya Yorgova, MS; ***Suken A. Shah, MD***

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

3:00 PM – 3:04 PM
114 *(page 266)*

Performing a Definitive Fusion in Juvenile CP Patients is a Good Surgical Option

Burt Yaszay, MD*; Paul D. Sponseller, MD; Suken A. Shah, MD; Jahangir Asghar, MD; Firoz Miyanji, MD; Amer F. Samdani, MD; Carrie E. Bartley, MA; Peter O. Newton, MD*

Rady Children's Hospital, San Diego, CA

3:05 PM – 3:09 PM
115 *(page 267)*

♦ Rigid Fixation Improves Outcomes of Spinal Fusion for C1-C2 Instability in Children with Skeletal Dysplasias

Ilkka Helenius, MD*; Haemish Alexander Crawford, MBChB, FRACS; Paul D. Sponseller, MD; Thierry Alphonse Odent; Robert M. Bernstein, MD; Anthony A. Stans, MD; Daniel J. Hedequist, MD; Jonathan H. Phillips, MD*

Department of Paediatric Orthopaedic Surgery, Turku University Central Hospital, Turku, FINLAND

3:10 PM – 3:19 PM Discussion

3:20 PM – 3:24 PM
116 *(page 269)*

Delay to Surgery Greater Than 6 Months Leads to Significant Deformity Progression in Risser 0, Pre-Menarchal Adolescent Idiopathic Scoliosis (AIS) Patients: A Retrospective Cohort Study

Brandon A. Ramo, MD*; Dong-Phuong Tran, MS; Sumeet Garg, MD; Mark A. Erickson, MD; Anil Reddy, BS; Cameron R. Niswander, BA; Kaitlyn Brown, BS*

Texas Scottish Rite Hospital, Dallas, TX

3:25 PM – 3:29 PM
117 *(page 271)*

Minimally Invasive Surgery in Adolescent Idiopathic Scoliosis: Lessons Learned at Mean Two-Year Follow-Up

Michael Nitikman; Sameer Desai, BS; ***Firoz Miyanji, MD***

British Columbia Children's Hospital, Vancouver, BC, CANADA

3:30 PM – 3:34 PM
118 *(page 273)*

The Effects of The Three-Dimensional Deformity of Adolescent Idiopathic Scoliosis on Pulmonary Function

Burt Yaszay, MD*; Tracey P. Bastrom, MA; Carrie E. Bartley, MA; Stefan Parent, MD; Peter O. Newton, MD*

Rady Children's Hospital, San Diego, CA

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

3:35 PM – 3:39 PM
119 *(page 275)*

Relationship Between Seat Restraints and Thoracolumbar Fracture Patterns in Pediatric Occupants in Motor Vehicle Crashes
Chirag A. Berry, MD*; Narayan Yoganandan, MD; Raj D. Rao, MD*
Medical College of Wisconsin, Milwaukee, WI

3:40 PM – 3:49 PM Discussion

3:50 PM – 4:00 PM Break

PERIOD 3

4:00 PM – 5:15 PM
Moderators: *Firoz Miyanji, MD*
Burt Yaszay, MD

WHAT IS THE EVIDENCE?

4:00 PM – 4:07 PM
Halo-Gravity Traction is Safe and Effective
Charles E. Johnston II, MD

4:08 PM – 4:15 PM
Treatment of Neuromuscular Scoliosis Improves Quality of Life
Paul D. Sponseller, MD

4:16 PM – 4:23 PM
Reduction and Instrumented Fusion is the Best Treatment for High Grade Spondylolisthesis
Harry L. Shufflebarger, MD

4:24 PM – 4:31 PM
Understanding AIS in 3D is Essential to the Operative Treatment of AIS
Stefan Parent, MD

PEDIATRIC CERVICAL SPINE

4:32 PM – 4:39 PM
Treatment of Cervico-Thoracic Scoliosis
John B. Emans, MD

4:40 PM – 4:47 PM
Occipital-Cervical Instability – Management Strategies
Jonathan Phillips, MD

4:48 PM – 5:05 PM
Pediatric Cervical Trauma – Is There a Best Practice?
Martin J. Herman, MD

5:05 PM – 5:15 PM
Case Presentations/Panel Discussion
Panel: *John B. Emans, MD; Jonathan Phillips, MD; Martin J. Herman, MD; William G. Mackenzie, MD*

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POSNA
PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 SUBSPECIALTY DAY AGENDA

SPORTS SUBSPECIALTY DAY

ACL "Mini-Fellowship"

Fri., May 1, 2015 • 1:00 PM–5:15 PM • International 9-10

Co-Chairs: *John D. Polousky, MD* and *M. Lucas Murnaghan, MD*

PERIOD 1	1:00 PM – 2:15 PM **Moderators:** *M. Lucas Murnaghan, MD* *John D. Polousky, MD*
1:00 PM – 1:30 PM	**45 Years with the ACL Lessons Learned** *John A. Bergfeld, MD*
1:30 PM – 1:35 PM	**How I Do It – BTB Autograft** *John D. Polousky, MD*
1:35 PM – 1:40 PM	**How I Do It – Hamstring Autograft** *M. Lucas Murnaghan, MD*
1:40 PM – 1:45 PM	**How I Do It – All-Epiphyseal** *Theodore J. Ganley, MD*
1:45 PM – 1:50 PM	**How I Do It – ITB** *Mininder S. Kocher, MD*
1:50 PM – 1:55 PM	**Risk Factors for Re-Injury** *Kevin G. Shea, MD*
1:55 PM – 2:00 PM	**Strategies for Revision** *Benton E. Heyworth, MD*
2:00 PM – 2:15 PM	Discussion
2:15 PM – 2:30 PM	Break

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PERIOD 2

2:30 PM – 3:45 PM
Moderators: *M. Lucas Murnaghan, MD*
John D. Polousky, MD

ACL – COMPLEX CASE PRESENTATION / DISCUSSION

2:30 PM – 2:40 PM **Gender-Based Differences in Adolescent Sports Injuries**
Cordelia W. Carter, MD

2:40 PM – 3:45 PM **Complex and Revision Cases – Presentation and Discussion of Surgical Strategy**
John G. Bergfeld, MD*; Michael T. Busch, MD; Theodore J. Ganley, MD; Benton E. Heyworth, MD; Mininder S. Kocher, MD; M. Lucas Murnaghan, MD; John D. Polousky, MD; Kevin G. Shea, MD*

3:45 PM – 4:00 PM Break

PERIOD 3

4:00 PM – 5:15 PM
FREE PAPERS
Moderator: *Michael T. Busch, MD*

4:00 PM – 4:04 PM
120 *(page 276)*
MRI Evaluation of the Epiphyseal Vascular Supply – Insights into the Etiology of Knee OCD
Jutta M. Ellermann, MD, PhD; Mikko J. Nissi, PhD; Luning Wang, PhD; Ferenc Toth, DVM, PhD; ***Kevin G. Shea, MD****; John D. Polousky, MD; Cathy S. Carlson, DVM, PhD*
University of Minnesota, Minneapolis/St. Paul, MN

4:05 PM – 4:09 PM
121 *(page 277)*
Catcher's Knee: OCD of the Knee in Baseball and Softball Catchers
Mark J. McElroy, BS, MS; Patrick M. Riley Jr., MD; ***Mininder S. Kocher, MD, MPH***
Boston Children's Hospital, Boston, MA

4:10 PM – 4:14 PM
122 *(page 278)*
The Use of Bone Marrow Concentrate and Demineralized Bone Matrix in the Treatment of Osteochondritis Dissecans
Paul R. Fleissner Jr., MD
Crystal Clinic Orthopedic Center, Akron, OH

4:15 PM – 4:24 PM Discussion

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4:25 PM – 4:29 PM
123 *(page 279)*

Pediatric ACL Injury is Associated with Increased Lateral Tibial Slope: A Case-Control Study with MRI Measurements of 152 Patients

Peter D. Fabricant, MD, MPH; *David M. Dare, MD; Moira M. McCarthy, MD; Brian J. Rebolledo, MD; Frank A. Cordasco, MD; Daniel W. Green, MD, MS, Kristofer J. Jones, MD*

Hospital for Special Surgery, New York, NY

4:30 PM – 4:34 PM
124 *(page 280)*

Complications Associated with All-Epiphyseal ACL Reconstruction in Skeletally Immature Patients

Michael McGraw, MD; ***Aristides I. Cruz Jr., MD****; Peter D. Fabricant, MD, MPH; Lawrence Wells, MD*

Children's Hospital of Philadelphia, Philadelphia, PA

4:35 PM – 4:39 PM
125 *(page 281)*

Does the Surgical Delay Before an Anterior Cruciate Ligament Reconstruction in Adolescents Affect the Quality of Life at a Minimum of Two Years Follow-Up?

Marie-Lyne Nault, MD; Panagiotis Glavas, MD; ***Guy Grimard, MD***

Sainte-Justine University Hospital Center, Montreal, QC, CANADA

4:40 PM – 4:49 PM Discussion

4:50 PM – 4:54 PM
126 *(page 282)*

Outcomes of Operatively Treated Non- Unions and Symptomatic Mal-Unions of Adolescent Diaphyseal Clavicle Fractures

Sasha Carsen, MD, MBA; *Donald S. Bae, MD; Mininder S. Kocher, MD, MPH; Peter M. Waters, MD; Kyna Silvana Donohue; Benton E. Heyworth, MD*

Boston Children's Hospital, Boston, MA

4:55 PM – 4:59 PM
127 *(page 284)*

Medial Patellofemoral Ligament (MPFL) Reconstruction with Hamstring Autograft Improves Patella Alta in Children

Peter D. Fabricant, MD, MPH; *Hannah N. Ladenhauf, MD; Eduardo A. Salvati, MD; Daniel W. Green, MD, MS*

Hospital for Special Surgery, New York, NY

5:00 PM – 5:04 PM
128 *(page 286)*

Does Isolated Gastrocnemius Tightness Predispose Children to Lower Extremity Injury?

Raymond W. Liu, MD; *Katherine K. Xie, BS*

Rainbow Babies and Children's Hospitals at Case Western Reserve University, Cleveland, OH

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

5:05 PM – 5:09 PM
129 *(page 287)*

Assessment of Side-Step Cutting in Pediatric Athletes with Recent ACL Reconstruction Compared to Those with No ACL Surgical History

James Lee Pace, MD; *Nicole M. Mueske, MS; Tracy L. Zaslow, MD; Mia J. Katzel, DPT; Matthew C. Chua, PhD; Tishya A.L. Wren, PhD*
Children's Hospital Los Angeles, Los Angeles, CA

5:10 PM – 5:19 PM Discussion

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SATURDAY, MAY 2, 2015

8:00 AM – 8:04 AM **Welcome and Remarks**

TRAUMA

Moderator: *Susan A. Scherl, MD*
eModerator: *Jeffrey E. Martus, MD*
Presider: *Christine Ann Ho, MD*

8:05 AM – 8:09 AM
130 *(page 288)*
Flexible Intramedullary Nails for Femur Fractures in Pediatric Patients Heavier Than 100 Pounds
James S. Shaha, MD; Jason M. Cage, DO; Sheena R. Black, MD; Steve Shaha; Robert Lane Wimberly, MD; ***Anthony Riccio, MD***
Children's Medical Center, Dallas, TX

8:10 AM – 8:14 AM
131 *(page 289)*
Titanium Elastic Nailing for Pediatric Tibia Fractures: Do Older, Heavier Kids Do Worse?
Christine M. Goodbody, BA; R. Jay Lee, MD; John (Jack) M. Flynn, MD; ***Wudbhav N. Sankar, MD***
Children's Hospital of Philadelphia of Philadelphia, Philadelphia, PA

8:15 AM – 8:19 AM
132 *(page 290)*
Physeal Bar Formation After Pediatric Medial Malleolus Fractures
Matthew D. Abbott, MD*; Anthony I. Riccio, MD; Robert Lane Wimberly, MD; Philip L. Wilson, MD*
Texas Scottish Rite Hospital for Children and Children's Medical Center, Dallas, TX

8:20 AM – 8:28 AM Discussion

8:29 AM – 8:33 AM
133 *(page 291)*
Closed Reduction and Percutaneous Pinning vs. Open Reduction Internal Fixation of Mildly Displaced Humeral Lateral Condyle Fractures
Andrew T. Pennock, MD*; Lissette Salgueiro MD; Vidyadhar V. Upasani, MD; Tracey Bastrom, MA; Burt Yaszay, MD*
Rady Children's Hospital, San Diego, CA

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

8:34 AM – 8:38 AM
134 *(page 292)*

Outcomes of ORIF More Than Seven Days After Injury in Displaced Pediatric Lateral Condyle Fractures
Mauricio Silva, MD; *Alejandro Paredes; Angela Cha, NP*
Orthopaedic Institute for Children, Los Angeles, CA

8:39 AM – 8:43 AM
135 *(page 293)*

Rate and Risk Factors for Delayed Healing Following Surgical Treatment of Lateral Condyle Humerus Fractures in Children
Lissette Salgueiro, MD; *Joanna H. Roocroft, MA; Tracey P. Bastrom, MA; Eric W. Edmonds, MD; Andrew T. Pennock, MD; Vidyadhar V. Upasani, MD; Burt Yaszay, MD*
Rady Children's Hospital, San Diego, CA

8:44 AM – 8:52 AM
Discussion

8:53 AM – 8:57 AM
136 *(page 294)*

Pathologic Arterial Changes in Neurovascularly Intact Gartland III Supracondylar Humerus Fractures
Christine Ann Ho, MD; *David A. Podeszwa, MD; Anthony I. Riccio, MD; Robert Lane Wimberly, MD; Brandon A. Ramo, MD; Mary Yang, MD; Surekha Patel, MSc*
Children's Medical Center, Dallas, TX

8:58 AM – 9:02 AM
137 *(page 296)*

Fracture Classification Predicts Functional Outcomes in Supracondylar Humerus Fractures: A Prospective Study
Justin J. Ernat, MD; ***Anthony I. Riccio, MD***; *Robert Lane Wimberly, MD; David A. Podeszwa, MD; W. Taylor Gheen, BA; Christine Ann Ho, MD*
Texas Scottish Rite Hospital for Children, Dallas, TX

9:03 AM – 9:07 AM
138 *(page 297)*

Recovery of Motor Nerve Injuries Associated with Displaced, Extension- Type Pediatric Supracondylar Humerus Fractures
Bryce T. Gillespie, MD; *Benjamin J. Shore, MD, MPH, FRCSC; Patricia E. Miller, MS; Donald S. Bae, MD; Peter M. Waters, MD*
Boston Children's Hospital, Boston, MA

9:08 AM – 9:16 AM
Discussion

9:17 AM – 9:21 AM
139 *(page 298)*

Is Timing of Surgery of Paediatric Supracondylar Fractures Related to Pinning Errors or Complications?
Luis Moraleda Novo, MD, PhD; *Maria Valencia, MD; Jesus Diez-Sebastian, MD, PhD*
Hospital Universitario La Paz, SPAIN

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9:22 AM – 9:26 AM **140** *(page 299)*	**Cervical Spine Clearance in Pediatric Trauma Centers: The Need for Standardization and an Evidence-Based Protocol** *Mitesh Shah, MD;* ***Martin J. Herman, MD****;* *Pediatric Cervical Spine Study Group* *Drexel University College of Medicine and St. Christopher's Hospital for Children, Philadelphia, PA*
9:27 AM – 9:31 AM **141** *(page 300)*	**Functional Outcomes Following Non- Operative vs. Operative Treatment of Clavicle Fractures in Adolescents** *Mackenzie M. Herzog, MPH; Rebecca Whitesell, MD; Lisa M. Mac, MPH; Morgan Lee Jackson; Brad Anthony Culotta, MD; Jed Axelrod, MD; Michael T. Busch, MD;* ***Samuel Clifton Willimon, MD*** *Children's Healthcare of Atlanta/Children's Orthopaedics of Atlanta, Atlanta, GA*
9:32 AM – 9:40 AM	Discussion
9:41 AM – 9:45 AM **142** *(page 302)*	**Displaced Medial Epicondyle Fractures in Children: Comparative Effectiveness of Operative vs. Non-Operative Treatment** *Emily Mayer, BS; Emily A. Eismann, MS;* ***Charles T. Mehlman, DO, MPH*** *Cincinnati Children's Hospital Medical Center, Cincinnati, OH*
9:46 AM – 9:50 AM **143** *(page 303)*	**Direction of Displacement is the Strongest Predictor of the Need for Open Reduction in a Cohort of Pediatric Patients Undergoing Operative Treatment for Supracondylar Humerus Fractures** ***Sayan De, MD****; Bryan Mark, BA; Patrick M. Carry, BA; Eduardo N. Novais, MD; Nancy H. Miller, MD* *Children's Hospital Colorado, Aurora, CO*
9:51 AM – 9:55 AM **144** *(page 305)*	**Radiographic Evaluation and Management of the Toddler's Fracture** *Daniel M. Dean, BS; Patrick T. Sweeney, BA; Paul J. Switaj, MD;* ***Rachel E. Mednick, MD****; John J. Grayhack, MD* *Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL*
9:56 AM – 10:04 AM	Discussion
10:05 AM – 10:25 AM	Break

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See pages 21- 66 for financial disclosure information.

NEUROMUSCULAR/CONGENITAL

Moderator: *Lori A. Karol, MD*
eModerator: *Cathleen L. Raggio, MD*
Presider: *Klane K. White, MD*

10:26 AM – 10:30 AM **Recurrence After Femoral Derotation Osteotomy in Ambulatory Youth with Cerebral Palsy**
145 *(page 306)*

Freeman Miller, MD; *Chris Church, PT; Nancy Lennon, PT; Kevin Gerard Pineault; Timothy Niiler, PhD; John D. Henley, PhD; Oussama Abousamra, MD; Kirk W. Dabney, MD*

Alfred I. duPont Hospital for Children, Wilmington, DE

10:31 AM – 10:35 AM **Reorientational Proximal Femoral Osteotomies for Arthrogrypotic Hip Contractures**
146 *(page 307)*

Harold J.P. van Bosse, MD; *Roger E. Saldana, MD*

Shriners Hospital for Children, Philadelphia, PA

10:36 AM – 10:40 AM **Results of Early Hip Reconstructive Surgery in Severely Involved Children with Cerebral Palsy**
147 *(page 308)*

Betsey K. Bean, DO; Glen O. Baird, MD; Bryan J. Tompkins, MD; William E. Bronson, MD; Mark McMulkin, PhD; ***Paul M. Caskey, MD***

Shriners Hospitals for Children, Spokane, WA

10:41 AM – 10:49 AM Discussion

10:50 AM – 10:54 AM **Correction of Tibial Torsion in Children with Cerebral Palsy by Isolated Distal Tibia Osteotomy: An Anatomic Study**
148 *(page 309)*

Emily M. Andrisevic, MD; *David Elbert Westberry, MD; Linda Pugh, RN; Anita Bagley, PhD, MPH; Stephanie Lewis Tanner, MS; Jon R. Davids, MD*

Shriners Hospital for Children, Sacramento, CA

10:55 AM – 10:59 AM **Measuring Physical Function in Children with Cerebral Palsy Using Computer Adaptive Testing (PEDI-CAT)**
149 *(page 310)*

Benjamin J. Shore, MD, MPH, FRCSC; *Patricia Miller, MS; Benjamin Allar, BA; Travis H. Matheney, MD; Brian Snyder, MD, PhD; Maria Fragala-Pinkham PT, DPT, MS*

Boston Children's Hospital, Boston, MA

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11:00 AM – 11:04 AM
150 *(page 311)*
Surgical Outcomes of Valgus Extension Derotation Osteotomy (VEDO) of the Hip in Children with Spondyloepiphyseal Dysplasia Congenita: Midterm Results
Ilhan A. Bayhan, MD; Tristan Nishnianidze, MD; Kenneth J. Rogers, PhD; Oussama Abousamra, MD; Michael B. Bober, MD, PhD; Freeman Miller, MD; ***William G. Mackenzie, MD***
Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE

11:05 AM – 11:13 AM Discussion

11:14 AM – 11:18 AM
151 *(page 312)*
Simultaneous Bilateral Femoral and Tibial Lengthening in Patients with Achondroplasia
Lior Shabtai, MD*; Shawn C. Standard, MD; John E. Herzenberg, MD*
International Center for Limb Lengthening, Rubin Institute for Advanced Orthopedics, Sinai Hospital, Baltimore, MD

11:19 AM – 11:23 AM
152 *(page 313)*
Outcomes of Multi-Level Surgery with and Without External Femoral Derotation Osteotomy in Children with Cerebral Palsy
Glen O. Baird, MD*; Mark L. McMulkin, PhD; Andi B. Gordon, PT; Bryan J. Tompkins, MD; Paul M. Caskey, MD*
Shriners Hospitals for Children, Spokane, WA

11:24 AM – 11:28 AM
153 *(page 314)*
Foot and Ankle Function at Maturity After Ilizarov Treatment for Atrophic- Type Congenital Pseudarthrosis of the Tibia (CPT). A Comprehensive Outcome Comparison with the Norms
Sang Gyo Seo, MD; ***In Ho Choi, MD****; Yeon Soo Kim Sr., MD; Dong Yeon Lee, MD; Won Joon Yoo, MD; Tae-Joon Cho*
Seoul National University Children's Hospital, Seoul, KOREA

11:29 AM – 11:37 AM Discussion

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

FOOT/ANKLE

Moderator: *Matthew Dobbs, MD*
eModerator: *David M. Scher, MD*
Presider: *Jamie R. Denning, MD*

11:40 AM – 11:44 AM **154** *(page 315)*	**How Important is Brace Compliance in Ponseti-Treated Idiopathic Clubfeet?** ***B. Stephens Richards III, MD****; Shawne Faulks, MSR, RN, CNS; Donald D. Virostek, CPO; Kevin Felton, CPO; Karl E. Rathjen, MD; Lori A. Karol, MD* *Texas Scottish Rite Hospital for Children, Dallas, TX*
11:45 AM – 11:49 AM **155** *(page 316)*	**The Use of the Foot Ankle Orthosis After Ponseti Treatment of Idiopathic Clubfoot: How Long is Long Enough?** ***Rachel Goldstein, MD****; Alice Chu, MD; Debra A. Sala, PT; Wallace B. Lehman, MD* *NYU Hospital for Joint Diseases, New York, NY*
11:50 AM – 11:54 AM **156** *(page 317)*	**Factors Associated with Clubfoot Recurrence in Individuals Treated with Ponseti Casting** *Donald Jeffrey Covell, MD; Ryan Hart, MD; Janet Walker, MD; Henry J. Iwinski, MD; Pooya Hosseinzadeh, MD; Todd A. Milbrandt, MD;* ***Vishwas R. Talwalkar, MD****; Donna Jean Oeffinger, PhD; Ryan D. Muchow, MD* *Lexington Shriners Hospital for Children, Lexington, KY*
11:55 AM – 12:03 PM	Discussion
12:04 PM – 12:08 PM **157** *(page 318)*	**Efficacy of Non-Operative Treatment for Symptomatic Tarsal Coalitions** ***Eric D. Shirley, MD****; Radu Gheorghe, BS; Kevin M. Neal, MD* *Nemours Children's Clinic, Jacksonville, FL*
12:09 PM – 12:13 PM **158** *(page 319)*	**Patient Reported Outcomes of Surgically Treated Tarsal Coalitions: A Prospective Review** ***Samantha Anne Spencer, MD****; Susan T. Mahan, MD, MPH; Anneliese M. Lierhaus, BA; Patricia E. Miller, MS; James R. Kasser, 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 9.

12:14 PM – 12:18 PM **Functional Outcomes and Health-Related Quality of Life**
159 *(page 320)* **Following Pediatric Lisfranc Tarsometatarsal Injury Treatment**

Jaime Rice Denning, MD*; Emily A. Eismann, MS; Leroy Butler, DO; John Lewis Eisenlohr, MS*

Cincinnati Children's Hospital Medical Center, Cincinnati, OH

12:19 PM – 12:27 PM Discussion

Adopting the EMR: Effect on Efficiency, Completeness, Accuracy, Teaching, and Surgeon Satisfaction in an Academic Pediatric Orthopedic Practice

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Burt Yaszay, MD
Rady Children's Hospital, San Diego, CA

†LOE-N/A - Level III

Purpose: The purpose of this study is to evaluate the impact the electronic medical record (EMR) has made on efficiency, completeness, accuracy, and surgeon satisfaction in an orthopedic practice based in a high volume teaching hospital.

Methods: Billing data was used to determine the volume of orthopedic outpatient visits per month and the number of providers seeing patients per month from January 2008 to July 2013. Sixty paper charts were compared to 60 EMRs. Twenty adolescent idiopathic scoliosis (AIS), 20 distal radius fractures (DRFx), and 20 anterior cruciate ligament (ACL) injury patients were included for each record type. Paper charts were compared to EMRs created two years after EMR implementation in our institution. Completeness was evaluated based on the inclusion/exclusion of standard data points expected to be recorded for each diagnosis. Accuracy was evaluated by confirming age and side of injury (when appropriate) for all notes. Surgeon satisfaction was studied by an 11 question survey of the 10 surgeon group.

Results: There was no statistically significant difference in overall clinic volume between 2008 and the 12 months prior to July 2013 (51,940 visits per year vs. 55,445)($p=0.075$). There was a significant increase in the number of providers required to see patients post-EMR (20.3 ± 0.7 vs. 26.7 ± 0.9 providers per month)($p<0.001$). There was a significant decrease in volume per provider per month pre-EMR (212.9 ± 15.1) vs. post-EMR (173.3 ± 16.2)($p<0.001$). This equated to a 19% reduction in the number of patient visits for each provider after the implementation of EMR. There was no statistically significant difference in the proportion of incomplete records between paper and EMR for AIS ($p=0.24$), DRFx ($p=0.07$), or ACL patients ($p=0.11$). Both paper chart and the EMR documentation was accurate for all three groups (AIS: 100% vs. 100%), (DRFx 94% vs. 100%), (ACL tear 99% vs. 100%). However, the only inaccuracies were documented in the paper charts. The surgeon survey demonstrated surgeon acceptance but frustration with the EMR and its risk to trainee education.

Conclusion: Both paper charts and EMRs are complete and accurate but the EMR is currently less efficient than the paper chart. In its current format, EMR creation time between patient evaluations frustrates the surgeon, decreases clinical volume, and limits teaching time for trainees in orthopedic clinics.

Significance: Future iterations of the EMR should include record creation methods that are fast (allowing high clinical volume) and do not detract from the clinic teaching time needed in a training center.

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Pediatric Orthopaedic Emergency Room Transfers: Are They Warranted?

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†LOE-N/A - Level III

Purpose: Emergency room transfers to a higher level of care is a vital component of modern healthcare in order to permit the optimal treatment of patients by providing access to specialized personnel and facilities. However, multiple studies have shown that transfers of adult orthopaedic patients are often unnecessary. The purpose of this study is to assess whether or not pediatric orthopaedic transfers to a tertiary care center are an appropriate use of medical resources.

Methods: A retrospective review was performed of all pediatric emergency room transfers to our tertiary care facility over a 4 year period. All cases were reviewed to assess patient demographics, the time of the request for transfer, the day of the week of the transfer, insurance status, whether or not the patient went to the operating room, whether or not a closed reduction maneuver was performed in the emergency department, and whether or not conscious sedation was provided in the emergency department. Simple statistical analysis was performed.

Results: 86% (188/218) of pediatric orthopedic emergency room transfers were cases related to an acute fracture. 27% (59/218) of the transfers occurred on the weekend and 61% (133/218) of transfers were initiated between 6pm and 6am. 47% (103/218) of the transfers involved patients with Medicaid.

55% (120/218) of cases required a procedure in the operating room, while 22% (49/218) had a closed reduction procedure performed in the emergency room. 22% (48/218) of patients had conscious sedation provided in the emergency room. Only 22% (47/218) of the transfers did not require a trip to the operating room, conscious sedation, nor a closed reduction procedure in the emergency room.

Conclusion: The vast majority of pediatric orthopedic transfers are warranted, requiring operative intervention, a closed reduction maneuver, or conscious sedation in the emergency department. Unlike adult orthopaedic transfers, the majority of pediatric transfers do not seem to be influenced by the day of the week, but a similar trend is present regarding off hour presentations and high percentages of patients with Medicaid insurance statuses.

Significance: While transfer of a patient to a tertiary care facility does increase healthcare costs, specialized pediatric facilities are needed to perform procedures that may not be routinely performed in community hospitals.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

What is the Role of Faculty in Training Residents?

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†LOE-N/A - Level I

Purpose: It is not clear where faculty should spend the bulk of their effort in training residents. How they best learn routine pediatric orthopaedic technical skills, such as fracture reduction, casting, k-wire fixation, and flexible IM rodding is not clear. The purpose of this study was to compare the efficacy of a self-education curriculum with a traditional faculty lead education program in residents achieving proficiency in these skills.

Methods: Twelve starting orthopaedic residents were randomly assigned to either (1) a one month self education program in which they were given explanatory reading, video, and other computer based material and allowed to practice on their own in a skills lab; or (2) a more traditional education curriculum in which they were taught these same skills by a faculty member. Outcome for the ability to achieve proficiency in these skills was measured using an objective, structured assessment of technical skills examination for the 2 groups at the beginning and the end of their first month, again at one year, and also using an standardized observation of their ability to perform these skills when treating patients at the start and end of a clinical rotation in which they had not done the skills before.

Results: Before the start of the training, there were no differences in performance scores between the 2 groups. On completion of the skills course, mean global rating scores for the skills tasks was significantly greater for the self-taught group compared with the faculty taught group ($P < .02$). This increased score was noted at the start of the clinical rotation evaluation in the self taught group, where the residents demonstrated a similar skills level as trainees finishing the rotation in the faculty taught group.

Conclusion: A trainee-regulated approach to learning basic surgical skills improved the performance of basic orthopaedic over education by a faculty member, suggesting that teaching technical skills may not be the most efficient use of a resident's time with the faculty.

Significance: Faculty may play a more critical role in teaching residents surgical selection, how to interact with patients, and how to manage unexpected problems, while residents may be more effective learning basic skills on their own.

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Characteristics of Medical Professional Liability Claims in Pediatric Orthopedics

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†LOE-N/A - Level IV

Purpose: The objective of this study was to perform an epidemiological study of closed medical professional liability (MPL) claims in pediatric orthopedics using data maintained by the Physician Insurers Association of America (PIAA), a trade association whose participating malpractice insurance carrier collectively insure over 60% of practicing physicians in the United States.

Methods: The PIAA established a registry of closed MPL claims in 1985. This registry contains data describing 286,021 closed claims in the United States from 1985 to 2013. The registry is maintained for educational programs that are designed to improve quality of care and reduce patient injury MPL claims. All closed MPL orthopedic surgery claims in the database between 1985 and 2013, where an event was alleged to have caused an injury to a patient < 18 years of age, were retrospectively reviewed. The study outcomes were frequency of the claims, average indemnity paid, paid to close ratio, most prevalent medical errors, most prevalent medical diagnosis and injury severity.

Results: Of 286,021 closed claims, 26367 involved orthopedic surgery and 2671 were pediatric orthopedic claims. Orthopedic surgery ranked 5th among all specialties in the total number of closed claims. Of these 2,671 claims, 881 resulted in a payment, and the average indemnity was $203,979. The paid to close ratio was 33%. In the entire registry, 29.1% of closed claims were paid and the average indemnity was $227,215. The most prevalent medical errors were improper performance, errors in diagnosis, failure to supervise care and failure to recognize complications. The most prevalent presenting diagnoses were fractures of the radius & ulna, humerus, femur & tibia/fibula. The most common resulting diagnoses were malunion, early complications of trauma, deformities of the forearm, nonunion and injury to nerves. The most prevalent procedures by paid claims were operative procedure on joints excluding spinal fusion, closed reduction of fractures, open reduction of dislocations, operative procedures on bones and procedures involving skeletal traction and immobilization.

Conclusion: Knowledge of the details of liability claims should assist practicing pediatric orthopedic surgeons in improving patient safety and quality of care, reducing patient injury and reducing the incidence of MPL claims.

Significance: Medical Professional Liability issues are common and are important to all practicing pediatric orthopedic surgeons.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Which Common Pediatric Orthopaedic Procedures are the Most Dangerous?

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†LOE-N/A - Level II

Purpose: Quality improvement in orthopaedic surgery has received increasing attention, however there is relatively little information available about the perioperative safety of many common pediatric orthopaedic procedures. This study aims to characterize the incidence of adverse events in a national, pediatric patient sample in order to understand the risk profiles of common pediatric orthopaedic procedures.

Methods: A retrospective cohort study was conducted using the prospectively-collected American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Pediatric database. Pediatric patients who underwent 29 different orthopaedic procedures were identified in the 2012 NSQIP Pediatric database. Patient demographics, along with the occurrence of any adverse event, mortality, surgical site infection, and readmission within 30 days, were reported for each procedure.

Results: A total of 8,975 pediatric patients were identified. Supracondylar humerus fracture fixation was the most common procedure performed in this sample (2,274 patients or 25.57% of all procedures), followed by posterior spinal fusion (1,916 patients or 21.55% of all procedures). An adverse event occurred in 352 patients (3.92%). Four deaths were noted (0.04%), all of which occurred in patients with neuromuscular disease undergoing posterior spinal fusion. Surgical site infections occurred in 143 patients (1.59%), and 197 patients (2.19%) were readmitted within 30 days. Posterior spinal fusion was responsible for the greatest absolute number of adverse events (170 patients or 48.30% of all adverse events in the population), followed by supracondylar humerus fracture fixation (46 patients or 13.07% of all adverse events), and revision of spinal fusion (27 patients or 7.67% of all adverse events). Table 1 reports the rates of adverse outcomes for the top ten procedures responsible for adverse events.

Conclusion: These results show that only a few procedures account for the majority of adverse events in the first 30 days following orthopaedic surgery in pediatric patients.

Significance: The results from this study of a large, national sample of pediatric orthopaedic patients are important for benchmarking and highlight areas for quality improvement.

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Table 1. Short-term outcome by orthopaedic procedure. The top ten procedures responsible for adverse events are listed in order of decreasing number of adverse events.

	Out of all procedures		Outcome							
			AAE		Mortality		SSI		Readmission	
Procedure	No.	%	No.	%	No.	%	No.	%	No.	%
Overall	8,975	100%	352	3.92%	4	0.04%	143	1.59%	197	2.19%
Posterior spinal fusion	1,916	21.55%	170	8.87%	4	0.21%	65	3.39%	81	4.23%
Supracondylar humerus fracture	2,274	25.57%	46	2.02%	0	0.00%	17	0.75%	22	0.97%
Revision of spinal fusion	564	6.34%	27	4.79%	0	0.00%	13	2.30%	25	4.43%
Tendon lengthening/ shortening	423	4.71%	11	2.60%	0	0.00%	5	1.18%	7	1.65%
Femoral shaft fracture	229	2.55%	11	4.80%	0	0.00%	1	0.44%	9	3.93%
Iliac and femoral osteotomy	131	1.46%	9	6.87%	0	0.00%	2	1.53%	6	4.58%
Midfoot caspulotomy	148	1.65%	8	5.41%	0	0.00%	2	1.35%	5	3.38%
Iliac osteotomy	123	1.37%	8	6.50%	0	0.00%	3	2.44%	6	4.88%
Hemiepiphyseal arrest	330	3.68%	7	2.12%	0	0.00%	4	1.21%	5	1.52%
Tibial osteotomy	118	1.31%	6	5.08%	0	0.00%	4	3.39%	2	1.69%

AAE = any adverse event, SSI = surgical site infection, OR = operating room.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Early Career Experience of Pediatric Orthopaedic Fellows: What to Expect and Need for Their Services

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†LOE-N/A - Level IV

Purpose: To characterize the early career experience for recent pediatric orthopaedic fellowship graduates. This will help new graduates with post-fellowship expectations as well as assess the demand for new pediatric orthopaedic surgeons entering the workforce.

Methods: Fellowship graduates from the SF match years 2012 and 2013 were identified from a POSNA database. A 36 question survey via Survey Monkey™ was done by each of the graduates.

Results: Of 120 graduates, 81 responded (68%). Ninety one percent of graduates were very or extremely satisfied with their fellowship and only 2.5% were not. There were 24 (30%) graduates who did an additional fellowship. When applying for a job, 50% had an offer before fellowship and there was variation in the number of interviews: 2(25%), 3(20%), 4 (10%), >4(16.5%). Only 2.5% of graduates did not receive an offer, 35% received one, and 62.5% received ≥ 2. Geography and family preferences (86%) had the greatest effect on job choice followed by academic opportunities (62%), finances (44%), and call frequency (20%). Of jobs taken, 63% represented an existing practice expansion, 15% represented adding pediatrics as a new service, and 20% represented replacing a retiring partner.

By type, 56% have academic, 28% have private practice, and 14% have hospital employment with 64% having a guaranteed salary. Salaries were evenly distributed and 44% of graduates felt their salary was appropriate, 37% felt it was too low but would increase and 13% felt their salary was too low and would not increase. Most have practices that are entirely pediatrics and that were consistent to what they expected. The majority (87%) are satisfied with the volume and complexity (85%) of cases. Half (52%) expect to be subspecialized within pediatric orthopaedics and 92% cover general pediatric call. Of the respondents, 28% feel there are too many fellows being trained.

Conclusions: Recent fellowship graduates are generally satisfied as they enter the workforce and their expectations were in line with their experience. Subspecialization within pediatric orthopaedics is becoming common. The ability of graduates to obtain full-time pediatric jobs with fair salaries indicates that there is demand at this time for new pediatric orthopaedic surgeons.

Significance: This study has shown that fellowship graduates are well prepared as they enter the workforce and are generally satisfied with their early practice. It also shows that currently, there is demand in the marketplace for their services. This will serve as baseline for future assessments.

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How Does Patient Radiation Exposure Compare with Low Dose O-Arm vs. Fluoroscopy for Pedicle Screw Placement in Idiopathic Scoliosis?

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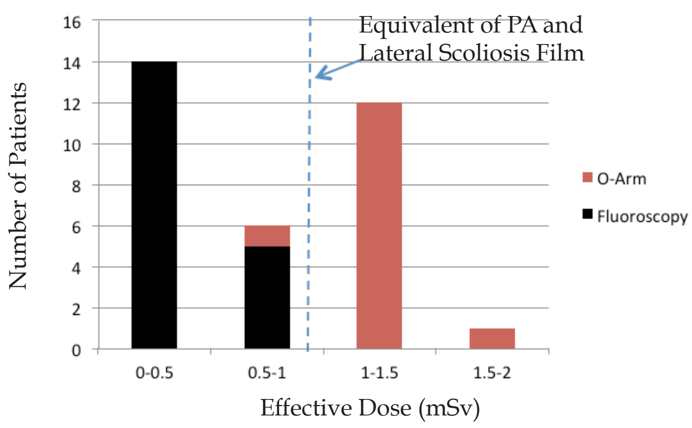
†LOE-Diagnostic - Level III

Purpose: CT-guided navigation and intraoperative CT have grown in popularity, but concerns remain regarding radiation exposure and potential increased cancer risk for pediatric patients. We sought to compare the radiation dose for fluoroscopy vs. intraoperative CT for placement of pedicle screws at two high volume pediatric centers.

Methods: Retrospective matched cohort study. At one center, pedicle screws for idiopathic scoliosis are typically placed using intraoperative fluoroscopy. At the 2nd center, O-arm is frequently used for intraoperative navigation using a low dose pediatric setting (80 Kv, 20 mA, 80 mAs as by described by Abul Kasim). These are much lower than the manufacturer-recommended settings. Patients undergoing spinal fusion with either O-arm or fluoroscopy were matched for diagnosis, weight, and length of fusion. Fourteen matched pairs of patients were compared, and the estimated effective dose was computed for each surgery. For reference, annual background radiation is 3 mSv, and the effective dose of a two-view intraoperative scoliosis radiograph is approximately 0.8 mSv.

Results: Mean number of levels fused in the O-arm group was 12 vs. 10 levels in the fluoroscopy group (p=0.13). In the O-arm group, there was a mean of 2 scans (range, 1-3). Mean seconds of fluoroscopy was 35 (range, 8-75), with mean estimated effective dose for the fluoroscopy of 0.27 mSv (range, 0.06-0.58). Mean estimated effective dose for the O-arm group was 1.3 mSv (range, 0.65 – 1.95 mSv, p<0.001). Considering the cases with more aggressive fluoroscopy use (> 30 seconds), the estimated effective dose for the patient was still 1/3 of that of O-arm cases (0.43 mSv vs. 1.2 mSv) and comparable to a single low-dose O-arm scan (0.65 mSv).

Estimated Effective Dose from Fluoroscopy vs. O-Arm



†LOE - Level of Evidence - Please see page 20 for details.
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Conclusions: Radiation dosing is higher with O-arm than with fluoroscopy, although prolonged fluoroscopy use (greater than 1 minute) can reach levels of exposure equivalent to a single low dose O-arm spin. Radiation imparted for both was similar to that of a standard PA and lateral full-length scoliosis films.

Significance: Fluoroscopy and low-dose O-arm are both reasonable means to assist in screw placement for AIS surgery. Avoid using the manufacturer O-arm settings and minimize the number of full-length radiographs for the greatest reduction in patient radiation dose over the entire course of treatment.

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Which Malpositioned Pedicle Screws Should Be Revised?

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Purpose: Up to 10% of free-hand pedicle screws are malpositioned, and 1 in 300 patients may undergo return to surgery for revision of malpositioned screws. The indications for revision of asymptomatic malpositioned screws have not been carefully evaluated in literature. We sought to evaluate the threshold among spinal deformity surgeons for revision of malpositioned screws.

Methods: Twelve experienced spine surgeons reviewed x-ray and CT images of 32 malpositioned pedicle screws with variable degrees of anterior, medial, and lateral breeches. The surgeons were asked whether based on the image they would revise the screw - 1) intraoperatively prior to rod placement, 2) intraoperatively after rod placement, 3) in clinic with an asymptomatic patient. For each scenario, we assumed no neuromonitoring and no neurologic changes.

Results: There was good agreement as to which screws were malpositioned (overall % agreement, 0.803, kappa 0.703). After the rod was placed or postoperatively (scenarios 2 and 3), surgeons less frequently recommended screw revision and there was greater variability among the surgeon's recommendations (Table). For return to OR from clinic for asymptomatic screw revision, % agreement was only 0.652 (kappa 0.477). Most surgeons recommended revision surgery for screws which approached the dura (10/12) or the aorta (7/12 surgeons). Exactly half the surgeons recommended revision surgery for an asymptomatic screw if the entire screw diameter was in the canal. Revision surgery was not recommended for asymptomatic patients with screws which partially violated the canal (<1/2 the screw diameter), were laterally malpositioned in the rib head, or had a small anterior cortical violations remote from a vascular structure.

Conclusions: There is significant variability of opinion among surgeons regarding which malpositioned screws can be safely observed in an asymptomatic patient. Given the frequency of malposition screws and morbidity of surgical return to OR, more long-term data is needed to develop practice guidelines for which malpositioned screws require revision.

Significance: Twelve surgeons rated CT images of 32 malpositioned pedicle screws, with good agreement as to which screws were malpositioned (overall % agreement, 0.803, kappa 0.703) but poor agreement on which screws required revision surgery (% agreement 0.652, kappa 0.477). Most surgeons found screws which touched the aorta or the dura to be in an unacceptable position.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Surgeon	Is Screw Malpositioned?	% Revised Screws Intraop Prior to Rod (1)	% Revised Screws Intraop After Rod (2)	% Revised in Clinic (Return to OR – 3)
1	67%	72%	47%	6%
2	78%	78%	71%	50%
3	75%	69%	69%	22%
4	58%	23%	23%	3%
5	72%	66%	53%	25%
6	47%	38%	9%	0%
7	74%	70%	45%	3%
8	72%	72%	38%	19%
9	81%	78%	69%	44%
10	81%	69%	63%	28%
11	84%	85%	31%	19%
12	81%	70%	61%	48%
% Overall Agreement	**0.803**	**0.725**	**0.606**	**0.652**
Free Marginal Kappa	**0.703**	**0.588**	**0.409**	**0.477**

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Improving Quality and Safety in Pediatric Spine Surgery: The Team Approach

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†LOE-Therapeutic - Level III

Purpose: The operative care of pediatric spinal disorders remains among the most complex and complication-ridden surgeries despite recent technological advances. There is growing evidence that standardized system and institutional team approaches can help reduce risk and improve safety following such complex surgical procedures. The aim of our study was to evaluate the quality and safety improvement of pediatric spine surgery following the implementation of an institutional pediatric spine surgical team (PSST) approach.

Methods: After institutional IRB approval, a retrospective consecutive case review of all pediatric spine surgeries done pre- (January 2008-December 2009) and post-implementation (January 2012-December 2013) of the PSST was performed. A comparative analysis of a priori determined outcome variables to include surgical site infection (SSI), operative time (ORT), estimated blood loss (EBL), length of hospital stay (LOS), unplanned staged procedures, and blood transfusion rates (allogenic and cell saver) was performed between cases in the pre-PSST group to those in the post-PSST group. The PSST consisted of a homogeneous core group of spine OR nurses, pediatric spine anesthetists, and neuromonitoring technicians. All surgeries were performed by 1 of 2 pediatric spine surgeons in both time periods.

Results: There were 130 cases in the pre-PSST period compared to 277 in the post-PSST period. Patient demographics are summarized in Table 1. There was no significant difference in age, gender, BMI, pre-operative major Cobb, and number of levels instrumented between the groups. In terms of outcome variables, we found a statistically significant difference in SSI, ORT, LOS, allogenic blood transfusion volume, and unplanned staged procedures between the groups. There was a 94% decrease in the rate of SSI's following the implementation of the PSST (6.9% pre-PSST compared to 0.4% post-PSST). In addition, patients in the post-PSST group had on average a reduction in ORT by 53±7.7min (p=0.013), LOS by 5.4±1.8days (p=0.019), and allogenic blood transfusion volume by 226.3ml±28.4 (p=0.000). There were significantly more unplanned staged procedures pre-PSST (6.2%) compared to post-PSST (2.9%) (p=0.001).

Conclusions: The implementation of a consistent, homogeneous core group of spine OR nurses, pediatric spine anesthetists, and neuromonitoring technicians (PSST) significantly improves surgical and peri-operative outcomes in pediatric spine surgery; namely SSI, ORT, LOS, allogenic blood transfusion rates, and unplanned staged procedures.

Significance: The quality and safety of pediatric spine surgery can be significantly improved with the implementation of a homogeneous and consistent PSST. In addition to quality and safety, other potential benefits may relate to efficiency of care and reduction in hospital costs.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Table 1.

Patient Demographics	Pre-PSST (n=130)	Post-PSST (n=277)	p-value (α=0.05)
Mean Age(yrs)	14.9 ±0.3	15.1±0.2	
Gender (% female)	57.7	73.7	
Mean Height (cm)	155.6 ±2.5	157.8±0.9	
Mean Weight (kg)	49.2 ±1.5	49.9±0.9	
Mean Preop Major Cobb (°)	73.9 (36-147)	70.9 (36-143)	
Mean No. of Levels Instrumented	10.5 (2-17)	11.3 (2-17)	
Outcome Variables of Interest			
Surgical Site Infections (%)	6.9	0.4	0.000*
Mean OR Time (min)	404.5 ±14.4	351.6 ±6.7	0.013*
Mean LOS (days)	14.3 ±2.5	8.9 ±0.7	0.019*
Mean EBL (mL)	909.1 ±93.5	580.2 ±30.1	0.135
Mean volume of Allogeneic Blood transfused (mL)	268.7 ±42.4	86.9 ±14.0	0.000*
Mean volume of Cell Saver Blood Transfused (mL)	201.5 ±40.9	87.3 ±7.8	0.401
Unplanned Staged Procedures (%)	6.2	2.9	0.001*

* - indicates point at which a significant difference ($p<0.05$) found

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ABOS Questionnaire as a Framework for QSV Evaluation in Pediatric Supracondylar Humerus Fracture Care

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†LOE-N/A - Level IV

Purpose: The study uses survey information and retrospective data based on the American Board of Orthopedic Surgery (ABOS) performance improvement questionnaire (PIQ) for pediatric supracondylar humerus fractures (SCHF) to evaluate quality, safety and value of clinical care provided in three different sites.

Methods: A survey (88 questions) and data sheet on preoperative assessment, intraoperative treatment and assessment, clinical and radiographic outcomes were developed based on the SCHF PIQ. All surgeons (17) taking call at three sites were surveyed, and five cases from the prior year with completed followup were reviewed for each surgeon. The survey and chart review were evaluated for variances in clinical care and outcomes.

Results: Survey showed consensus on assessment of neurological and vascular function, positioning, reduction without varus, assessment of stability fluoroscopically, not burying pins, pin fixation for 3 or 4 weeks, and no physical therapy after pin removal. No consensus was noted for planned change of intraoperative immobilization in clinic, number of postoperative radiographs or number of postoperative visits. 85 patients who had operative treatment of SCHF were reviewed- median age 6 years, 37% type II fractures, 57% type III, one flexion type. All patients had informed consent documented, the operative site signed and a timeout performed preoperatively. 90% received preoperative antibiotics. The postoperative immobilization was changed in clinic prior to pin removal in 58% of cases. Pin tract infection occurred in 3.5%. Pins were removed at 3 weeks in 60%, 4 weeks in 30%, 5 weeks in 7%, and after 5 weeks in 3%. No major complications or malunions occurred.

Variation	Range	Median
Procedure time	13-171 minutes	37 minutes
Anesthesia time	32-233 minutes	72 minutes
# follow-up visits	2 to 7 visits	3 visits
# postoperative radiographs	1 to 14 studies	3 studies

Despite survey consensus about documenting perfusion status, perfusion was not documented intraoperatively in 61%, and was not recorded in last office visit in 9%.

Conclusions: Quality - opportunity to lower pin tract infection rate. Safety – documentation of limb perfusion can be improved. Value - variations in immobilization, postoperative visits and radiographs may be reduced to decrease costs.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Significance: Value in healthcare can be increased by improving the outcomes or lowering the costs. Variations in care for the same condition may contribute to poor outcomes and increased cost, unless the variation is attributable the patient's condition. Variations in care that do not worsen outcomes or increase costs are acceptable and allow for surgeon preference. Variations in SCHF care to target for improvement were found.

♦ 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 9.

Implementation of a Standardized Clinical Assessment and Management Plan (SCAMP) for Pediatric Distal Radius Fractures: Effect on Quality and Care

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†LOE-Economic & Decision - Level III

Introduction: Standardized Clinical Assessment and Management Plans (SCAMPS) have been proposed as a means of improving quality, safety, and cost-effective care. The purpose of this investigation was to evaluate the effect of a distal radius fracture (DRF) SCAMP on clinical care and resource utilization.

Methods: One hundred ninety-nine patients treated from October 2010 to March 2012 prior to the initiation of the DRF SCAMP (pre-SCAMP) were compared to 384 patients treated from August 2012 to April 2013 after DRF SCAMP implementation (post-SCAMP). All patients were 4 -18 years of age with acute distal radius fractures. Exclusion criteria included open fractures, pathologic fractures, refractures, and vascular insufficiency. Mean patient age was 10.5 years. Approximately 45% of patients sustained torus fractures, 40% bicortical metaphyseal fractures, and 15% physeal fractures. There were no significant differences between the pre- and post-SCAMP cohorts with respect to age, gender, or fracture type. Radiographic alignment was assessed at each encounter. Acceptable radiographic alignment was deemed <10 degrees angulation and 50% translation or <20 degrees angulation and 50-100% translation for older and young patients, respectively. Remanipulation, surgical intervention, and complications were recorded.

Results:
Torus fractures: All patients with torus fractures achieved satisfactory clinical healing with non-operative care. However, following SCAMP implementation, there was significant improvements in avoidance of casting (99% pre-SCAMP vs 28% post-SCAMP), appropriate use of splinting (1% pre- to 72% post-SCAMP), and avoidance of unneeded follow-up clinical visits after three weeks of immobilization.

Bicortical metaphyseal and physeal fractures: While there were no significant changes in remanipulation or surgery rates, there were significant decreases in rate of initial fracture reduction after SCAMP implementation (68% pre- vs. 53% post-SCAMP). There were also increased rates of acceptable alignment after the first encounter (86% pre- vs. 99% post-SCAMP) and at the 6 week post-injury mark (83% pre- vs. 98% post-SCAMP).

Overall: Throughout the post-SCAMP period, there was a trend for decreased number clinical visits and radiographs for all patients. Over time, adherence to the SCAMP approached 82-100%. No cases of compartment syndrome, malunion, or post-surgical infection were recorded.

†LOE - Level of Evidence - Please see page 20 for details.
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Conclusion: Implementation of a DRF SCAMP resulted in equivalent clinical outcomes, improved adherence to best practice guidelines, decreased number of clinical visits and radiographs (and thus cost of care), and high provider acceptance.

Significance: SCAMPs are an effective tool to improve clinical care and resource utilization. Further investigation is underway to characterize accompanying reductions in cost in the DRF model.

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Does the Use of Midlevel Providers in the Closed Treatment of Pediatric Both Bone Forearm Fractures Increase Malunion Risk?

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†LOE-Therapeutic - Level IV

Purpose: Midlevel providers are playing an expanding role in pediatric fracture management, with the increasing emphasis in today's healthcare environment on cost-effectiveness and patient convenience. This study assesses whether the use of midlevel providers for fracture follow-up during nonoperative management of pediatric both bone forearm fractures increases the risk of ultimate malunion.

Methods: Hospital records were reviewed to identify children under age 18 years treated non-operatively by attending physicians for a forearm shaft fracture over a 12 month period. Exclusion criteria were: 1) Monteggia, metaphyseal, or buckle fractures, 2) plastic deformations, 3) refractures, and 4) patients with inadequate radiographic follow-up. Additional providers (attendings or physician assistants) who independently saw the patients during up to two months of fracture management during were recorded. Injury radiographs were used to determine fracture type and location. Malunion was determined at the two month follow-up visit based on age, gender, fracture location, and maximum angulation according to criteria of Bowman et al. (2011).

Results: Forearm shaft fractures were treated nonoperatively in 141 patients (68 male, 73 female) at an average age of 8±3 (range: 3-17) years. Malunion was identified in 42 patients (30%). The likelihood of malunion did not differ based on whether or not the providers included a physician assistant (28% vs. 56%, $p=0.13$, Fisher exact test) or on the number of physician assistant providers ($p=0.11$, Cochran-Armitage trend test), even though some patients had up to 4 physician assistants involved in their care. However, patients treated by two attending providers were significantly more likely to have a malunion (70%) than patients treated by a single attending provider (27%, $p=0.008$, Fisher exact test; RR=2.4, 95% CI: 1.1-9.1), even after controlling for fracture type, fracture location, number of clinic visits, number of physician assistants, and whether the patient had a change in treatment ($p=0.032$, multivariate logistic regression).

Conclusion: The involvement of even multiple midlevel providers in the nonoperative management of pediatric forearm fractures does not increase the risk of malunion. However, patients treated by two attending providers have more than twice the risk of malunion than patients treated by one attending provider.

Significance: Midlevel providers can continue to play a safe and valuable role in the nonoperative management of pediatric forearm fractures, an important consideration in today's practice environment. However, a change in attending providers during treatment of these fractures significantly increases the risk of malunion, arguing for consistency in the leadership of the treatment team.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Are We Giving Our Patients Too Much Pain Medication After Surgery?

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†LOE-Therapeutic - Level I

Purpose: The nonmedical use of prescription narcotics has become a major problem in the United States. However, there is limited evidence-based guidance available to surgeons regarding how much medication should be prescribed postoperatively, especially for pediatric patients. The goal of this study was to prospectively evaluate a cohort of patients' pain medication usage and self-reported pain scores in the first 4 weeks after hospital discharge following posterior spinal fusion (PSF) for scoliosis.

Methods: We prospectively enrolled patients who underwent PSF for scoliosis, were able to swallow pills, and were able to assent to the study. Preoperative and weekly postoperative surveys were administered for 4 weeks after surgery. Self-reported pain scores on the visual analog scale (VAS 0-100), number of pills remaining, medication refills, and operative details were recorded.

Results: Forty-one patients were enrolled, 37 (90%) completed the final survey and were included for analysis. The average age was 15.2 years; 68% were females. The underlying scoliosis diagnoses were adolescent idiopathic (32 patients), juvenile idiopathic (3 patients), congenital (1 patient), and Chiari-associated (1 patient). Pain levels dropped steadily each week for the first four weeks (49.7, 31.3, 24.1, 12.6), which was concordant with self-reported preoperative expectations. A standard postoperative pain medication regimen was prescribed (oxycodone and acetaminophen) and the average number of pills prescribed at discharge was 61. Twenty-two percent of patients required refills. Patients used an average of 51 pills each, the majority of which occurred in the first (54% of total use) and second (33% of total use) weeks. Males used more medication than females (M: 65 pills; F: 45 pills; p=0.02). Pre-operatively, patients' self-reported pain tolerances were "very high" (16.2%), "high" (40.5%), "average" (40.5%), and "low" (2.7%). Patients with "high" self-reported pain tolerance used a mean of 22 more pills than those with "average" self-reported pain tolerance (p=0.01). Early pain levels and pill usage does not appear to be associated with number of levels fused or number of Ponte osteotomies performed. On the final survey, 75% of patients stated that they planned to dispose of the medication, while 25% planned to keep if for future potential use.

Conclusion: This study provides a guide for narcotic usage following posterior spinal fusion in adolescents. As expected, narcotic use is greatest during the first two weeks after discharge. Male patients and those with a "high pain tolerance" used more medication postoperatively. Continued counseling should be provided to patients regarding proper narcotic disposal.

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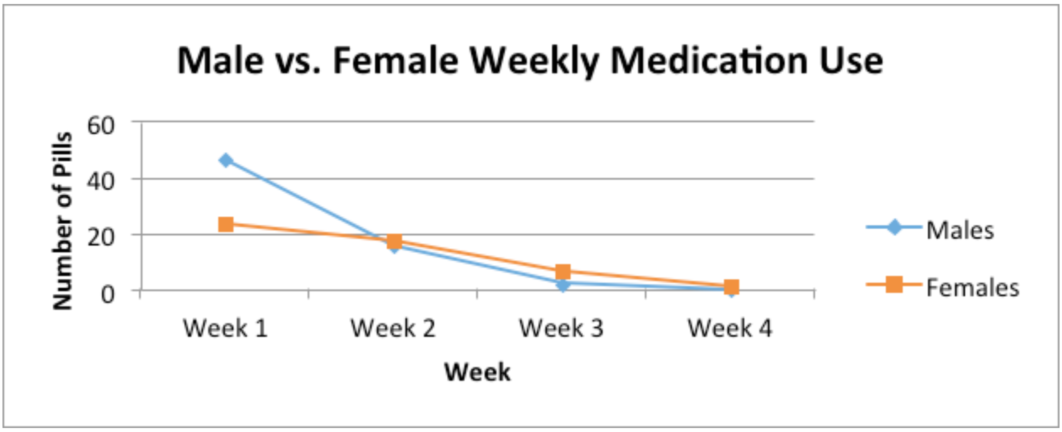
Significance: Level 1—Prognostic Study



†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Volume, Charges, and Costs of Operative vs. Non-Operative Management of Diaphyseal Clavicle Fracture in Adolescents at Thirty-Four U.S. Children's Hospitals

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Purpose: The purpose of this study was to characterize the collective volume, charges, and costs incurred for the treatment of diaphyseal clavicle fractures in adolescents in a large, diverse group of U.S. pediatric hospitals, with an emphasis on comparing non-operatively to operatively treated cases.

Methods: The Pediatric Health Information System (PHIS), a database containing comprehensive demographic, diagnostic, and administrative patient data from 46 freestanding children's hospitals across the United States, was queried for patients between 10 and 19 years old between 2009 and 2013, principally treated for clavicle fracture (ICD-9-CM diagnosis codes: 810.00, 810.02, or 810.12) in the emergency department, ambulatory surgery, or inpatient setting. The resulting retrospective cohort of 9802 patients from 34 hospitals (each of which contained a complete data set for each of the five years) was analyzed. Cost data was estimated using cost-to-charge ratio conversions reported to CMS. Cost and charge data was adjusted for the regional wage index, as reported by CMS, and to 2013 dollars to adjust for inflation. Chi-squared analysis was used to compare demographic characteristics, and Wilcoxon signed rank tests were used to test for differences in total hospital costs over time.

Results: Of 9802 adolescents treated for clavicle fractures over a 5-year period (mean age 13.9 years, SD 2.1 years, 83% males), there was a significantly higher percentage of males in the operative (86%) than non-operative sub-population (82%)($p<0.05$). The percentage of patients treated operatively increased from 5.7% in 2009 to 9.5% in 2013 ($p<.001$).The median total costs in 2013 for operative treatment was $6,465 (IQR 4,691 - 8,904), compared to $362 (IQR 254 – 500) for non-operative care (ratio, 18:1). Median charges were $21,356 (IRQ 12,833 – 28,006) and $1,221 (IQR 895 – 1,653), respectively (ratio, 18:1).

Conclusion: Surgery is being pursued with increasing frequency on adolescents at U.S. children's hospitals. Costs are approximately 18 times greater for operative treatment than non-operative treatment.

Significance: In the current healthcare climate, where cost-effective care is increasingly prioritized, higher levels of evidence investigating the outcomes of operative vs. non-operative treatment of adolescent clavicle fractures are critical to justify the increasing costs imposed by surgical treatment of adolescent clavicle fractures.

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Magnetically Controlled Growing Rod Achieves Estimated Cost Savings Compared to Traditional Growth Rods Over Five Years

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†LOE-Economic & Decision - Level II

Purpose: Traditional growing rods provide effective treatment for severe early onset scoliosis but require twice yearly lengthening surgery. The MAGEC system (MG) allows for rod lengthening in clinic, but the implant is very expensive, and the cumulative cost savings are not well understood. We aimed to compare the estimated direct cost of growing rod (GR) vs. MG from the time of index surgery to five years of treatment using an economic model with sensitivity analysis. We hypothesized that over the follow-up period the MG would become a cost-effective treatment strategy from a payer's perspective.

Methods: We developed a medical model identifying implant cost, index surgery, lengthening surgery, implant failure and infection as the major components of the cumulative treatment cost (**Table 1**). We estimated the implant cost at $38K for the MG and $9K for the GR. Cost of GR lengthening surgery was estimated at 10K. The individual costs of each variable as well as the occurring numbers of each event were estimated by literature and public inpatient database search or expert consultation. The cumulative cost was compared at each cumulative year over five years. Marginal cost was defined as the cost of (GR – MG) for each cumulative year. Sensitivity analysis was performed for adjusting for cost of implant, cost of lengthening procedure, infection and revision surgery.

Results: Use of MG resulted in a higher cumulative cost only at year one and two, then progressed toward lower costs than GR starting from year three through year five. The marginal cost at year one was a negative value of ($15,610), then trended to positive $37,948 at year five. (**Fig 1**) Sensitivity analysis showed an optimal marginal cost of $3,647 by maximizing the top three variables with highest uncertainties, as opposed to the base value of $37,948 at cumulative year five.

Conclusion: The MAGEC system achieved cost neutrality to the traditional growing rod system at three years after the index surgery and after three years became more cost effective than the GR system.

Significance: This is the first medical economic study in the US to compare the cost of the MG and GR systems. These results demonstrate the cost effectiveness of magnetically controlled growing rod from a payer perspective if at least three years of lengthenings are planned.

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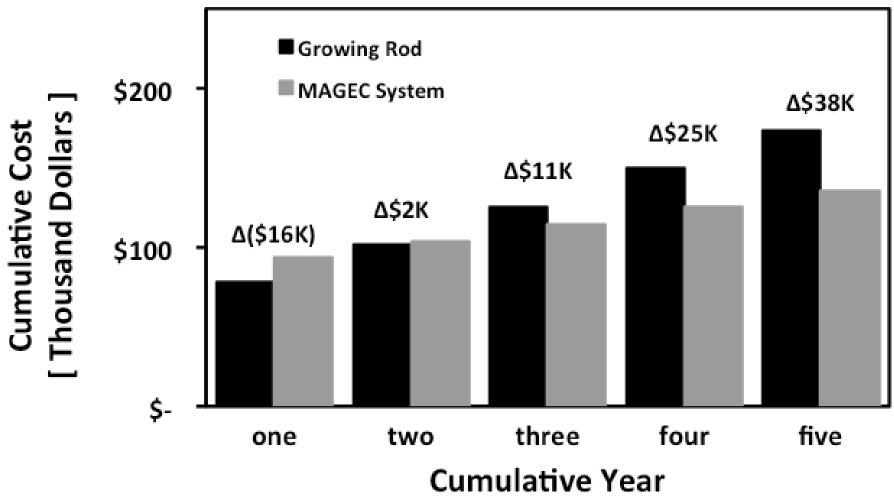

Figure 1. Cumulative cost by year; marginal costs presented atop of each bar group.

Table 1. Base, low and high cost values for sensitivity analysis comparing GR and MG.

	Base value ($)	Low value ($)	High value ($)	Events / year	Total Events / 5 years
Index Surgery ***GR & MG***	44,784	38,352	51,216	1	1
GR					
Cost of implant*	9,000	7,200	10,800	1	1
Lengthening procedure*	10,000	8,000	12,000	2	10
Revision surgery	44,784	38,352	51,216	0.038	0.190
Infection management	40,992	14,459	114,763	0.055	0.275
MG					
Cost of implant*	38,000	30,400	45,600	1	1
Lengthening procedure*	100	80	120	2	2
Revision surgery	44,784	38,352	51,216	0.218	1.090
Infection management	40,992	14,459	114,763	0.015	0.075

* expert consultation with the industry and institutional professionals

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Recurrence After Radiofrequency Ablation Treatment of Osteoid Osteomas Over a Decade in a Pediatric Hospital: Rates and Associated Factors

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†LOE-Therapeutic - Level IV

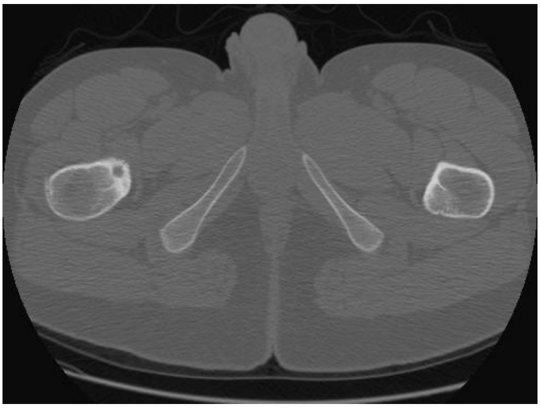
Purpose: To investigate the rate of recurrence of symptoms associated with osteoid osteoma after treatment with radiofrequency ablation (RFA) and to identify factors that are associated with higher rates of recurrence.

Methods: From 2004-2014, 91 patients (76% male; mean age 13.2 years) with a diagnosis of osteoid osteoma were treated with RFA. Lesions were treated using contiguous 1-mm CT imaging, 20G/1-cm active tip electrodes, and one 6-minute ablation at 90°C. Some multiform lesions were treated with two cathode placements in the same session. Records were reviewed for relief of symptoms, recurrence of symptoms, patient, tumor, and treatment variables.

Results: There were only 3 patients with recurrent symptoms after RFA treatment for osteoid osteoma, (3%). These lesions were more likely to be larger (nidus >10 mm) compared to those that did not recur. Factors that did not affect recurrence were age, gender, non-extremity location, intramedullary location, residual pain in the first week after treatment, and pathologic confirmation of osteoid osteoma.

Conclusion: CT-guided RFA of osteoid osteoma is a highly successful treatment modality resulting in full resolution of symptomatic pain in greater than 90% of pediatric patients after primary treatment. Larger tumors may be at higher risk for recurrence.

Significance: This is the largest reported series of patients in a pediatric hospital with osteoid osteomas treated with RFA.



†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Long-Term Outcome Following Lower Limb Salvage with Massive Bone Allograft and Intramedullary Free Fibula (Capanna Technique) in Pediatric and Adolescent Patients

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†LOE-Therapeutic - Level IV

Purpose: Following tumor resection, reconstruction of large segmental bone defects remains a major challenge in limb salvage surgery. Traditionally, structural allografts have been used to fill these voids; however, allograft reconstruction is associated with a high complication rate. Developed to reduce complications and improve outcomes, the Capanna technique involves supplementing the massive allograft with an intramedullary vascularized free fibula. The purpose of this study is to examine intermediate-term complications and outcomes using the Capanna technique for lower limb salvage in pediatric and adolescent patients.

Methods: Over a 15-year period 17 pediatric patients underwent lower extremity limb salvage using massive cadaveric allograft and intramedullary free fibular transfer (Capanna technique). Patients were followed prospectively and radiographic and medical records were reviewed for clinical and functional outcomes as well as postoperative complications. Time to union was determined by radiographic evaluation. Mankin functional outcome and Musculoskeletal Tumor Society (MSTS) rating scales were recorded for each patient.

Results: There were 8 male and 9 female patients, with an average age of 11(range 5 – 18) years at the time of surgery. Average follow-up was 6 (range 2 - 12) years. Limb salvage was successful in all patients. The average time to union of the allograft and fibula to the native bone was 10 months. Locked plating significantly reduced the time to union (p=0.03). Six patients (35%) underwent an additional procedure for symptomatic non-union. Sixteen (94%) of the patients had a good or excellent Makin score, with an average MSTS rating of 94 at last follow-up. Six patients required a limb lengthening procedure. Two patients experienced wound infection and late allograft fracture occurred in 3 patients. Femoral reconstruction and male gender increased the odds of complications; however this was not statistically significant (Table 1).

Conclusion: The Capanna technique is a reliable option for the reconstruction of large bone tumors of the lower extremity in pediatric patients. The use of locked plates improves union times. Limb preservation rates are excellent, and complication rates are acceptable.

Significance: The Capanna technique should be considered for pediatric and adolescent patients undergoing reconstruction of large, lower extremity, segmental bone defects.

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Table 1: Factors Associate with Complications Following the Capanna Technique

Factors Associated with Non-Union	Odds Ratio	95% CI	*p* Value
Postoperative Chemotherapy	0.35	0.02-4.15	0.60
Use of a Non-Locking Construct	0.18	0.02-1.61	0.18
Male Gender	2.4	0.3-19.04	0.61

Incidence of Intraspinal Exostoses in Multiple Hereditary Exostoses

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†LOE-Diagnostic - Level III

Purpose: To determine if the incidence of intraspinal exostoses in patients with Multiple Hereditary Exostoses (MHE) supports routine spinal screening with magnetic resonance imaging (MRI) for all patients.

Methods: A retrospective chart review of routine spinal screening performed with MRI on 39 patients (21 males, 18 females) with MHE was completed. The average age at screening was 12.3 years (range 3-17 years). Screening was done routinely after the age of eight years unless a child had complaints that could be related to intraspinal exostoses (2 patients). 8 patients complained of neurologic symptoms at the time of screening and 3 others had extremity or back pain.

Results: Intraspinal lesions with cord impingement were seen in the cervical spine of two patients and in the thoracic spine of one patient. All three patients had neurologic symptoms. Resection of two of the three intraspinal lesions was carried out and the third patient is under observation. The patient with the thoracic lesion has a permanent neurologic deficit due to delayed treatment. Four additional patients had enlargement of bony elements the around the spinal canal but no intraspinal lesions. No patients had evidence of syringomyelia. Three other patients with neurologic symptoms were found to have local peroneal nerve compression at the knee. Two patients had neurologic symptoms without a known cause. The pain complaints resolved spontaneously in the children with pain.

Conclusion: The incidence of intraspinal lesions is this group of 39 patients with HME was 8%. This percentage is considerably lower than that reported in a similar size study of surveillance (27%) [1] and closer to the results of a smaller study (11.5%) [2]. All of the patients with intraspinal lesions had neurologic symptoms.

Significance: Routine spinal screening with MRI in HME is expensive. Routine screening of the cervical spine only or selective screening based on symptoms may be more appropriate.

References:

1. Roach JW, Klatt J, Faulkner ND. Involvement of the Spine with Multiple Hereditary Exostoses, *J Bone Joint Surg Am*. 2009;91:1942-8.
2. Thompson RL et al, Synringomyelia and vertebral osteochondromas in patients with multiple hereditary exostosis. *J Ped Orth B*. 2014; 23(5):449-453.

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Can You Retain Spinal Hardware in Acute Postoperative Infections? A Multicenter Study

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Purpose: Unlike chronic (>3 months) surgical site infections (SSIs) after pediatric posterior spinal fusion (PSF) where attempts of implant retention is often futile, the natural history of acute SSIs (<3 months) after PSF is not known and removing the implants during this time period is not often an option. The purpose of this study is to understand factors that may indicate whether implants should be retained or removed when treating these events.

Methods: Between 1999 and 2011 patients with SSIs who required irrigation and debridement (I&D) within 3 months of PSF were identified from 4 institutions. Univariable and multivariable regression analysis was used to identify risk factors associated with failure of treating the acute infection.

Results: 101 patients, including 70 females and 31 males with a mean age of 14.1 (8.4 to 23.4) years were identified. 76 had syndromic or neuromuscular disease. Median follow up after initial surgery was 2.3 yrs. Eighty (79.2%) were treated with serial I&D and implant retention (71), acute implant exchange (8), or hardware removal (1) and did not return with recurrent infection (cleared infection (group C)); twenty-one (19.8%) returned later with persistent chronic infection (recurrent infection (group R)). Group R patients re-presented at a median of 542 days [IQR: 462-900] after index procedure; patients in group C were followed from first I&D for a median of 882 days (596-1333). For each additional I and D required during acute treatment, the odds of recurrent infection increased by 21% (OR=1.23; 95%CI=1.02-1.48; p=0.03). The proportion of non-idiopathic patients in Groups C (76%) and R (75%) were similar (p=0.91). In multivariable analysis, patients with stainless steel implants presented with recurrent infection (14/48; 29%) more frequently than other metal types (2/41; 5%, OR=8; 95%CI=1.7-37.9); p=0.008. There was no different in the initial time of presentation after index procedure between Group C (20d) and Group R (14d) p=0.11. Rate of positive cultures (80% vs. 87% p= 0.43) and microbiology of cultured organisms did not differ between groups. The time on antibiotic treatment was not significantly different between Groups C and R (median 6 weeks both groups).

Conclusion: 79.2% of patients presenting with a SSI <3 months after PSF did not require implant removal to clear their infection.

Significance: Acute postoperative SSIs can often be treated with retention or exchange 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 20 for details.
See pages 21- 66 for financial disclosure information.

Cumulative Radiation Exposure with EOS® Imaging Compared to Standard Spine Radiographs

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†LOE-Diagnostic - Level III

Purpose: EOS® is a slot-scanning x-ray system designed to reduce radiation exposure in orthopaedic imaging. There are few independent studies comparing EOS® PA, AP, and lateral imaging vs. conventional projection radiographs for children with spinal deformity and most report skin entrance dose. We sought to estimate the total radiation exposure to scoliosis patients during the course of treatment using standard imaging techniques vs. EOS® PA and AP views.

Methods: Forty-two skeletally immature idiopathic scoliosis patients were treated with bracing (21) or spinal fusion (21) and were followed to skeletal maturity. The number of scoliosis radiographs (PA and lateral) for each patient was recorded. A computerized dosing model was used to calculate estimated patient and organ doses for PA and lateral scoliosis x-rays taken with EOS®, computed radiography with and without filter (CR and CRF). At this time, our EOS system did not have a copper filter. Assuming that each x-ray taken delivered the same radiation as the phantom calculation, we estimated the total effective and organ dose that each child would have received using EOS®, CR, or CRF. Annual background radiation is 3 mSv.

Results: Mean number of radiographs per patient was 20.9 (range 8-43). Patients who underwent surgical treatment had a significantly greater number of x-rays than patients who were braced (27.3 vs. 14.5, $p<0.001$). Assuming all films were CR, the mean cumulative dose is estimated at 5.4 mSv. With EOS® films, the mean cumulative estimated dose is 2.7 mSv, a decrease of 51%. An AP vs. PA EOS® radiograph results in an 8X higher radiation dose to the breasts and 4X higher dose to the thyroid.

Conclusions: The EOS® imaging system moderately reduced the total radiation exposure to skeletally immature scoliosis patients. Over the entire treatment course, use of EOS instead of CR represents 2.7 mSv mean dose reduction (or 0.91 years of background radiation). PA films significantly reduced breast and thyroid dose.

Significance: Dosing to the thyroid is 4 times higher and to the breast is 8 times higher with an EOS AP compared to PA film. Compared to CR imaging, our EOS imaging technology (without the copper filter) resulted in a 50% decrease in total effective radiation dose. This is less reduction than most previous studies on this topic, which simply reported skin entrance dose.

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Table. Estimated Dosing for Each Type of Radiograph

		Estimated Dose PA				Estimated Dose Lateral			
	EOS® AP	EOS® PA	X-ray with Filter (CRF)	X-ray no Filter (CR)	Intraop T-Spine	EOS® Lateral	X-ray with Filter (CRF)	X-ray no Filter (CR)	Intraop T-Spine
Thyroid (mGy)	0.19	0.05	0.02	0.09	0.03	0.24	0.07	0.51	0.13
Breast (mGy)	0.19	0.02	0.02	0.08	0.05	0.16	0.06	0.21	1.70
Ovary (mGy)	0.08	0.08	0.07	0.27	0.00	0.09	0.20	0.25	0.00
Testicles (mGy)	0.25	0.04	0.01	0.02	0.00	0.05	0.03	0.02	0.00
Active Bone Marrow (mGy)	0.05	0.10	0.08	0.32	0.15	0.09	0.19	0.29	0.39
Effective Dose ICRP103 (mSv)	0.121	0.069	0.057	0.215	0.119	0.121	0.162	0.295	0.712

Spinal Infections in AIS and Neuromuscular Scoliosis: Are MRSA Nares' Cultures Predictors of Trouble To Come?

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Purpose: Infections after PSF are rare but significant. Infections with MRSA makes these even more overwhelming. The purpose of our study was to review our series and also evaluate the usefulness of performing preoperative nasal MRSA cultures as a risk factor for the development of infection.

Methods: 526 spinal procedures were identified and demographic data collected. Nares' cultures for MRSA and the results were recorded and compared to the database for presence or absence of spinal infection and organisms. 332 patients were prior to nares' cultures.

Results: We had nares' cultures for 205 patients. 193/205 nare cultures were negative and 12 positive (5.8%). 4/12 developed an infection, two of those demonstrated MRSA as the causative organism. 12/193 patients without positive nares cultures developed an infection (6.2%), 2/12 were MRSA infections, one of them had a prior MRSA infection at another site. 201 Neuromuscular and syndromic patient. 19 infections were identified (9.5%); 7/19 had multibacterial infections.14 infected neuromuscular patients with positive nares cultures: 4 positive, 10 negative; 5 additional infections were prior to nares cultures. Of the 4 positive for MRSA, 2 were infected with MRSA despite MRSA decolonization. 2 patients infected with MRSA were negative on the nares' cultures. However, one of the negative nares cultures developed the MRSA infection, 192 days post op after undergoing a hip procedure that became infected with MRSA.

325 AIS patients. 5 patients developed infection with MSSA (1.5%); 2 were multibacterial infection. All the AIS patients (89) had negative nare cultures and none developed MRSA infection.

Conclusion: There is a higher incidence of wound infections in neuromuscular patients. All MRSA infections in our series developed in the neuromuscular population. Surprisingly, patients who developed infection had similar surgical times and lesser blood loss. The nasal cultures did not seem predictive for infection risk. However, positive MRSA cultures in the nares correlated with deep wound infection with MRSA.

Significance: The risk to develop a MRSA infection is present despite negative cultures. Most of the neuromuscular patients will develop multibacterial infection. Coverage for pseudomonas and fecal bacteria should be considered as part of the prophylactic antibiotic protocols. Every attempt should be made to try to eradicate any MRSA colonization prior to 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 9.

Predictive Factors for Differentiating Between Septic Arthritis and Lyme Disease of the Knee

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Purpose: Differentiating between septic arthritis and Lyme disease of the knee in endemic areas can be challenging and has major implications for patient management. The purpose of this study was to identify a prediction rule to differentiate septic arthritis (SA) from Lyme disease (LD) in children with knee pain and effusion.

Methods: We retrospectively reviewed the records of children <18 years of age with knee effusions who underwent arthrocentesis at our institution from 2006-2009. Patients with either joint fluid cultures positive for SA or positive Lyme IgG on western blot analysis were included. To avoid misclassification bias, patients with culture negative SA, and undiagnosed knee effusions were excluded. Historical, clinical, and laboratory data were compared between groups to identify variables for comparison. Binary logistic regression analysis was used to identify independent predictive variables.

Results: 92 patients were studied: 31 (34%) with culture positive SA and 61 (66%) with LD. Based on univariate analysis, patients with SA were significantly more likely to have elevated temperature on presentation, pain with short arc motion on physical exam, and elevated WBC, ANC and CRP. Multivariate binary logistic regression identified short arc pain, presenting temperature >100° F, and CRP> 3mg/L as independent predictors for SA. (Table 1) A simpler model was developed which showed that the risk of septic arthritis with 0, 1, 2 or all 3 of these factors was 0, 21, 56 and 100% respectively.

Conclusion: Although SA of the knee and Lyme monoarthritis share common features that can make them difficult to distinguish clinically, the presence of pain with short arc motion, CRP >3.0, and presenting temp >100° F were independent predictors of SA. In our cohort no patient without a risk factor had SA, whereas patients with all three risk factors had SA in every case.

Significance: Application or our prediction rule can help differentiate SA from LD in Lyme endemic areas, and therefore expedite patient management decisions.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Table 1: Multivariate analysis for three independent predictors

Multivariate Predictor	Regression Coefficient	Adjusted Odds Ratio	95% Confidence Interval	P Value
Pain with short arc motion	3.4	31.4	5.9 – 167.4	<0.01
CRP (> 3mg/L)	1.6	4.8	1.0 – 22.4	0.046
Temperature (>100° F)	2.3	9.6	1.8 – 52.4	<0.01

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The Use of C-Reactive Protein as a Guide to Transition to Oral Antibiotics in the Management of Pediatric Osteoarticular Infections

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Purpose: In the treatment of paediatric osteoarticular infections, early transition to oral antibiotics is desirable to shorten hospital stays and complications of prolonged intravenous therapy. C-reactive protein (CRP) is an acute phase reactant with a short half-life and is utilized at our institution to monitor progress and determine transition to oral antibiotics. We hypothesized that patients can be safely transitioned from parenteral antibiotics to oral antibiotics when patients improve clinically and CRP drops below 50% over a period of five CRP half-lives or approximately four days.

Methods: From 2007 to 2013, all paediatric patients between the ages of 1 month to 18 years were admitted and treated for acute bacterial osteomyelitis and/or septic arthritis at the authors' institution. We recorded all relevant data, inpatient progress, and outpatient follow-up through retrospective chart review.

Results: Thirty-seven patients fulfilled the inclusion criteria and were reviewed for this study. Patients were an average of 8.37 ± 4.91 years old. Surgery was performed for 33 patients (89.1%). The average duration of intravenous antibiotics was 11.00 ± 5.61 days and the average duration of oral antibiotics was 28.75 ± 8.69 days, with an average total duration of antibiotics of 39.16 ± 9.08 days. The average peak CRP was 156.91 ± 97.81 mg/L and the average CRP at discharge was 24.94 ± 22.35 mg/L. Thirty-five patients (94.5%) experienced a 50% decline in CRP over four days. Of these patients, only one (2.9%) went on develop complications in the follow-up period. The average hospitalization period was 11.5 ± 6.56 days. The average duration of follow up was 7.83 ± 6.56 months.

Conclusion: We found that the combination of clinical improvement and a specific reduction of 50% in CRP levels over four days or five CRP half-lives could be used to determine when to transition children with osteoarticular infections from parenteral to oral therapy. Complicated outcomes were associated with negative cultures, longer hospitalizations, and persistently elevated CRP, suggesting difficulty in optimizing antibiotic therapy or poor response to therapy.

Significance: While there is some consensus with respect to the total duration of antibiotics for pediatric osteoarticular infection, there remains very little objective clarity with regards to the guidelines for transition to oral antibiotics. Our study provides an objective guide using CRP as described above.

†LOE - Level of Evidence - Please see page 20 for details.
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Prevalence and Complications of Musculoskeletal Infections in Adolescents: A Result of Delay in Diagnosis?

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Purpose: Musculoskeletal infections in children commonly occur in the first decade of life and there is little data about their prevalence and characteristics in adolescents. The purpose of this study was to evaluate the prevalence, characteristics, and complications of musculoskeletal infections in adolescents at a tertiary care children's hospital.

Methods: A retrospective study of patients with musculoskeletal infections ages 10-17 years at our institution from 2008 to 2013 was performed. Demographic data, historical information, laboratory values, imaging studies, surgical records, and clinical outcomes were extracted from the medical record.

Results: Thirty patients (21 males, 9 females) with an average age of 12.6 years were diagnosed with and treated for musculoskeletal infection including osteomyelitis (n = 15), septic arthritis of the hip (14) and knee (3), deep soft tissue infections (8), and sacroiliitis (3). Mean time from onset of symptoms to diagnosis was 9.2 days (range, 1-30 days). Twenty-five of 30 patients were assessed by at least one outpatient provider including 11 who had seen 2 or more providers and were discharged without a diagnosis of musculoskeletal infection. At admission, 93% had focal pain symptoms, 57% were full or partial weight-bearing, but only 6% were febrile. Mean admission white blood cell count was 11.6, ESR 50.6, and CRP 15.5. Eight patients (27%) had multifocal infection confirmed on MRI. Twelve patients (40%) had medical complications (including DVT, PE, and secondary pneumonia) or musculoskeletal sequelae of infection (including avascular necrosis, limb length discrepancy, and arthralgia requiring arthroplasty or arthrodesis) at final follow-up. Compared to the group with no complications, the complication group had a significantly elevated admission CRP (22.7 vs 10.7, p=0.003), longer length of hospital stay (15.1 vs 5.1 days, p = 0.002), and a trend toward longer duration of symptoms prior to diagnosis (11.5 vs 7.9 days, p=0.256).

Conclusion: Adolescents with musculoskeletal infections frequently experience a profound delay in diagnosis and high complication rate. These patients present with pain but are usually afebrile and able to weight-bear. These nonspecific presenting symptoms may contribute to missed diagnosis by multiple providers and thus delay in diagnosis. In this population, a delay in diagnosis is associated with significant medical and musculoskeletal complications. Multifocal infection was diagnosed in 27% of these patients, suggesting that axial imaging may be an important diagnostic tool in this population.

Significance: The long-term morbidity of infection in older children is significant and may be related to delay in diagnosis.

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Remodeling and Longitudinal Growth of the Hip After Unthreaded Fixation of Slipped Capital Femoral Epiphysis

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Introduction: The optimal treatment in patients with slipped capital femoral epiphysis (SCFE) remains controversial. The standard treatment in Sweden is unthreaded fixation over the physis with the LIH-hook pin, permitting continued growth of the femoral neck. The purpose of the present study was to study the amount of remodelling of the proximal femur that occurs after fixation with the LIH-hook pin.

Methods: We performed a retrospective study of 54 patients treated with the LIH-hook pin for SCFE between 2001-2009. The immediate postoperative radiograph and the radiograph after physeal closure (mean interval: 34 months) were analysed. Four radiographic assessments were used: head-shaft angle (HSA), alpha angle of Notzli, displacement from Klein's line and longitudinal growth assessed by nail protrusion from the lateral cortex.

Results: Significant remodelling was detected in all measured parameters. Mean lengthening of the femoral neck was 7,1 mm ($p<0,001$) over the reviewed period. The mean postoperative HSA decreased by 9.0° ($p < 0.001$). Displacement from Klein's line decreased by mean 1.6 mm ($p=0,006$). The alpha angle improved by a mean of 14.5° ($p=0,001$). A positive correlation was found between the alpha angle and the longitudinal growth of the femoral neck.($p = 0.01$).

Conclusion: Unthreaded fixation of SCFE with the LIH-hook pin leads to substantial remodelling and continued growth of the femoral neck. The positive correlation between the improvement of the alpha angle and femoral neck growth supports the use of a method that allows continuous growth in order to reduce the risk of femuroacetabular impingement.

Significance: Favourable remodelling and continued growth of the femoral neck by using unthreaded fixation of SCFE suggests advantages in using a device not causing a physiodesis in the proximal physis of the femur.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Slip Progression After In-Situ Screw Fixation of Slipped Capital Femoral Epiphysis

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Purpose: Slip progression after in situ screw fixation is rarely reported and its true incidence is unknown. Greater than five threads across the physis is the only known factor to minimize slip progression after in situ screw fixation. The purpose of this study was to determine the incidence of continued slip progression after in situ screw fixation and identify potential risk factors for this post-operative complication.

Methods: This was a retrospective review of all patients presenting for treatment of a slipped capital femoral epiphysis from January 1, 2003 through December 31, 2012 at two major children's hospitals. Exclusion criteria were previous surgical treatment at an outside institution or lack of follow-up through physeal closure. A slip was considered to have progressed if the Southwick angle increased post-operatively by more than ten degrees prior to physeal closure.

Results: A total of 112 patients met the inclusion criteria. Thirteen of these patients demonstrated an increase in Southwick angle of ten degrees or more after in situ screw fixation (11.6%). Males were significantly more likely to demonstrate slip progression than females (26% versus 3%, $p<0.001$). Body mass index, weight, age at presentation, duration of symptoms, and co-morbid conditions were not significantly associated with continued slip. Patients with bilateral SCFE at presentation did not have an increased incidence of continued slip ($p=0.223$). Twenty-three percent (12/52) of stable slips demonstrated slip progression versus 14% (1/7) of unstable slips ($p=0.598$). Wilson percent displacement ($p=0.06$) and Southwick angle ($p=0.899$) at presentation were not associated with continued slip. Less than five screw threads across the physis was associated with continued slip ($p=0.049$). However, number of screws used was not associated with continued slip ($p=0.605$).

Conclusion: Male patients and patients with less than five threads across the physis were at increased risk of continued slip after in situ pinning.

Significance: Male patients have an increased risk of continued slip progression after in situ pinning and may warrant closer follow-up. Greater than five screw threads across the physis decreases the risk of slip progression after in situ pinning.

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Long-Term Health Status After In-Situ Fixation for Slipped Capital Femoral Epiphysis

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Purpose: Percutaneous in-situ fixation is the gold-standard treatment for slipped capital femoral epiphysis (SCFE). Previous long-term studies have documented good to excellent clinical and radiographic outcomes. Few studies have documented long-term health status in these patients.

Methods: We performed a cross-sectional study with retrospective chart review to describe the long-term health status of a cohort of 66 patients (93 affected hips) and to determine whether higher slip angle was predictive of poorer health outcomes. Health outcomes included SF-12 Physical Component Score (PCS) and Mental Component Score (MCS), modified Harris Hip Score (mHHS) and UCLA Activity Scale.

Results: Mean age at presentation and follow-up were 12.7 years and 32.5 years, respectively (mean follow-up = 19.8 years, range: 13.5-29.4 years). The cohort reported a 4 times higher rate of diabetes and 2.5 times higher rate of hypertension than the general US population. 7% reported chest pain with exertion and 29% reported that their health interferes with their work performance. Mean BMI increased 10.0 kg/m2 with 73% of subjects meeting the criteria for 'obese' (BMI>30) at follow-up.

Mean age- and gender-adjusted PCS and MCS were 49.2 (range: 18.8-64.0) and 50.1 (range: 26.0-64.6), respectively. Mean mHHS was 84.4 (range: 40.4-99.0). Multivariable general linear modeling revealed no significant association between initial slip angle and all patient-reported outcomes. Male sex and lower BMI were the only predictors significantly associated with PCS, mHHS and UCLA Activity Scale. Bilateral involvement was not associated with worse outcomes.

Conclusions: The general self-reported health of this cohort was poor compared to the general population. BMI showed a dramatic increase from presentation to follow-up and was one of the only clinical predictors associated with worse patient-reported health status. Surprisingly, slip angle on presentation did not correlate with these outcome measures. Weight management should be incorporated in the management of children with SCFE to in an effort to improve long-term general health and health outcomes. Further study is indicated to determine whether self-reported health status declines with longer follow-up.

Significance: The long-term general health of a cohort of SCFE patients was poor but increased slip angle did not correlate with our patient-reported outcomes.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

The Modified Dunn Procedure vs. In-Situ Pinning for Treatment of Severe Stable Slipped Capital Femoral Epiphysis

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Purpose: The purpose of this study was to compare the modified Dunn procedure versus in-situ pinning for treatment of severe stable slipped capital femoral epiphysis (SCFE) in terms of (1) proximal femoral radiographic deformity, (2) clinical outcome, (3) complication rate, and (4) need for subsequent surgery.

Methods: Following IRB approval, 323 patients who underwent treatment for SCFE between January 2001 and December 2012 were identified. A total of 49 severe (Southwick angle ≥60°) and stable (weight bearing at presentation) SCFE patients were identified. In two bilateral cases, only the first hip was included. We excluded 15 patients with less than one-year follow-up, one treated by femoral osteotomy and one with high-energy trauma after initial treatment. Thus 15 patients treated by modified Dunn and 15 by in-situ pinning with mean follow-up of 2.5 years (range 1-6) were included. The two groups were statistically comparable in regards to age at surgery, gender, affected side and follow-up duration. Medical records and preoperative and most recent radiographs were assessed for Southwick angle, femoral head-neck offset and alpha angle measurements. The Heyman and Herndon system was used for assessment of clinical outcome.

Results: Preoperative AP-alpha angle (p=0.1480), lateral alpha angle (p=0.7336), femoral head-neck offset (p=0.9256), and Southwick angle (p=0.6143) were similar between groups. At the latest follow-up there was significant difference in AP-alpha angle (p=0.0017), lateral alpha angle (p=0.0005), femoral head-neck offset (p=0.0002), and Southwick angle (p<0.0001) between groups. At latest follow-up 9/15 patients in the modified Dunn group were rated good or excellent compared to 4/15 in the in-situ pinning group (p=0.0343;odds-ratio 5.86; 95%CI:1.13 to 40.43). Three patients developed five complications after in-situ pinning, whereas 2/15 patients developed three complications after modified Dunn (p=0.6588;odds-ratio,1.6; 95%CI:0.20 to 15.03). In the modified Dunn group, 2/15 patients required three subsequent surgical procedures while seven patients in the in-situ pinning group required nine subsequent surgeries (p=0.0230; odds-ratio 8.4; 95%CI:1.32 to 90.37).

Conclusion: The modified Dunn procedure allows for greater radiographic restoration of the femoral head and neck morphology, better short-term clinical outcome, lower rate of reoperation and similar occurrence of complications when compared to in-situ pinning for treatment of severe stable SCFE. Further studies are necessary to evaluate the role of the modified Dunn procedure in preventing the development of osteoarthritis associated with severe stable SCFE.

Significance: When compared to in-situ pinning, the modified Dunn achieves superior short-term results for the treatment of severe stable SCFE.

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The False Profile Radiograph: Is it an Accurate and Precise Method of Assessing Anterior Coverage?

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Purpose: The false profile radiograph is commonly utilized to assess anterior hip coverage and is positioned with the pelvis rotated 25° from a true lateral of the pelvis. However, the validity of the anterior center edge angle (ACEA) in assessing anterior femoral head coverage has not been validated. The purpose of the current study was (1) to determine the correlation between the ACEA on plain radiographs and anterior coverage on three-dimensional CT imaging and (2) to determine the variability in pelvic rotation present in the clinical use of the false profile radiograph.

Methods: Fifty-eight patients undergoing hip preservation surgery, including 31 with acetabular dysplasia and 27 with femoroacetabular impingement, were included in the study. False profile radiographs using a standardized positioning and low-dose computed tomography (CT) scans were obtained for preoperative planning. An ACEA less than 20 degrees was considered deficient. Three-dimensional models were constructed utilizing novel software. A simulated false profile projection was created with exactly 25° of pelvic rotation. In the "CT-based" false profile radiograph, the distance between femoral heads and the width of the obturator foramen was recorded. Finally, the pelvic model was positioned to match the distance between the femoral heads seen on plain radiographs and the "actual" degree of rotation of the false profile radiograph determined.

Results: The ACEA averaged 26.3° (range -8° to 59°). The ACEA was most strongly correlated with radial coverage at 12:00 (Pearson correlation coefficient 0.75), compared to 1:00 (0.69), 2:00 (0.53), and 3:00 (0.53). An abnormal ACEA was most predictive of deficient coverage at 12:00 (positive predictive value 0.80), while an abnormal ACEA was sensitive to deficiency at the 1:00/2:00/3:00 positions (sensitivity 0.78, 1.0 and 0.78, respectively). Utilizing three-dimensional modeling, the mean distance between femoral heads on an optimal (25° rotation) false profile radiograph (was determined to be 0.7 $\pm$ 0.1 (range 0.4 to 0.9) of the diameter of the femoral head. The rotation of false profile radiographs averaged 37.0° $\pm$ 9.4° (range 14-60°) in the cohort.

Conclusion: Measurements of the ACEA on false profile radiographs do not strongly correlate with anterior femoral head coverage on three-dimensional imaging. Despite standardized radiographic techniques, significant variation exists in the actual pelvic rotation observed during false profile radiographs with excessive rotation generally occurring.

Significance: CT-based analysis reveals that a correct false profile radiograph is present when the distance between the femoral heads is approximately 0.4-0.9 times the diameter of the femoral head.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Expectations and Satisfaction of Patients of Outcomes After PAO Surgery

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Purpose: The fulfillment of patients' expectations is an essential factor in their satisfaction with outcomes of their surgery. Comparison of the clinical outcomes anticipated by the patients and their surgeons provides an effective assessment of whether patients have realistic expectations based on adequate understanding of the nature of their symptoms and the likely effects of the prospective surgery on their condition. This study explored the agreement in expectations of patients and surgeons of the outcomes of PAO surgery, and the relationship between patient expectations and the patient-rated global treatment outcome.

Methods: Two surgeons and their combined 58 patients (82.5% female; mean age of 26.8 ± 9.7 years), preoperatively completed 4-point Likert-scales rating their realistic expectations of improvement ("not improved at all" to "greatly improved") in six domains representing different hip symptoms after surgery. Domains included pain, stiffness, locking, stability, walking ability and athletic ability. Concordance between patient and surgeon expectation was evaluated by the percent of exact and partial (within one rating) agreement as well as Kappa coefficients. 6 and 12 months postoperatively, 50 and 33 patients respectively rated the global outcome of surgery (GTO, 5-point Likert-scale: surgery was "extremely helpful" to "extremely unhelpful"), and their perceived fulfillment of expectations for improvement in each symptom domain (4-point Likert: "beyond expectation" to "not as I expected").

Results: Exact agreement between patients and surgeons ranged from 19.6% to 55.2%. Partial agreement between patients and surgeons ranged from 51.8% to 100%. Agreement was lowest regarding expected hip stiffness and highest regarding expected pain following surgery. Weighted Kappa estimates were low ranging from 0.08 to 0.52. In instances of disagreement, patients consistently had higher expectations than the surgeon especially with respect to athletic ability, walking ability and stiffness of the hip. The median (IQR) for the GTO were 1 (1-2) and 2 (1-2) at 6 and 12 months after surgery respectively. Spearman's rank correlation analysis of follow-up data revealed strong associations ($P<0.001$) between the GTO and the patients' ratings of their fulfilled expectations for each symptom domain.

Conclusions: Patients' expectations were more optimistic than their surgeons of the outcomes of the PAO. Fulfilling expectations of improvement in each hip symptom was important for a good outcome. Our findings highlight the need for clearer understanding between patients and surgeons on the effectiveness of the PAO in improving hip stiffness, walking and athletic ability.

Significance: A study on expectations and satisfaction with outcomes has not yet been reported on patients undergoing periacetabular osteotomy (PAO) to treat Developmental Dysplasia of the Hip (DDH).

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Ilfeld Abduction Orthosis is an Effective Second Line Treatment Following Failure of Pavlik Harness for Infants with DDH

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Purpose: Closed reduction and spica casting is the most commonly recommended choice for infants with DDH who fail Pavlik harness, but this requires general anesthesia in addition to the challenges of spica cast care. The purpose of this study was to evaluate the effectiveness of Ilfeld bracing for infants in whom a Pavlik is unsuccessful and compare these results to a similar cohort of patients directly undergoing closed reduction.

Methods: We retrospectively reviewed a consecutive series of children with DDH who failed Pavlik harness and were subsequently managed with Ilfeld bracing (BR), and compared this cohort to a similar historical group of infants who failed Pavlik treatment but underwent standard closed reduction and spica casting (CR). Syndromic hips and those that were irreducible were excluded. Clinical and ultrasonographic data at the time of Pavlik discontinuation were compared between both cohorts. At one year, hip stability and acetabular index were assessed; presence of avascular necrosis (AVN) was graded according to Salter's criteria.

Results: 28 hips (18 infants) comprised the BR cohort and 22 hips (16 infants) comprised the CR cohort. Ultrasonographic indices at Pavlik discontinuation (alpha angle and % femoral head coverage) were comparable between the two cohorts (p=0.66, 0.19). Following treatment, a stable reduction was achieved in 23/28 (82%) hips in the BR cohort compared to 20/22 (91%) hips in the CR cohort. Of the five hips that failed Ilfeld bracing, two subsequently failed CR and required open reduction. At 1 year, acetabular indices were similar between both cohorts (27° ± 6° for BR vs. 27° ± 5° CR, p=0.62); however, the CR cohort had 3 cases of AVN compared to none in the braced cohort.

Conclusions: In our series of infants with DDH who had previously failed a Pavlik harness, 82% were treated successfully with Ilfeld bracing and avoided anesthesia and a series of spica casts. In addition to achieving similar clinical outcomes, abduction bracing avoids the burden of prolonged casting and may be associated with a lower risk of AVN compared to CR.

Significance: Ilfeld bracing should be considered as the next step for those infants who have failed Pavlik treatment prior to proceeding with CR.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

The Risk of Avascular Necrosis Following Early Treatment with the Von Rosen Splint for Neonatal Instability of the Hip

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Purpose: The purpose of this study was 1) to determine the risk of avascular necrosis of the femoral head (AVN) after early treatment with the von Rosen splint and 2) to measure the diameter of the ossific nucleus of the femoral head at 1 year, comparing to a reference group.

Methods: All children born in Malmö undergo clinical screening for neonatal instability of the hip (NIH). We retrospectively reviewed the1-year radiographs of children treated for NIH with the von Rosen splint in our department from 2003 through 2010. Signs of AVN were classified according to Kalamchi and MacEwen. All subsequent hip or pelvic radiographs, hospital charts and a local registry of diagnoses were also reviewed. The diameter of the ossific nucleus at 1-year radiographs was measured. Comparisons were made to a reference group of children who had been referred on suspicion of NIH, but had normal hip stability on dynamic sonography.

Results: 240 of 586 referred children received treatment for NIH during the study period. 6 treated children were lost to 1-year follow-up. 229 of the remaining 234 children had early treatment start (age ≤ 7 days). The other 5 had treatment initiated at median 12.5 days age (range: 8 – 34), due to neonatal intensive care. 2 cases of group 1 AVN (0.9%) were found in the treated children. Both had spontaneous resolution and were asymptomatic during the observation time (3.6 and 8.0 years respectively). One treated child was diagnosed with acute myeloid leukemia at 2.5 years age and developed Perthes' disease concurrently. The mean observation time was 6.5 years (range: 2.8 – 10.8). 466 children met the inclusion criteria for radiographic measurement of the ossific nucleus. Neonatally dislocated hips had smaller ossific nuclei compared to neonatally stable hips ($p < 0.001$): 9.4 mm (95% CI: 9.1-9.8) vs. 11.1 mm (95% CI: 10.9-11.3) at 1 year.

Conclusion: Early treatment with the von Rosen splint for NIH carries a 0.9% risk of group 1 AVN. The ossification of the femoral head is slower in children with NIH compared to controls.

Significance: Since studies on closed reduction of hip dislocation in older children show higher rates of AVN, we argue that neonatal screening and early treatment is comparatively safe.

♦ 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 9.

Success with Pavlik Treatment for Dislocated but Irreducible Hips in Infants Aged <6 Months

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†LOE-Therapeutic - Level IV

Purpose: To compare treatment methods and outcomes for infants with dislocated but irreducible (D/I) hips, in order to optimize management of this difficult patient cohort.

Methods: A multi-center prospective hip dysplasia study database was analyzed from 2010 to 2014. All infants aged <6 months with dislocated but irreducible hips were included in the study.

Results: 53 hips in 47 patients aged <6 months were included. All hips were clinically and radiologically dislocated and have ≥2 year follow up. Mean age at diagnosis was 1.6 months (range 0.0 – 5.9 months). There were 31 left hips, 10 right hips and 12 bilateral hips (6 patients). 42 of 53 hips were treated initially in Pavlik harness, 11 hips were treated by alternative braces / primary closed or open reductions. Pavlik treatment was successful in 5 out of 12 bilateral D/I hips (42%). 32 unilateral D/I hips were treated in Pavlik harness. 21 of 32 unilateral hips were successfully reduced (66%). 11 of 32 unilateral D/I hips had Pavlik treatment abandoned, 2 due to femoral nerve palsy and the remainder due to failure to achieve reduction. No statistical difference in age at diagnosis was demonstrated between success or failure of reduction ($p=0.37$). Left sided hips were more likely to be successfully reduced in Pavlik harness than Right hips ($p=0.005$). Five complications occurred. Three patients developed femoral nerve palsy in Pavlik harness, but had subsequent successful closed or open reductions. Two patients developed avascular necrosis, one at 18 months of age, having had 3 weeks of unsuccessful Pavlik harness treatment aged 3 months and a closed reduction aged 11 months, and one at 24 months of age having had femoral nerve palsy in harness and subsequent open reduction aged 11 months.

Conclusion: Pavlik harness treatment has been demonstrated to be a safe and sensible first line treatment for infants with unilateral D/I hips. Left sided hips were more likely to be successfully reduced in Pavlik harness than Right hips, but age has not been shown to be a predictor up to the age of 4 months. This study has identified less success in Pavlik treatment for patients with bilateral D/I hips.

Significance: The outcomes demonstrated from this multi-centre prospective database inform management of this complex patient cohort.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Avascular Necrosis in Children with Cerebral Palsy After Reconstructive Hip Surgery

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Purpose: Progressive hip subluxation is one of the most common orthopedic pathologies in children with cerebral palsy. Reconstructive hip surgery has become the standard treatment of care. Reported avascular necrosis (AVN) rates for hip reconstructive surgery in patients with cerebral palsy (CP) vary widely in the literature. The purpose of this study is to identify the frequency and associated risk factors of AVN for reconstructive hip procedures.

Methods: A retrospective analysis was performed of 54 children (87 hips) with CP, treated with reconstructive hip surgery between 2009 and 2013. All 87 hips underwent a varus derotation osteotomy (VDRO), with 59% (51) having combined VDRO and pelvic osteotomies, and 21% (18) requiring open reductions. The mean age at the time of surgery was 8.78 (3-17.3) years and 91% of the patients were Gross Motor Function Classification System (GMFCS) IV and V. Radiographic parameters of dysplasia were analyzed at selected intervals, to a minimum of two years post-operatively. Presence of AVN was recorded. Bivariate statistical analysis was conducted using chi squared and Student's t-test methods.

Results: The average preoperative Reimer's Migration Percentage (MP) improved by 48%, from 59% (8-100%) to 11% (0 -54%) six months postoperatively. The mean improvement in Acetabular Index was 9° degrees, from 33° (5-65°) to 24° (0-47°). The mean Neck Shaft Angle (NSA) changed from 154° (126-193°) to 115° (92-138°) and the Hilgenreiner Epiphyseal Angle changed by a mean of 42° (-1-86°) postoperatively. There were 20 (23%) identified cases of AVN, all occurring within the first postoperative year. There was a statistically significant association between AVN and preoperative Reimer's MP (p=.04), preoperative Neck Shaft Angle (p=.023), and the change in MP (p=.014) and NSA (p=.017) at six months. There was also evidence of a relationship between higher GMFCS level (p=.081), left sided surgery (p=0.88) and an adductor tenotomy (p=.017).

Conclusion: Avascular necrosis was observed in one-quarter of our patients. Only two studies have previously investigated AVN in this population and they also found alarmingly high rates. Preoperative MP, NSA, and the immediate change in MP and NSA following surgery were identified as risk factors for AVN. Other contributing factors included higher GMFCS level, side of surgery, and a concomitant adductor tenotomy.

Significance: We present newly identified risk factors for AVN following hip reconstruction in cerebral palsy; namely aspects of the preoperative femoral geometry and MP, postoperative changes in NSA and MP, as well as simultaneous adductor tenotomy.

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The Birmingham Interlocking Pelvic Osteotomy: Controlled Predictable Correction of Acetabular Dysplasia. 15 to 23 Year Survival

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†LOE-Therapeutic - Level IV

Purpose: Our purpose was to perform a retrospective review of our first 100 patients treated with the Birmingham Interlocking pelvic osteotomy. The operation uniquely combines use of an external fixator attached to the acetabular fragment in the plane of the presenting deformity,(using the Ilizarov principle) to manoeuvre and accurately control the final position of the central acetabular fragment, with interlocking iliac bone cuts for intrinsic bony stability allowing rapid mobilisation.

Methods: We were able to contact all but three of our patients and performed up-to-date x-rays on them. They were interviewed and a UCLA score was calculated. The end-point for failure was arthroplasty. The three non-responders, all UK residents, were searched for on our National Joint registry to determine if an arthroplasty had been performed.

Results: We report the results at a mean of 19.5 years (15.8 to 22.8) of our first 100 patients (116 hips) treated by the Birmingham Interlocking Pelvic Osteotomy (BIPO) in patients with previously untreated acetabular dysplasia. The mean age at operation was 31 years (7 to 57). Eighty-eight operations were performed on females and 28 on males. None of the unresponsive patients had had an arthroplasty. Survivorship was 76% at 12.5 years and 50% at 19.5 years. Younger patients had the best survivorship (89% at 19.5 years if under 20 years at operation).

The median UCLA score was 5 (range4-9) There was one temporary sciatic nerve injury and one early and one late presenting mal-position; the total complication rate was 10.4%, much lower than a PAO.

Conclusion: The Birmingham Interlocking Pelvic Osteotomy provides controlled and reliable correction of acetabular dysplasia. The survivorship was similar to the PAO, but the complication rate was much lower.

†LOE - Level of Evidence - Please see page 20 for details.
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Prevention and Treatment of Major Complications of Femoral Neck Osteotomies

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Purpose: Femoral neck osteotomies are being done commonly to correct slipped capital femoral epiphysis (SCFE). The procedure is technically demanding and the reported results and complications varied with experience and from center to center. The results of the largest single surgeon series were reviewed with emphasis on preventable complications.

Methods: The complications of 94 consecutive femoral neck osteotomies in 85 patients (7-21 years; 54M - 31 F) for 27 unstable, 41 stable, and 24 healed SCFE were reviewed at an average follow-up of 18 months. Two osteotomies were performed arthroscopically and all others were through surgical dislocation. Routine clinical and radiographic evaluation and all complications were recorded prospectively.

Results: There were no systemic complications, blood transfusions, or deep infections except for one patient with symptomatic deep vein thrombosis. The overall complication rate including reoperations from any cause was 26% for unstable slips, 21% for stable and 20% for healed slips. All complications except for 3 cases of heterotopic ossification occurred in the first year. The complication rate decreased after the first 30 procedures, especially preventable complications. Pre-existent joint space narrowing from acetabular and femoral chondromalacia was common.

Preventable complications were hardware problems in 14, hip joint instability in 5, iatrogenic avascular necrosis in 1, and nonunion in 2 hips. Proper implant selection and placement, and avoidance of varus reduction can avoid most hardware problems. Avoidance of excessive shortening of the neck, advancement of the greater trochanter, avoidance of valgus reduction, varus and/or derotation subtrochanteric osteotomies, and postoperative precautions can prevent/correct hip instability. Proper technique of flap development and avoidance of tension on the flap throughout the procedure can prevent avascular necrosis. Both nonunions occurred from screw threads crossing the osteotomy site and healed promptly with revision of the screws.

Unpreventable complications included traumatic avascular necrosis in 2 unstable slips and superficial wound drainage in 5 hips. Postop chondrolysis seen in 3 hips could have occurred from unrecognized bone fragments or instability.

Conclusions: All major complications of femoral neck osteotomies occurred within one year after the procedure. The overall complication rate fell from 63% in the first 30 cases to 12.5% in the last 64 cases. Decrease in preventable complications with experience represented the learning curve.

Significance: Adequate knowledge of incidence, prevention, and treatment of complications should make femoral neck osteotomies safer.

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Long-Term Results Following Bernese Periacetabular Osteotomy, Minimum 15-Year Follow-Up

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Purpose: The Bernese periacetabular osteotomy (PAO) continues to be a commonly performed non-arthroplasty option to treat symptomatic developmental hip dysplasia (DDH). There are few long-term follow up studies evaluating results following PAO. Previously, we had reported the minimum 5 year results of a single surgeon's experience with the Bernese PAO assessing risk factors for early failure by either requiring total hip arthroplasty (THA) or reporting significant pain. The purpose of this study was to evaluate the long-term outcome of the Bernese PAO.

Methods: Institutional review board approval was obtained and a retrospective analysis was conducted of a single surgeon's experience with the Bernese PAO between May, 1991 and September,1998. Of the initial cohort of 135 hips (109 patients), 118 hips had not undergone THA at a minimum of 5 years. Since our initial review, 21 of these hips were lost to follow up and these remaining 97 hips (in 77 patients) were retrospectively reviewed at an average follow up of 17.9 years. PAO was considered a failure if the patient had either undergone THA or reported a pain score on the Western Ontario and McMaster Universities scale (WOMAC) of 10 or higher.

Results: Ninety-seven hips were reviewed and their results were combined with the 17 hips that underwent THA during the initial analysis. We did not include the WOMAC failures from the initial study as it only recounts the past 4 weeks of symptoms and, as such, some of the previous WOMAC failures subsequently rated their pain as less than 10 at most recent evaluation. Sixty-seven hips (65.2%) remained preserved at an average of 17.9 years. Their average WOMAC pain score of 2.5 out of 20 (minimal discomfort). Thirty hips (34.8%) met failure criteria. Twenty eight underwent conversion to THA (20.7%) and 19 (14.1%) reported WOMAC pain scores of $\geq$ 10.

Conclusion: In this long-term study, the majority of hips undergoing Bernese periacetabular osteotomy have minimal to no pain at an average of 17.9 years. Although this study demonstrates the durability of the Bernese periacetabular osteotomy in a single surgeon's experience, there was progression of failure over time which corroborates findings in prior, smaller long-term follow-up studies of PAO outcomes.

Significance: Periacetabular osteotomy is the leading joint-preserving treatment for pre- or mildly arthritic hip dysplasia. Reporting the long-term outcome of this procedure is critical to our understanding of it's ability to relieve symptoms and delay arthroplasty in this younger patient population.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Risk Factors for Late Presenting Developmental Dysplasia of the Hip from a Multi-Centre, Prospective Study Group

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Purpose: Most infants with Developmental Dysplasia of the Hip (DDH) are diagnosed within the first 3 months of life. However, late presenting DDH does occur and is defined by a diagnosis of DDH after 3 months of age. The purpose of this observational, prospective, multi-centre study was to compare infants diagnosed at less than 3 months of age with those diagnosed between 3 and 18 months to determine potential risk factors for late diagnosis.

Methods: A database for a multi-centre prospective study on hip dysplasia was analyzed from 2010 to 2014. Baseline demographics for fetal presentation (cephalic/breech), birth presentation (vaginal/cesarean) and swaddling history of patients were compared between nine different sites for patients that were enrolled at age less than 3 months and those enrolled between 3-18 months of age.

Results: A total of 378 patients were enrolled at baseline between 0 and 18 months of age with at least one dislocated hip. Of that group, 248 patients were less than 3 months of age and 130 were 3 to 18 months of age. Baseline demographics of those older than three months showed fetal presentation of 85% cephalic and 9% breech and birth presentation of 58% vaginal and 42% cesarean (Figure 1). When looking at the same demographics for their younger counterparts, fetal presentation show 65% cephalic and 32% breech and birth presentation of 49% vaginal and 51% cesarean (Figure 1). 40% of those older than three months at baseline stated "yes" to swaddling compared to 22% of those less than three months at baseline.

Conclusion: Those presenting with DDH after 3 months of age have fewer of the traditional risk factors for DDH (e.g. breech birth) which may explain the reason for missed diagnosis at a younger age. In addition, swaddling history was more common in late-presenting infants.

Significance: A high index of suspicion for DDH should be maintained for all infants, not just those with traditional risk factors for DDH. Further investigation is required to determine if swaddling is a risk factor for the development of hip dysplasia in older infants.

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Table 1: Demographics for patients enrolled at baseline with at least one dislocated hip for less than 3 months of age and 3 to 18 months of age.

Presentation at diagnosis Total = 378	Less than three months n=248	Three months to 18 months n=130
Sex (m/f)	47/201	23/107
Fetal presentation (cephalic)	160 (65%)	110 (85%)
Fetal presentation (breech)	80 (32%)	12 (9%)
Birth method (vaginal)	122 (49%)	75 (58%)
Birth method (cesarean)	126 (51%)	55 (42%)
Swaddling History (yes)	55 (22%)	52 (40%)
Swaddling History (no)	178 (72%)	72 (55%)

*numbers that do not add to "n" are subject to having "unknown" values

Factors Affecting the Outcome of Open Reduction Performed Over the Age of 18 Months for Developmental Dysplasia of the Hip

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Purpose: To determine the success rate and factors predicting adverse outcome following open reduction when performed over the age of 18 months.

Methods: We performed a case control study of 145 consecutive patients (170 hips) undergoing open reductions >18 months by one of 6 surgeons from 1999 to 2014 in two tertiary referral centres. Median age at reduction was 26 months (range, 18 to 152). Any one of the 6 surgeons performed between 9 and 60 open reductions in the period of study and age group of >18 months. We reviewed case notes to ascertain clinical variables. With a mean follow-up of 5 years (range 1-14), two blinded assessors graded all radiographs for re-dislocation, subluxation and osteonecrosis using established indices. We defined adverse outcomes as cases that developed a re-dislocation, subluxation or osteonecrosis of grades II-IV. We used logistic regression to examine whether surgeon caseload, age at reduction and previous failed treatment could predict adverse outcome.

Results: 101/170 hips (59%) had a successful outcome. We identified 7 (4%) re-dislocations, 32 (18%) subluxations and 51 (33%) hips with osteonecrosis grade II-IV. Age at reduction (P=0.0005) and failed previous treatments of any type (P=0.002) were associated with adverse outcome but surgeon caseload was not (P=0.3).

Conclusion: At 59%, the overall success rate of this series is lower than previously reported. A composite outcome that incudes osteonecrosis and not just re-dislocation or subluxation alone is a more meaningful quality indicator of DDH treatment and generates “true” success rates. We identified two modifiable predictors of adverse outcome in DDH treatment that can easily be addressed in clinical care.

Significance: Clinicians can reduce the risk for re-dislocation, subluxation and osteonecrosis by avoiding multiple attempts to relocate a hip and by early specialist referral.

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It's Not Just the Big Kids: Both High and Low BMI Impact Bracing Success for AIS

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Purpose: Bracing is a common treatment for adolescent idiopathic scoliosis (AIS), and is recommended for most skeletally immature patients with a curve of 25-45 degrees in order to prevent or delay curve progression. Our goal is to stratify patients based on body mass index (BMI) to determine at what body habitus orthotic management becomes less effective.

Methods: We analyzed a retrospective cohort of consecutive patients with AIS treated with a thoracolumbosacral orthosis at a large pediatric tertiary care center. The inclusion criteria were no previous treatment, skeletal immaturity, a curve of 25-45 degrees at brace initiation; and follow-up to skeletal maturity, surgery, or clinical brace discontinuation. Patients were divided into three groups: BMI >85th percentile (high-BMI), BMI <20th percentile (low-BMI), and BMI 20th-85th percentile (mid-BMI). Successful orthotic treatment was defined as less than 5 degrees of progression in the primary curve, prevention of progression past 45 degrees, and avoidance of surgery.

Results: 182 patients (118 mid-BMI, 29 high-BMI, 35 low-BMI) were included with a mean age of 12.5 years at brace prescription and mean follow-up of 2 years. Average curve progression was mid-BMI: 2.5 ± 8.8 degrees, high-BMI: 5.7 ± 10.0 (p=0.09), and low-BMI: 7.4 ± 10.9 (p=0.01). As compared to the mid-BMI group, both high- and low-BMI patients were significantly more likely to experience poor outcomes (**Table**). When accounting for compliance and for adequacy of in-brace correction, the association between high-BMI and orthotic failure disappeared, while the association between low-BMI and each poor outcome remained significant.

Table: Odds Ratio of Outcome

	Progression ≥ 5^{o}	Progression past 45^{o}	Need for surgery	Any poor outcome
High-BMI	2.6 (p=0.02)	3.4 (p=0.01)	2.2 (p=0.13)	2.4 (p=0.04)
Low-BMI	3.2 (p<0.01)	3.7 (p<0.01)	4.1 (p<0.01)	3.7 (p<0.01)

Conclusion: Children on either end of the BMI spectrum are more likely to fail brace treatment for scoliosis than their mid-BMI counterparts. In high-BMI patients, this appears to be largely attributable to inadequacy of in-brace curve correction and poorer brace compliance, while having a low BMI appears to be an independent risk factor for brace failure.

Significance: This confirms previous findings that high-BMI children are more likely to fail brace therapy for AIS and, to our knowledge, is the first time low-BMI children have been demonstrated to have poorer outcomes as well. These results are useful in informing the clinical decision-making process for patients with AIS and add to the literature on the ill-effects of a non-ideal BMI.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

The Effect of Risser Sign on the Likelihood of Failure with Bracing in Adolescent Idiopathic Scoliosis

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Purpose: To determine the incidence of surgical curves in children wearing orthoses for the treatment of AIS, and to assess the influence of the Risser sign and compliance on the likelihood of surgery.

Methods: 160 patients with AIS were prospectively enrolled at time of brace prescription and followed until the cessation of bracing or surgery. Inclusion criteria were patients with curves 25 to 45 degrees, who were less than 1 year post-menarchal and Risser 0,1,or 2 at the time of brace prescription . Compliance was measured using thermal monitors.

Results: The incidence of surgery or progression to 50 degrees was 42.0% in Risser 0 (n=112), 6.9% in Risser 1(n=29), and 0% in Rissser 2 patients (n=19). Brace wear averaged 11.8 hours/day in Risser 0, 13.3 hours/day in Risser 1, and 14.2 hours/day in Risser 2 groups. While the groups had no difference in initial curve magnitude, Risser 0 patients experienced more curve progression than the Risser 1 and 2 patients despite bracing (p=0.0003). Dividing the Risser 0 group by triradiate closure, the Risser 0/open triradiate group (n=42) had a surgical incidence of 59.5%, while the Risser 0/closed triradiate group (n=70) underwent surgery in 30%. 65.6% of Risser 0/open triradiate patients with curves 30-45 degrees underwent surgery, compared to 41.3% of patients with similar curves who were Risser 0/closed triradiates. Only 14 of 47 (29.8%) Risser 0 patients who underwent surgery wore their braces ≥ 15 hours daily. 24 of 66 (36.4%) nonsurgical Risser 0 patients wore their braces ≥ 15 hours/day. Twenty of the 54 Risser 0 patients (37%) who wore their brace ≥ 12.9h/day experienced surgical progression.

Conclusions*:* Risser 0 patients were most at risk for surgical progression despite brace wear. 12.9 hours/day, as recommended in the BRAIST study, was not protective against surgery in the Risser 0 population. Open triradiate at brace prescription had the highest rate of surgery, especially in curves ≥ 30 degrees.

Significance : Risser 0 patients should be prescribed full-time brace wear. Hours of recommended wear can be reduced with advancing maturity. Attempts should be made to initiate bracing in curves less than 30 degrees in Risser 0 patients, especially those with open triradiate cartilages.

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Does Spinal Cord Morphology Predict Curve Progression in Adolescent Idiopathic Scoliosis Treated by Bracing? A Prospective Cohort Study with Magnetic Resonance Imaging

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Purpose: Existing predictors for curve progression in AIS have focused mainly on curve-, maturity- and bone-related factors. Previous studies have shown significant correlations between curve severity and morphological evidences of relative shorter spinal cord tethering in AIS. In conjunction with increased prevalence of abnormal somatosensory cortical evoked potentials (SSEP) and low-lying cerebellar tonsil in severe AIS, suggest that there might be neural morphological predictors. This study aimed to identify any morphological predictors associated with cord tethering, as measured by MRI, for curve progression in AIS patients with bracing.

Methods: 81 AIS girls aged 10-14 with right-sided major thoracic/thoracolumbar curves between 20 to 40° Cobb angle and Risser 0-2 were recruited. All subjects had tailor-made underarm brace and longitudinal follow-up beyond skeletal maturity in 6-month intervals. Clinical and radiographic data were recorded at each clinic visit. Areal bone mineral density (BMD) at bilateral femoral necks and MRI measurements including ratio of spinal cord to vertebral column length, ratio of anteroposterior (AP) and transverse (TS) diameter of cord, lateral cord space (LCS) ratio, cerebellar tonsil level, and conus medullaris position were obtained at baseline. AIS girls were assigned into three groups according to bracing outcome: (A) Non-Progression (≤5°); (B) Progression (≥6°); (C) Progression to surgical indication (Cobb angle≥50°).

Results: The average duration of follow-up was 3.4 years. No significant intergroup differences were found in spinal cord length, tonsil level and conus position. Group C had significantly longer vertebral column length, smaller cord-vertebral length ratio, and higher AP/TS cord ratio as compared to group A, while LCS ratio in group C was significantly increased when compared with both group A and B. In regression model, five significant independent predictors including cord-vertebral length ratio (Odds Ratio (OR): 1.993, p=0.034), LCS ratio (OR: 2.639, p=0.025), initial Cobb angle (OR: 1.156, p=0.006), menarche age (OR: 1.688, p=0.046), BMD (OR: 2.960, p=0.010), and marginally significant AP/TS cord ratio (OR: 1.463, p=0.096) were obtained.

Conclusion: This is the first prospective study using MRI to demonstrate that cord-vertebral length ratio and LCS ratio were significant independent predictors for curve progression in AIS treated with bracing. AP/TS cord ratio might also be a potential predictor for further validations.

Significance: The findings of the present study provides an additional important "neuro-related" prognostic factor to further enhance the predictive power of outcome of bracing in addition to the current list of curve and maturity based clinical and radiological parameters.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

♦ New EOS Imaging Protocol Allows a 50-Fold Reduction in Radiation Exposure for Scoliosis Patients

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Purpose: To evaluate the reliability of 3D spinal reconstructions from bi-planar x-rays utilizing 5 to 8-fold further reduction in radiation dosage compared to the current EOS, low dose images (8-fold less than traditional XR) utilized for evaluating patients with adolescent idiopathic scoliosis (AIS).

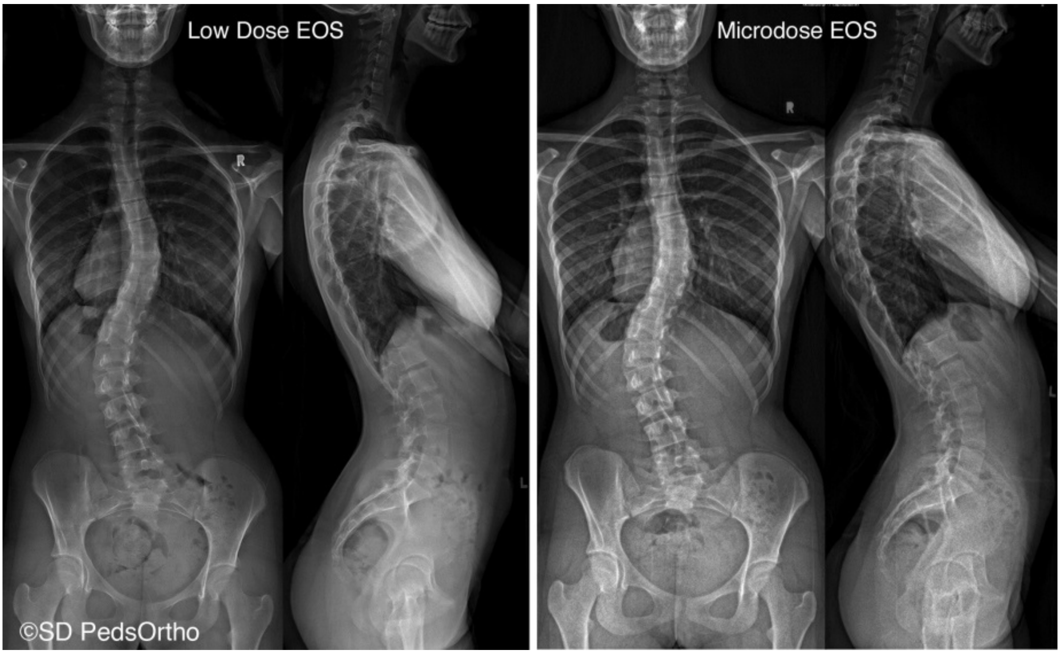
Methods After IRB approval, 60 AIS patients (30 non-op, 30 post-op) who received "standard", biplanar, anteroposterior and lateral low dose spine x-rays in our EOS imaging unit (~ 0.31mGy) as part of routine care, also underwent an additional set of "microdose" EOS x-rays (~ 0.06 mGy) using a new protocol. Two reviewers created 3D reconstructions, twice, of each set of images using sterEOS software (Standard low dose x2, Microdose x2). Typical measures of scoliosis were made: coronal Cobb angles, sagittal (T1-T12, T4-T12, L1-L5, L1-S1), and apical axial rotation. Interrater reliability was also assessed on standard 2D measures done on the low dose and microdose images. Intraclass correlations (ICC) and standard error of measurement (upper bound of 95% confidence interval) for the differences between low dose and microdose image measurements were compared.

Results The correlations (ICC's) were rated as 'substantial' to 'almost perfect' for low dose 3D, microdose 3D, and 2D measures (range 0.78-0.99). The calculated error in measurement was not significantly greater in the microdose images for all variables except for intrarater 3D error on 3D L1-L5 lordosis (2.9° microdose vs. 2.2°, p=0.04), interrater 3D rotation of the apex of the lumbar curve (2.6° microdose vs. 1.7°, p=0.03), and 2D T12-sacrum lordosis (4.6° microdose vs. 3.4°, p=0.04). Although the images have slightly less clarity and detail, the critical measures of the curvature were reliably measured.

Conclusion Good reliability was found between 3D and 2D measurements of the low dose EOS images and the microdose images in patients with idiopathic scoliosis. A statistically significant difference in mean measurement error was observed in both 3D and 2D measures of lordosis and 3D lumbar apex rotation. However, the magnitude of difference in error is not clinically important (~1° avg difference).

Significance: There is a strong suggestion that radiation exposure can be further reduced with EOS imaging in scoliosis patients, achieving an overall reduction in radiation of ~ 50 times less than standard xrays. This represents a major reduction in this group of patients who often require serial exams during their growing years.

♦ 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 9.



†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

SRS-22R Scores in Non-Operatively Treated Adolescent Idiopathic Scoliosis Patients with Curves Greater Than Forty Degrees

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†LOE-Therapeutic - Level III

Purpose: The intermediate term outcomes of individuals with adolescent idiopathic scoliosis (AIS) who had curves of sufficient magnitude to qualify for surgery (≥40 degrees) but instead elected non-operative treatment were evaluated. AIS produces a deformity of the trunk but not significant functional, pain, or cardiopulmonary risks. In spite of this relatively benign natural history, surgery is routinely recommended when curves exceed 40 degrees. This study provides functional outcomes data on intermediate term follow-up of patients treated non-operatively, giving physicians and patients useful information to aid decision-making for potential scoliosis surgery.

Methods: Since 2000, potential surgical patients/families with AIS have been counseled employing a standardized explanation of the expected long-term consequences when AIS is not treated surgically. 138 patients, currently over age 18 years, with curves ≥40 degrees, elected non- operative treatment. During follow-up, SRS-22r questionnaires and radiographs were obtained. Comparisons were made to surgically treated cohorts that were similar to the non-operative cohort in sex and curve patterns.

Results: Of the 138 individuals, 12 were excluded (7 subsequently elected to have surgery and 5 had incomplete SRS-22r scores or radiographs). At an average follow-up of 8.1 years since the curve reached ≥40 degrees, with an average of 23.3 years of age at the last follow-up, the average Cobb angle was 50.2 degrees. Comparison of the 126 non-operatively treated individuals to the surgical groups demonstrated small but statistically significant improvement in average SRS-22r score only for patients operated under 18 years of age (N=199) ($p<0.0005$) but no difference in the group operated after 18 years of age (N=16)($p=0.48$). This statistical difference was due to perceived improvement in Self-Image ($p<0.0001$) and Satisfaction domains ($p< 0.0001$) but not in Pain ($p=0.14$), Function ($p=0.85$), or Mental Health domains ($p=0.06$).

Conclusions: Compared to the non-operative group, average SRS-22r scores are statistically significantly greater in the Self-Image and Satisfaction domains following surgery for patients less than 18 years of age. However the improvement is small, possibly not clinically significant, and likely biased by the patient's pre-operative expectations.

Significance: The similarity in functional outcomes between our non-operative group and our surgical groups imply the benefit from surgery was limited to a perception of better cosmesis on the part of post-surgical individuals younger than age 18 at time of surgery. This information should be valuable to many scoliosis patients and their physicians as they consider surgical treatment.

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A Three-Dimensional Analysis of Apical Lordosis Correction – The Role of the Ponte Osteotomy

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Purpose: The efficacy of Ponte osteotomies (PO) in adolescent idiopathic scoliosis (AIS) remains in question. The objective of this study was to evaluate the use of PO in correcting the loss of kyphosis (apical lordosis) common in thoracic AIS.

Methods: 120 consecutive AIS patients (Lenke 1-4) from a single center who were prospectively enrolled in a registry and underwent posterior correction with 5.5 ultra-strength stainless steel rods were reviewed. 3D reconstructions of biplanar images at pre and post-op were generated and each vertebral motion segment was "rotated" to a direct lateral projection to measure true 3D kyphosis/lordosis at each motion segment. Segmental sagittal plane measures were summed for T5-T12 region. Each level was identified as having undergone PO or not (surgeon discretion) and segmental sagittal plane 3D measures were compared.

Results: The frequency of PO ranged from 0-88% for the 11 thoracic motion segments, with the majority released between T6-7 to T11-12 (range 63-88%). Frequency of PO was significantly increased (T6-7 through T10-11) when segments were frankly lordotic ($p<0.05$). The increase in kyphosis at each of the 4 segments between T7-8 and T10-11 when a PO was performed ranged 4-5° (max. 11 - 17°). The number of releases within T5-T12 was significantly correlated with preop 3D T5-T12 kyphosis (rho = -0.49, $p\leq0.001$). The preop to postop change (increase) in 3D T5-T12 kyphosis was significantly related to the number of PO performed (Figure). Increase in 3D T5-T12 kyphosis when 4-5 or 6-7 segments were released with a PO averaged 17.8 and 25.4°, respectively (max change 43°).

Conclusion: This analysis confirms that apical Ponte osteotomies are associated with substantial improvements in the sagittal plane. Patients who received Ponte osteotomies gained an average of 4-5 degrees per level. In the setting of thoracic lordosis this 3D assessment of Ponte osteotomies confirms utility of this approach.

Significance: The role of Ponte osteotomies (PO) in correcting the apical lordosis of adolescent idiopathic scoliosis was demonstrated. PO can be used successfully to aid in the restoration of thoracic kyphosis, particularly in cases of frank apical lordosis.

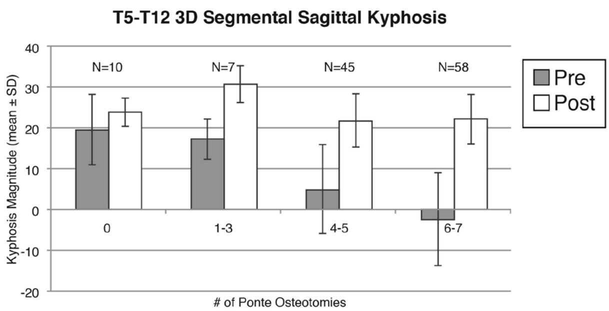

Figure: Preop and Postop Kyphosis vs the number of Ponte Osteotomies performed. There was progressively more improvement in kyphosis as the # of PO per case increased.

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Minimum 20-Year Outcomes for Treatment of Adolescent Idiopathic Scoliosis: Results From a Novel Cohort of U.S. Patients

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Purpose: There is limited recent data regarding the long-term outcomes of scoliosis treatment. This study evaluates the minimum 20-year outcomes following treatment of adolescent idiopathic scoliosis with bracing, surgery, or observation in a novel cohort of US patients.

Methods: All patients had radiographs from adolescence at skeletal maturity (Risser 4 or 5) and were contacted for current radiographs, pulmonary function tests, and physical exam. Patients had at least a 35 degree or greater idiopathic scoliosis curve magnitude during adolescence. Childhood treatment included bracing/observation (26) and surgery (24).

Results: Fifty patients had radiographs/physical exam at a minimum of 20 years following treatment. Mean time to follow-up was 31 years (range, 20-40). Mean age at childhood radiographs was 16.4 (range, 14 – 20). Mean age at follow-up was 45 years (range, 33-56). Of the 26 nonoperative patients, 5 did not progress (Figure). For the remaining 21 patients, thoracic curves progressed a mean of 0.4 degrees per year (range, 0 – 1.3), and lumbar curves progressed 0.3 degrees/year (range, 0-1.0). Larger curves more frequently progressed (Rsquare 0.40, 0.53; $p=0.002$, $p<0.001$). Four patients in the nonoperative group (15%) underwent spine surgery in adulthood for lumbar discectomy (2), anterior cervical fusion (1), and lumbar fusion (1) below the level of the deformity. Of the 24 operative patients, 5 (20%) had additional procedures in adulthood, including implant removal (4) and distal extension of the fusion (1). Patients undergoing spinal fusion also had a slow rate of curve progression in adulthood over the fusion at a mean 0.20 degrees per year.

Conclusions: Idiopathic scoliosis curves between 35-50 degrees continue to progress during adulthood, but this varies by individual. Larger curves progress more quickly, but this does not entirely account for varying rates of curve progression. Elucidation of the factors which govern progression in adulthood may help guide improved childhood treatment recommendations.

Significance: Nonoperative patients had ongoing curve progression in adulthood at a mean rate of 0.3-0.5 degrees per year, although this varied substantially among patients. Pulmonary function testing and health-related quality of life measures were similar between an operative and nonoperative adolescent idiopathic scoliosis cohort at a mean 31 year follow-up, but maximal inspiratory and expiratory pressures were decreased.

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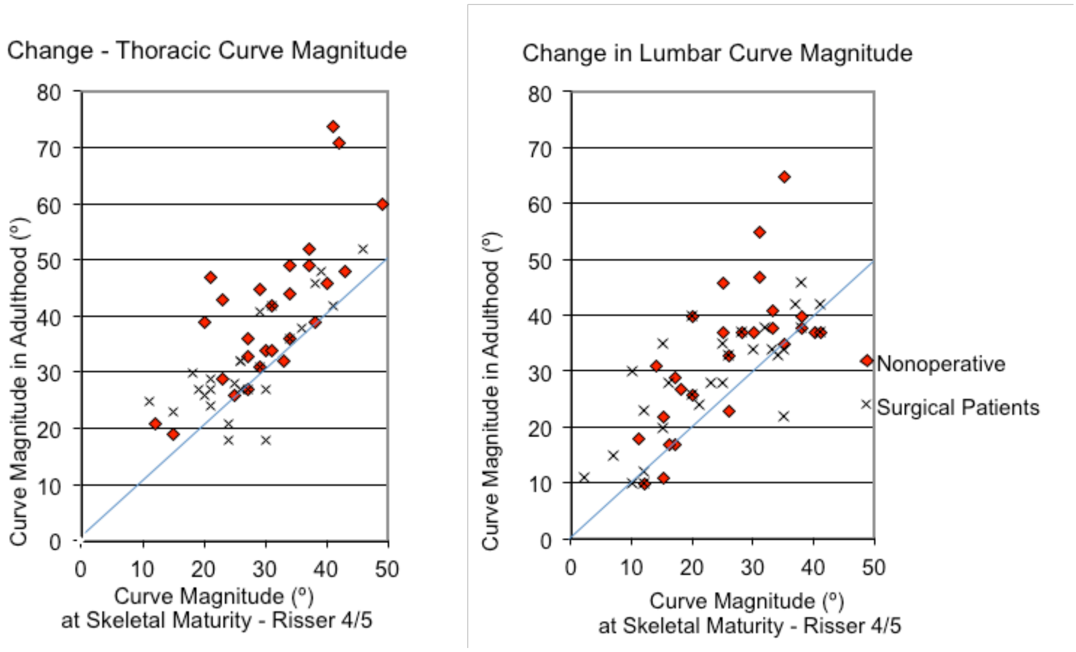

Figure. Change in Thoracic (A) and Lumbar (B) curve magnitude over the mean 31 year follow-up period. Any data points above the equivalence line (shown in blue) represent curve progression in adulthood, which was more pronounced in the nonoperative cohort of patients. Curves between 20 to 50 degrees at skeletal maturity showed progression in adulthood at a mean of 0.3-0.4 degrees per year.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Use of Tranexamic Acid (TXA) on Reducing Blood Loss During Scoliosis Surgery in Adolescents

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†LOE-Therapeutic - Level III

Purpose: Many reports had been received on the application of antifibrinolytic medications on spinal corrective surgery and the surgical outcome evaluations of its efficacy on reducing blood loss. This study aimed to assess the efficacy of tranexamic acid (TXA) in reducing operative blood loss during posterior spinal fusion for the treatment of severe adolescent idiopathic scoliosis (AIS).

Methods: A retrospective cohort study was carried out on 90 (TXA = 55, Control = 35) AIS girls undergoing posterior spinal fusion with total pedicle screw fixation under navigation guide. Patients in TXA group used TXA as an additional antifibrinolytic agent to reduce blood loss, while control group did not. Blood loss, hemoglobin change and amount of blood transfused was estimated from intraoperative measurement by anesthesiologists. Demographics were compared using Student's T-test or Chi-square test where appropriate. Linear regression modeling was carried out between the use of TXA and total blood loss per unit body weight with controlling of confounding factors.

Results: Mean age and mean maximum Cobb angle were 15.2 and 73^{o}, and 15.3 and 63^{o} in TXA and control groups respectively. In average, patients received TXA had 13.5 segments fused, and 12.14 segments in controls. TXA group showed significantly less intra-operative blood loss than the control group from intraoperative measurement (1.8L vs. 3.9L, $p<0.01$) and volume of cell saver blood transfused back to patients (0.6L vs. 1.7L, $p<0.01$). TXA group also showed significantly shorter total time taken for surgery (437 min vs. 502 min, $p<0.01$), much less cell saver blood transfused (0.6L vs. 1.7L, $p<0.01$), and total blood loss per surgical segment level (0.1L vs. 0.3L, $p<0.01$). Regression models showed that the use of TXA decreased total blood loss per unit body weight by 5.5 times ($r^2=0.46$, $p<0.01$) after adjusting for maximum Cobb angle, age, number of segments fused, bone graft, clotting capability, and infusion of coagulation factors

Conclusion: Patients undergoing posterior spinal corrective surgery with the use of TXA showed much reduced total blood loss, reduced use of transfused blood, much less cell saver blood transfused back to the patient. The total blood loss per body weight was decreased by after using TXA after controlling for maximum Cobb angle, age, surgical parameters, clotting capability, and infusion of coagulation factors.

Significance: Use of tranexamic acid significantly reduced total surgical blood loss over corrective surgery for severe AIS patients, after adjusting for possible confounding factors.

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Is MRI Necessary for Adolescent Idiopathic Scoliosis When Patients Present with Curves Over 80 Degrees?

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Summary: In a large cohort of 1138 AIS patients, the likelihood of obtaining a preoperative MRI is higher for those with curves ≥80° (63 vs 39%), however, the incidence of neural axis abnormalities (15.6 vs 11.1%) and the likelihood of neurosurgical intervention was the same. These data call into question the greater need to obtain an MRI for large AIS curves.

Introduction: The well-accepted published criteria for obtaining an MRI for patients with adolescent idiopathic scoliosis (AIS) do not include an indication based on curve magnitude. There are no studies which have studied the indications for MRI in patients who have AIS with curves greater than 80 degrees.

Methods: A retrospective review of a prospective series of AIS operative patients from a single institution from 2002-2013. All data was analyzed and patients were compared based on a preoperative curve ≥80 degrees (group ≥80) and those who were <80 degrees (group <80).

Results: There were 1138 patients (920 females/221 males) who underwent fusion and instrumentation for AIS; mean preoperative age was 14.6 years. Overall, 471 (41.6%) had a preoperative MRI. There were 102 (8.9%) in ≥80 group and 1036 (91.0%) in <80 group. There was a greater incidence of obtaining an MRI for the ≥80 group compared to the <80 group (62.7 vs 39.3%) (p<0.001). However, the incidence of having an abnormality was not different between the two groups (15.6 vs 11.1%). The overall distribution of having a Chiari, syrinx, Chiari/syrinx and tethered cord was similar between groups (P=0.10). There were differences between the ≥80 group and the <80 group for syrinx (70 vs. 33%), Chiari/syrinx (10 vs 33%) and tethered cord (0 vs 17.8%) (P=0.032), while the incidence of a Chiari alone was the same (20 vs 15.6%). There were no differences in the likelihood of having neurosurgical intervention between the ≥80 group and <80 group (40% vs 53.3%). There were no permanent neurologic deficits in this series of patients.

Conclusion: Surgeons obtain a preoperative MRI significantly more often for patients with large curves in AIS, however, the incidence of neural axis abnormalities and the need for neurosurgical intervention are the same. These data call into question the need for obtaining an MRI more often for larger curves. The indications for a preoperative MRI for AIS should not include large curve magnitude and the indications for those patients with curves <80 degrees could be safely applied to all patients.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Patients Without Intraoperative Neuromonitoring (IONM) Alerts During VEPTR Implantation Did Not Sustain Neurologic Injury During Subsequent Routine Expansions: A Retrospective Multi-Center Cohort Study

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†LOE-Prognostic - Level IV

Purpose: To determine rate of IONM alerts and neurologic injury with a modern cohort of VEPTR patients during various VEPTR procedures.

Methods: After institutional review board approval, a multicenter retrospective study reviewed intraoperative neurologic records at 17 institutions from 2005-2011. Surgeries were categorized into implant, revision, expansion, and removal procedures. Cases where IONM signal changes or neurologic injury occurred had additional chart review for surgical and postoperative recovery information. Descriptive statistics were used for data analysis.

Results: 538 consecutive VEPTR procedures in 216 patients were reviewed: 158 implant, 90 revision, 258 expansion, and 32 removal procedures. IONM alerts occurred in 18/538 procedures (3.4%): 5 implant, 5 revision, 3 expansion, and 5 removal. New neurologic injury occurred in only 3/216 patients (1.4%), or 3/538 procedures (0.6%). All 3 of the neurologic injuries were associated with implant procedures. The rate of neurologic injury for implant procedures was 1.9%. All 3 of the patients experienced upper extremity motor deficits, and one patient also had an accompanying upper extremity sensory deficit. All neurologic injuries had full postoperative recovery at 17, 30, and 124 days post-injury. One patient without prior neurologic injury or IONM alert had an IONM alert during a routine expansion procedure which resolved after increase in blood pressure. The remaining IONM alerts during expansion procedures were all in children with prior neurologic injury or IONM loss.

Conclusion: The highest rate of neurologic injury in VEPTR surgery was found for implant procedures. There were no instances of neurologic injury during VEPTR expansion, revision, or removal procedures. IONM did not identify new neurologic injuries in patients undergoing VEPTR expansion who did not previously have a history of IONM signal change or neurologic injury.

Significance: IONM may not be necessary in patients undergoing VEPTR expansion procedures who have not previously had neurologic injury or IONM alerts.

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Re-Operation After Magnetically Controlled Growing Rod Implantation: A Review of 26 Patients with Minimum Two-Year Follow-Up

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Purpose: Traditional growing rods (TGR) have been widely used for the treatment of early onset scoliosis (EOS). High complication rate is attributed to frequent surgical lengthening. Magnetically controlled growing rod (MCGR) allows non-invasive distractions in awake patients and is believed to reduce the number of additional surgeries after rod implantation. This study aims to report on the rate and reason for reoperation after MCGR surgery.

Methods: Consecutive patients undergoing MCGR treatment with a minimum of 2-year follow-up from 6 centres were included. All clinical and radiographic data were collected prospectively.

Results: Twenty-six patients were included in this study. The mean age at the time of surgery was 7.3 years (range, 4 to 14 years) and the mean follow-up period was 35 months (range, 24 to 50). Four had single- rod and 22 had dual-rod implanted. Eleven patients (42.3%) required reoperation within the follow-up period, with a mean time to reoperation of 17 months after initial surgery (range, 5 to 29 months). Five were due to failure of rod distractions and the rods were changed except in one case, when one of the 2 rods was removed; 3 were due to failure of proximal foundation implants; 2 were due to rod breakage; and there was one case of wound infection with failure of proximal fixation. Comparing the group that needed reoperation to those that did not, there was no relationship between reoperation and preoperative Cobb angle, age at surgery, level of instrumentation, number of distraction episodes or cases that were converted from TGR.

Conclusion: This is the largest series with the longest follow-up to date that examines the need for additional surgery after the initial procedure. MCGR surgery is associated with a high frequency of reoperations for a variety of reasons. However, it compares well with TGR patients, as all will require reoperation within the first year for lengthening. Longer-term studies and comparisons with TGR patients are required to evaluate the efficacy and cost-effectiveness of this new implant for the management of patients with Early Onset Scoliosis.

Significance: MCGR surgery for the treatment of early onset scoliosis is associated with a high frequency of reoperations for a variety of reasons. However, it compares well with traditional growing rods, as all will require reoperation within the first year for lengthening.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

♦ Can a "No Final Fusion" Produce Equal Results to Final Fusion After Growing Rod Treatment?

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Purpose: Definitive "final" fusion is the common endpoint to growing rod treatment (GR) for early onset scoliosis (EOS). However, final fusion may not be necessary for a subset of EOS patients who have reached skeletal maturity with good alignment, and these patients may end their GR treatment with no definitive fusion. The aim of our study was to characterize patients who completed GR treatment but received no final spinal fusion (NF, and compare them to those who underwent fusion

Methods: A multicenter EOS database was queried to identify 160 patients who received GR treatment and reached skeletal maturity (Risser 3 or above). Radiographs and clinical records of these patients were reviewed. 19 patients were identified as having received GR surgery without a final fusion. Clinical and radiographic characteristics of NF patients were compared against those who did receive final fusion (FF) at skeletal maturity. All patients had a minimum of 2 year follow-up from final procedure.

Results: There was no significant difference in the NF and FF groups in: age at which growing rod treatment was initiated, in % female patients, or in the distribution of C-EOS patient diagnoses. There was no significant difference in the two groups in the mean lengthening procedures (NF group 6.4±3.5 procedures vs. FF group 5.6±3.9 procedures, P=0.36). All 19 patients in the NF group had their rods retained at final distraction, and there were no rod fractures at 2 year follow-up. The mean follow-up time in NF group after last distraction was 3.3±1.6 years. The mean age at last follow-up in the NF group was 14.5±3.1 years and in the FF group was 15.2±2.8 years. In the NF group, at the end of treatment, the average primary curve correction was 46%, from 76±23° to 41±21°. In the FF group, the average primary curve correction was 37%, from 74±19° to 46±18°. The difference in the final curve magnitude between the two groups was not significant (P=0.23). In the NF group, the average increase in trunk height (as defined by T1-S1 length) was 30%, from 270±54 mm to 385±30 mm. In the FF group, the average increase in T1-S1 trunk height was 25%, from 269±54 mm to 361±25 mm. The final trunk height in the NF group was significantly higher (P<0.01).

Conclusions: Patients who did not receive a final fusion had excellent final coronal correction and trunk height, and had no rod fractures. Due to progressive ankylosis, "No Final Fusion" at maturity is a viable option for patients being treated with GR in all C-EOS diagnostic groups who have satisfactory final alignment. Final fusion may thus be needed only in patients having a residual problem at maturity.

Significance: Upon completion of growing rod treatment, final fusion may only be necessary in patients who have a residual problem upon reaching skeletal maturity.

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Risk Factors for ACL Reconstruction Failure in Pediatric and Adolescent Patients: A Review of 913 Cases

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Purpose: Anterior cruciate ligament (ACL) reconstruction failure is relatively common in young high-risk athletes. The purpose of this study was to examine a single center's 10-year experience with ACL reconstructions in pediatric and adolescent patients to better define failure rates and risk factors for revision ACL surgery.

Methods: This IRB approved retrospective study included all patients who underwent a primary ACL reconstruction between 2002 and 2013. Chart and radiographic review was performed to assess patient demographic, injury, and surgical data including patient age, gender, BMI, mechanism of injury, growth plate status, concomitant ligament/meniscus/cartilage injury, surgical procedures, femoral drilling technique, graft source and type, femoral and tibial fixation devices, and graft size. Graft failures had to be confirmed both with clinical exam and MRI or the patient had to undergo a revision ACL reconstruction. Potential factors associated with failure were evaluated utilizing either parametric or non-parametric analysis as appropriate.

Results: A total of 913 ACL reconstructions were performed. The average patient age was 15.6 years (range 5-20 years) and 55% of the patients were male. The majority of patients had a bone-patellar tendon-bone (BTB) graft (53%) where as 44% had a hamstring tendon graft. Allograft was used in 10% of patients. The growth plates were open in 15% of the cohort of which 85% underwent a transphyseal reconstruction, 13% an all-epiphyseal reconstruction, and 2% an iliotibial band reconstruction. The majority of femoral tunnels were drilled with a transtibial technique (65%) where as 35% utilized an "anatomic" approach with either an anteromedial portal or an outside-in technique. Femoral fixation was achieved with a cortical suspensory device in 42%, a cross pin technique in 41%, and an interference screw in 17% while nearly all tibial fixation was achieved with an interference screw. In all, 54 failures were identified for a 6% failure rate. Risk factors for failure included younger patient age, hamstring grafts, more anatomic reconstructions, and cortical suspensory devices ($p<0.05$). BTB grafts had a three times lower failure rate than hamstring grafts ($p<0.001$). There was a trend towards increased failures with allograft tissue (10% vs 5%; $p=0.07$).

Conclusion: ACL failure rates in adolescent and pediatric patients vary based on patient age, graft selection, and surgical technique. BTB autografts had the lowest failure rate in this high-risk population.

Significance: Families should be counseled appropriately about the pros and cons of the various surgical and graft options at the time of surgical decision making.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Long-Term Follow-Up of Pediatric ACL Reconstruction in New York State: High Rates of Subsequent ACL Reconstruction

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†LOE-Therapeutic - Level III

Purpose: The primary aim of this study was to determine the rate of subsequent ACL reconstruction and additional non-ACL knee surgery in children that had previously undergone ACL reconstruction in New York State. The secondary aim was to assess factors associated with additional ACL and non-ACL knee surgery.

Methods: Pediatric patients (age < 21) who underwent ACL reconstruction between 1997 and 2010 in New York State were identified using the Statewide Planning and Research Cooperative System (SPARCS) database. Patients were tracked for subsequent ACL reconstruction and additional non-ACL knee surgery. Each case had a minimum of one year follow up. A Cox proportional hazards model was used to assess time to subsequent surgery, adjusting for age, sex, race, comorbidity index, insurance type, surgeon and hospital ACL volume, and poverty prevalence.

Results: 23,912 primary pediatric ACL reconstructions were identified. 1955 patients (8.2%) underwent subsequent ACL reconstruction. 7.4% had one additional ACL reconstruction and 0.7% had two or more additional ACL reconstructions. 3341 patients (14%) had subsequent non-ACL knee surgery with 11.1% having one subsequent surgery and 2.9% having two or more additional knee surgeries. Risk factors for revision ACL surgery were younger age at time of primary ACL surgery ($p<0.001$), male gender ($p<0.001$), white race ($p=0.003$), private insurance ($p<0.001$), higher hospital ACL volume (>20 per year; $p=0.002$), and higher surgeon ACL volume (>10 per year; $p=0.003$). Risk factors for return to the OR for other non-ACL knee surgeries were younger age at the time of primary ACL reconstruction ($p<0.001$), white race ($p<0.001$), private insurance ($p=0.016$), and higher hospital ACL volume (>20 per year; $p=0.007$).

Conclusion: This study aims to provide information on the rate of return to the operating room and rate of secondary ACL reconstruction in an adolescent population over the past 20 years in New York State. Males and younger patients had a higher rate of subsequent ACL reconstruction. Higher rates of ACL reconstruction in younger children may be due to greater at-risk activities in younger children, longer follow up, or inherently less reliable reconstructions given the non-anatomic reconstructions that are frequently required in the skeletally immature. The association between socioeconomic factors and increased subsequent knee surgeries likely represents a disparity in access to care for low socioeconomic status patients.

Significance: This study is the first to evaluate, on a population level, the rate of subsequent ACL surgery and additional non-ACL knee surgery following primary pediatric ACL reconstruction.

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All-Inside, All-Epiphyseal ACL Reconstruction in Skeletally Immature Athletes: Return to Play, Incidence of Second Surgery and Two-Year Clinical Outcomes

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†LOE-Prognostic - Level II

Purpose: The purpose of this study was to evaluate 2 year clinical outcomes of an all-inside, all-epiphyseal ACL reconstruction in skeletally immature athletes with 3-6 years of remaining growth, focusing on return to play and incidence of second surgery.

Methods: Twenty-three skeletally immature athletes (6 females, 17 males) were prospectively evaluated after an all-inside, all-epiphyseal ACL reconstruction utilizing hamstring autograft. The mean chronological age was 11.8 years (range: 10-13) and the mean bone age (Greulich and Pyle method) was 12.1 years. Lacrosse (38%) and soccer (31%) were the sports most commonly associated with ACL injury in our cohort. All athletes were evaluated with a physical examination, KT-1000 arthrometry, isokinetic testing, and validated outcome scores (IKDC, Lysholm and Marx activity scales). Standing radiographs and SPGR MRI analysis was performed at 6, 12 and 24 months post-operatively. A 'Return to Play' analysis was performed to postoperatively assess symmetry, alignment, control and the ability to decelerate and return to play safely.

Results: At a minimum follow-up of 2 years (range 2-4.5), the mean IKDC score was 94.5 ± 5.4, the mean Lysholm score was 98.1 ± 4.1 and the mean Marx activity score was 12.8 ± 3.1. Lachman and pivot shift testing was negative in all patients. The mean side-to-side difference in the KT-1000 arthrometry was 0.9 ± 0.6 mm, with a maximum difference of 2 mm. Isokinetic testing showed a mean deficit of 4.3% in extension torque and 9.1% in flexion torque at a repetition speed of 180 degrees per second. No angular deformities, significant leg length discrepancies or physeal disturbances were observed on postoperative radiographs or MRI. Two athletes (8.6%) required a second surgery: one (4.3%) underwent revision ACLR for traumatic graft disruption at 10 months and one (4.3%) required meniscectomy for an incompletely healed meniscal repair at 13 months. There were no contralateral injuries in this cohort of athletes. The mean time for return to unrestricted competitive activity after successful completion of the 'Return to Play' analysis was 12.5 ± 1.25 months from the time of surgery.

Conclusions: An all-inside, all-epiphyseal ACL reconstruction technique demonstrates excellent clinical outcomes in skeletally immature athletes without growth disturbance.

Significance: All-inside, all-epiphyseal ACL reconstruction using hamstring autograft can be performed safely with good short-term clinical results.

†LOE - Level of Evidence - Please see page 20 for details.
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Post-operative saggital MRI demonstrating femoral socket in 10 y.o. male

Post-operative saggital MRI demonstrating tibial socket in 10 y.o. male

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Outcomes Following Operative Treatment of Bucket Handle Meniscus Tears in Children and Adolescents

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Purpose: To review the demographics, clinical presentation, operative details, clinical outcomes, and risk factors for re-operation associated with operatively treated bucket handle meniscus tears (BHMT) in a pediatric population.

Methods: A departmental database was queried to identify all patients <19 years-old who presented with BHMT which underwent surgery from 2003-2012. Clinical and surgical data were retrospectively collected from medical records, and risk factors for reoperation and persistent pain were assessed in all patients with >6 months of follow up.

Results: Two-hundred eighty BHMT's were treated arthroscopically by 8 different sports-medicine fellowship trained surgeons. Mean age at surgery was 15.5 ±2.5 (range: 2.1-19.2), and most patients were male (177/280, 63%). Most injuries occurred during sports (203/248, 82%) and involved the medial meniscus (157/248, 63%), though a lateral discoid meniscus was identified in 30/248 cases (11%). Concurrent ACL reconstruction (ACL-R) was performed in 118/248 cases (42%). Common presenting findings included inability to weight bear (79/272, 29%) and flexion contracture >10 degrees (92/181, 51%). Meniscal repair was performed in 181/280 cases (65%), and was more common in younger patients (p=0.01) and for the lateral meniscus (p=0.01). Reoperation occurred in 45/185 (24%) cases, for 24 recurrent BHMTs (7 re-repaired), 18 non-bucket re-tears (8 re-repaired) and 3 cases of arthrofibrosis. Of the 15 re-repairs, only 2 required a third surgery. As expected, reoperation was more common following meniscal repair than meniscectomy (40/126, 32% vs. 5/59, 8%) (p<.001), and less common with concurrent ACL-R (p=.04). All-inside repair technique had a lower reoperation rate than inside-out or hybrid technique (13/58, 22%) vs. (27/68, 40%) P = 0.05 which likely reflects tear pattern variation immeasurable with retrospective study methodology. 184/185 (99%) returned to sports, slower in meniscal repair (p=.002) and ACL-R (p<0.01) patients. At last follow up 170/185 patients (92%) were pain-free, 11 (6%) had mild pain and 4 (2%) significant pain, with no predictors identified for persistent pain.

Conclusion: Most BHMT's in adolescents occur in males, during sports, and affect the medial meniscus. Concurrent ACL-R is common, and associated with a lower re-operation rate, but slower return to sports. Two-thirds of patients underwent meniscal repair, which had a higher re-operation rate, but successful re-repair was achieved in most cases when attempted.

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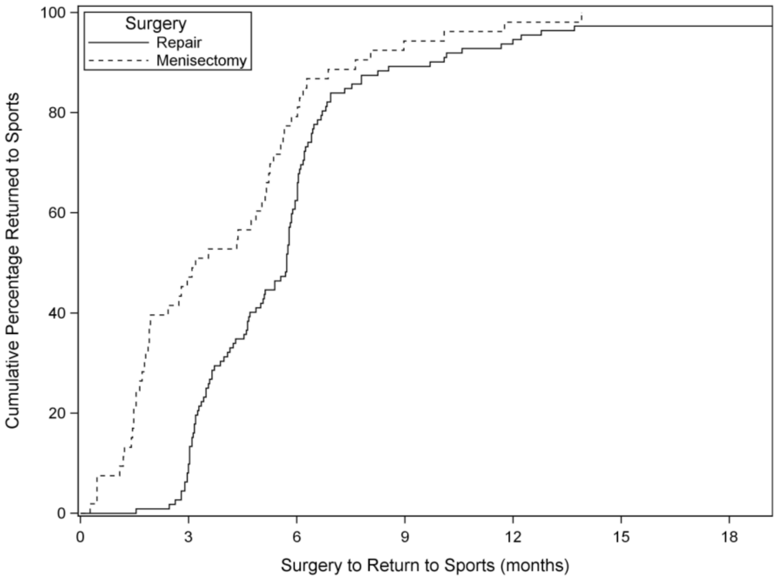
Significance: These data enhance understanding of BHMTs in children by elucidating demographics and clinical presentation, and establishing natural history patterns following surgical treatment.



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The Critical Age for Arthroscopy in Juvenile OCD of the Knee: Is Arthroscopy Necessary at the Time of Drilling?

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Purpose: Treatment of juvenile osteochondritis dissecans (OCD) often involves diagnostic arthroscopy to determine if the cartilage is intact. For patients with intact cartilage, retro-articular drilling is our procedure of choice. The purpose of this study was to determine if age and MRI findings can be used to identify patients with intact cartilage thereby eliminating the need for arthroscopy.

Methods: A retrospective review was performed including operative reports and pre-operative MRI's of all patients from 2001-2014 who presented with an OCD of a femoral condyle treated surgically for this IRB-approved study. Gender, age at surgery, location of lesion, laterality, presence of mechanical symptoms, pre-operative MRI findings, procedure performed, and arthroscopic assessment of the cartilage were recorded. Exclusion criteria included trochlear and patellar OCD lesions, juvenile idiopathic arthritis, and traumatic osteochondral lesions. MRI results were recorded as either "intact" or "disrupted" cartilage. For all patients, an arthroscopy was performed to visualize and probe the articular surface. When the cartilage was intact, no further arthroscopic procedures were done, and a retro-articular drilling was performed with fluoroscopic guidance. When the articular surface was disrupted, additional treatment was performed as guided by lesion severity.

Results: There were 119 patients (81 male, 38 female) with 139 OCD lesions in 136 knees. The mean age at time of surgery was 13.0 years (range: 7.2-19.3). There were 115 knees with intact cartilage and 24 with disrupted cartilage. There was a significant difference in age between patients with intact cartilage (12.5 years, range: 7.2-16.7) and patients with disrupted (15.3 years, range: 10.9-19.3)($p<0.0001$). Multivariate regression analysis revealed that age ($p=0.0045$) and MRI status ($p<0.0001$) were strong independent and combined predictors of cartilage status. Based upon ROC curves, 16.6 years was the critical age in which both false positive and negative rates were optimized. Overall, 88 OCD lesions had MRIs pre-operatively, showing 69 (78.4%) "intact" and 19 (23.6%) "disrupted". Overall, MRI reading for cartilage status had 94.4% sensitivity and 97.1% specificity. Among patients aged ≤16.6 years, MRI had 100.0% sensitivity and 97.14% specificity.

Conclusion: The combination of age under 16 years and MRI showing intact cartilage resulted in 100% accuracy within our sample in predicting intact articular cartilage at the time of diagnostic arthroscopy.

Significance: In patients who meet these criteria, diagnostic arthroscopy appears to be unnecessary prior to retro-articular drilling for juvenile OCD.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Revisions Meniscus Surgery in Children and Adolescents: The Effect of Skeletal Immaturity

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†LOE-Therapeutic - Level IV

Purpose: The purpose of this study was to investigate the incidence and risk factors for revision meniscus surgery in a pediatric population as well as to describe mechanisms of failure and subsequent operative management.

Methods: A retrospective review was performed of all patients under 20 years who had arthroscopic management for meniscus pathology at a single institution between 2008 and 2012. Demographic data and intraoperative findings at the time of the initial surgery were documented. All patients undergoing a second procedure on the same meniscus were further analyzed to calculate the incidence and risk factors for revision surgery. The mechanism and date of reinjury as well as subsequent surgical management were documented. Patients with persistent pain following the initial operation were considered a non-traumatic surgical failure. Multivariate logistic regression with purposeful selection was performed to identify independent risk factors for revision meniscus surgery.

Results: Arthroscopic knee surgery was performed on 293 patients and 324 menisci, including 129 repairs, 149 meniscal debridements, and 46 discoid saucerizations. With a minimum follow-up period of 17 months, 13% of the cohort required a revision procedure. The primary repair group had the highest failure rate (18%) followed by the discoid saucerization group (15%) and the meniscus debridement group (7%). Multivariate analysis indicated that meniscus repair was predictive of re-tear (OR = 2.04, 95%CI 1.01-4.1, p=0.046), and children with an open physis and a bucket handle tear had the highest retear rate of 46% (p=0.039). Independent variables shown to have no significant relationship to revision meniscus surgery included: age, gender, BMI, laterality, time to repair, tear location, and associated ligament injury. The most common indication for revision surgery was an acute traumatic re-injury during physical activity. Revision procedures were performed at an average of 14 months after the index surgery and the majority of failures (69%) were identified within a year. 44% of patients undergoing a revision surgery underwent a further debridement whereas 56% underwent a repair.

Conclusions: Revision meniscus surgery is not uncommon in pediatric and adolescent patients especially those undergoing a primary repair of a bucket-handle meniscus tear when the physes are still open. Most failures are the result of a traumatic injury and nearly half will require further debridement of the torn meniscus.

Significance: Surgeons treating meniscal lesions in this young population, as well as children and their families, should be aware of the short-term rate of revision meniscus surgery, especially when they are still skeletally immature.

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Functional Assessment in Tibial Hemimelia
(Can We Also Save the Foot in Reconstruction?)

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†LOE-Therapeutic - Level IV

Background: The congenital absence of the tibia is a rare disease, and an orthopedic surgeon may not encounter such cases during the course of his/her career. This is the largest report to date of the management of such cases by a single surgeon. The foot and leg were persevered in the majority of the cases, and a functional evaluation system was used to report outcomes.

Methods: Thirty-six patients with tibial hemimelia, who had been under the direct care of the authors since infancy, were evaluated clinically and radiographically. The patients or their parents filled out the Pediatric Quality of Life (PedsQL) and the parents' satisfaction forms. The surgical interventions performed, and their effects on school attendance and, and also the shoe type they wore were documented.

Results: Thirty-six patients (19 girls and 17 boys) with 48 tibial-deficient limbs (19 right, 5 left, and 12 both right and left sides) were studied. The patients were assessed at 12 years (2.5 to 32.5 years), with a mean follow-up of 9 years (2 to 23 years). The 48 limbs included 14 type I, 16 type II, 11 type IV, and 7 unclassified by using the Jones classification; and 6 type I, 11 type II, 16 type III, 1 type IV, and 14 type VII by using the Weber classification.

Primary amputation was performed in 8 patients (10 limbs), and limb preservation surgeries on 38 legs (28 patients). Tibiofibular synostosis, centralization of the ankle, and Ilizarov lengthening were the most common procedures. Nonunion of tibiofibular synostosis (2 cases) and knee stiffness (6 cases) were the main complications.

Among the reconstructed limbs, 12 were in regular and 18 in modified shoes. The PedsQL of 68 points in the reconstructed group was a significant achievement, and it was also better than the score of patients who had undergone amputation.

Conclusion: Reconstruction of tibial hemimelia with foot preservation, provides good functional outcome, in the majority of cases.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Extra-Articular Drilling for Adolescents with Osteochondritis Dissecans of the Talus: A Lost Cause or a Call to Develop Better Treatment?

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Purpose: To determine the radiographic outcome and need for further surgery in children with osteochondritis dissecans (OCD) of the talus treated with extra-articular drilling. Children requiring further surgery for pre-operative risk factors of the initial failure were also evaluated.

Methods: Fifty-six ankles were identified between August 2006 and August 2012 with talus OCD that underwent extra-articular talar drilling. Demographic data, mechanism of injury, conservative treatment history, surgical details of initial treatment and subsequent treatment, if necessary, was collected. Pre-operatively, radiographs were evaluated for physeal status, signs of osteoarthritis according the Kellgren and Lawrence Scale, location of the lesion, border, and size of the lesion. Each lesion was classified according to the Berndt and Harty classification for radiographs, Hepple classification for MRI, and Ferkel and Sgaglione for CT. Radiographs at each follow-up visit were evaluated by a Healing matrix that assessed serial changes in lesion length, lesion depth, perilesional sclerosis, or density of the lesion. At final follow-up, lesion size, border, Berndt and Harty classification, and signs of osteoarthritis were recorded.

Results: At final follow-up, all but one lesion showed radiographic improvement but no lesion reached complete radiographic resolution. The mean Healing matrix score at final follow-up was 59/100. Risk factors for reaching statistical significance for poor healing included closed physes ($p = 0.025$) and lesions with a distinct border ($p = 0.029$). Age, size of lesion, and length of follow-up did not correlate with healing. Comparison of pre-operative and final follow-up radiographs showed no significant change in the size or border of the lesion. For the 23% of children who underwent a second surgery, they were found to have a lower Healing matrix score after index surgery compared to those without repeat surgery, $p < 0.001$). Moreover, patients with closed physes were more likely to have second surgery, 38% vs. 14% (OR 3.7). After a second extra-articular talar drilling surgery, the mean Healing matrix score improved to match the mean of the entire cohort.

Conclusion: Extra-articular talar drilling of OCD does not appear to improve radiographic outcomes as compared with other reported techniques of intra-articular drilling. As with other joints, successful radiographic resolution is associated with open physes – highlighting that children have better OCD healing potential.

Significance: Other modalities of talus OCD treatment should be explored, especially for higher-grade lesions at risk for instability, since the radiographic results of current drilling techniques are disappointing.

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Patient-Reported Outcomes for Syme vs. Boyd Amputation in Congenital Fibular Deficiency

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Purpose: The Syme and modified Boyd amputations have been described to have similar outcomes in treating congenital fibular deficiency. The aim of this study is to determine if a patient-reported difference exists between the two amputations using the pediatric outcomes data collection instrument (PODCI).

Methods: An IRB-approved, retrospective review was performed to identify patients with fibular deficiency who were not candidates for limb salvage and underwent Syme or modified Boyd amputation. Demographic variables were collected in addition to Kalamchi type, unilateral v. bilateral, heel pad migration, complications, and PODCI scores. The PODCI domains of Transfer, Sports, Comfort, Global, and Happiness were utilized to assess patient outcome as reported by the parents and the child (>10 years). Statistical analysis was utilized to identify differences between the amputation groups and their outcome.

Results: Forty-four patients met inclusion criteria for a total of 51 amputations – 12 Syme and 39 modified Boyd. The Syme and modified Boyd groups were similar in age at surgery (1.3 v. 1.7 years, respectively), average follow-up (13.8 v. 10.9 years, respectively), and Kalamchi type (Syme = 3 Type I, 9 Type II; Boyd = 11 Type I, 28 Type II). There were three patients with heel pad migration reported in both groups – 25% of Syme patients and 7.7% of modified Boyd patients, p=0.134. For all domains of the PODCI, there was no statistically significant difference between Syme amputation and modified Boyd. Further, there was no difference in outcome when comparing Syme v. modified Boyd for Kalamchi type or unilateral/bilateral. For both Syme and modified Boyd, the PODCI scores were significantly lower for bilateral amputees in the domains of Sports Child (p=0.039), Global Parent (p=0.033), and Happiness Parent (p=0.0001).

Conclusion: Based on the PODCI patient-reported outcome tool there is no difference between modified Boyd amputation and Syme amputation in patients with fibular deficiency. Bilateral amputees, regardless of technique, have lower PODCI scores in the domains of Sports Child, Global Parent, and Happiness Parent. The statistical analysis is limited by the discrepant group size.

Significance: Syme amputation or modified Boyd amputation results in similar patient-reported outcomes making either surgery an appropriate choice for patients.

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See pages 21- 66 for financial disclosure information.

Percutaneous Transphyseal Screw Epiphysiodesis: Efficacy and Complications

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†LOE-Therapeutic - Level IV

Purpose: Previous reports have identified a number of complications associated with percutaneous transphyseal screw epiphysiodesis (PTSE), including implant failure, implant prominence, angular deformities, and delayed growth inhibition. The aim of this study was to assess the efficacy and complications associated with screw epiphysiodesis at a single high volume orthopedic center.

Methods: Chart review identified all patients who underwent distal femoral and/or proximal tibial PTSE between 2007 and 2013 inclusive. Complications including pain, knee effusion, angular deformity, unscheduled implant removal, infection and failed epiphysiodesis were recorded. For patients with complete pre- and post-operative calibrated imaging, total limb length and length of each tibial and femoral segment were recorded pre-operatively and at skeletal maturity. The Multiplier Method was used to calculate expected length at maturity of each bone segment, and expected physeal inhibition for each bone segment. Efficacy (actual growth inhibition divided by expected growth inhibition) was calculated. Mean leg length discrepancy (LLD) was evaluated at maturity.

Results: Sixty-two patients with 96 treated physes (47 distal femurs and 49 proximal tibias) were included. Thirty-five percent of patients had complications including pain (N=22, 19%), failed epiphysiodesis requiring revision (N=2, 3%), knee effusions (N=4, 6%) and angular deformity (N=4, 6%), defined as a change in mLDFA or MPTA ^{3}5°. No deformities were severe enough to require revision. Twenty-seven percent of patients underwent screw removal.

Average LLD at maturity was 1.8 cm (SD=0.7cm). 81% of patients underwent epiphysiodesis later than the predicted ideal surgical timing. Delayed epiphysiodesis was primarily due to late presentation of the patient, or surgeon preference to err on the side of under-correction. Surgeon experience with the procedure was not associated with improved length discrepancy at maturity.

Overall, efficacy was 110%;107% for distal femur epiphysiodesis and 113% for proximal tibia epiphysiodesis, suggesting that PTSE on average provided slightly more growth inhibition than calculated.

Conclusion: PTSE is an effective method of permanent epiphysiodesis. Although 35% of patients experienced some form of complication, the majority were mild and transient, not requiring additional unplanned surgery. Contradicting previous reports, significant angular deformities were not identified in this series.

Significance: Contrary to previous reports, PTSE in this series did not result in significant angular deformity, insufficient growth inhibition or other serious complications. Further comparative studies, such as a randomized trial, could further elucidate the relative outcomes for this and other epiphysiodesis techniques.

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Weight Loss Programs Fail in Obese Children with SCFE and Blount's Disease

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†LOE-Therapeutic - Level III

Purpose: The development of slipped capital femoral epiphysis (SCFE) and Blount's disease in children are strongly associated with obesity. Prior studies have described the benefit of weight and BMI reduction to prevent disease progression and have shown that surgical correction of the deformity alone does not lead to weight loss. The purpose of this study is to evaluate the effectiveness of pediatric weight management programs in achieving weight loss in overweight and obese children with SCFE and Blount's disease.

Methods: A single-center retrospective review of overweight and obese children (BMI >85th percentile for age) treated surgically for SCFE and Blount's Disease between 2008 and 2013.

Results: 33 patients, including 16 females and 17 males with a mean age of 12.7 years were identified. 21 (64%) patients were treated surgically for SCFE and 12 (36%) for Blount's Disease. Preoperatively, patients had a mean BMI of 32.4 kg/cm^2 and a mean BMI percentile for age of 97.0. Median follow-up after initial surgery was 2.0 years. Compared with their preoperative BMI, 25 (76%) children had an increase in their BMI at the latest follow-up. All patients were offered a referral for weight loss management during follow-up. 17 (52%) patients accepted the offer for a weight loss consultation and 12 (36%) patients attended a pediatric weight loss center. 83% (10/12) of children who attended the weight loss clinic had an increase in BMI at final follow-up versus 71% (15/21) of those who did not. Children who attended a pediatric weight loss center also experienced a larger increase in BMI over this time (3.4 kg/cm^2 vs. 2.0 kg/cm^2; $p>0.05$). For patients who attended the weight loss clinic, average BMI increased from 36.9 kg/cm^2 at the preoperative visit to 40.3 kg/cm^2 at final follow-up ($p=0.003$).

Conclusion: Overweight and obese pediatric patients with SCFE or Blount's disease showed poor insight into weight as one of their healthcare problems, poor compliance in attending a pediatric weight management center when a referral was accepted, and those who attended failed to decrease their BMI during follow-up.

Significance: These results indicate that pediatric weight loss centers are an ineffective means of achieving weight loss in overweight and obese pediatric patients with lower extremity orthopaedic disease and other means of achieving weight loss in this population should be considered.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Mid and Long-Term Outcomes of Patients Undergoing Femoral Lengthening Using the Ilizarov Technique

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Purpose: To evaluate the mid- and long-term clinical, radiographic, and functional outcomes of patients who underwent femoral lengthening using the Ilizarov technique.

Methods: A single institution call-back evaluation of patients who underwent femoral lengthening utilizing the Ilizarov technique, with a minimum 5 year follow-up from their most recent lengthening. Sixty-six patients met the inclusion criteria with 20 agreeing to return for evaluation. Upon return, each patient completed an interview, physical exam, self-reported outcome scores (Satisfaction with Life Scales [SWLS], PRIME MD, Lysholm knee score [LKS], Hip Disability and Osteoarthritis Outcome Score [HOOS]) and radiographic evaluation (pelvis, hip, knee and lower extremity).

Results: Twenty patients (11 females) who had femoral lengthening at an average age 13.3 years (range 9-17) returned an average 15 years (range 5- 24 years) post-operatively. Ten patients underwent lengthening for congenital deficiencies and 10 for acquired deficiencies. Forty percent (n=8) underwent >1 lengthening with each patient undergoing an average of 7.25 surgical procedures (range 2-14) and sustaining 1.95 complications (range 0-7). Limb length discrepancy (LLD) at final follow-up was 1.5 cm (0-6 cm).

For the lengthened extremity at final evaluation (n=19), the knee and hip flexion/extension strength were weaker than the contralateral side (84% and 68%, respectively). 84% of patients had ≥ 90° hip flexion with 78% having ≥ 90° arc of motion. Three quarters of patients (74%) had ≥ 90° of knee flexion with 79% having ≥ 90° arc of motion.

Fifteen patients (79%) had radiographically normal hip joints. The remaining 4 patients had previous septic destruction of the hip. The average Kellegren/Lawrence knee arthritis score was 1.94 (range 0-4). Eleven (58%) demonstrated knee joint space narrowing, osteophytes and sclerosis. The average LKS was fair (71.8, range 34-100) with 8 (42%) having a poor score. The average overall HOOS was 75, with pain as the primary influence for overall HOOS score. Only 4 patients had pain scores below 70 (range 30 -100).

Fourteen patients (70%) were satisfied or extremely satisfied with life. Patients reported mild, if any, symptoms of somatization, depression and anxiety.

Conclusions: At an average 15 years after femoral lengthening utilizing Ilizarov technique, the majority of patients demonstrate deficits in hip and knee strength and range of motion compared to the contralateral side. However, most patients reported good hip and fair knee function, satisfaction with ADLs and good mental health.

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Significance: Femoral lengthening with the Ilizarov technique may result in high patient satisfaction despite ipsilateral knee and hip dysfunction.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Treatment of Congenital Vertical Talus: Comparison of Minimally Invasive vs. Traditional Surgical Technique with Minimum Five-Year Follow-Up

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†LOE-Therapeutic - Level III

Background: Congenital vertical talus is an uncommon foot deformity that poses many treatment challenges. The most common historical treatment method is an extensive soft-tissue release. A minimally invasive treatment approach (Dobbs method) that relies primarily on serial cast correction was introduced almost 10 years ago with promising early results. The purpose of our study was to assess the long-term outcome of congenital vertical talus patients managed with the minimally invasive technique and compare them to a cohort treated with an extensive soft-tissue release surgery.

Methods: The records of twenty-eight consecutive vertical talus patients (forty-four feet) were retrospectively reviewed at a median of 7.1 years (range, 5 to 11.3 years) after initial correction was achieved. The Dobbs method was used to treat sixteen patients (twenty-four feet), while an extensive soft-tissue release surgery was performed in twelve patients (twenty feet). Patient demographics, ankle range of motion, Pediatric Outcomes Data Collection Instrument (PODCI) questionnaire, and radiographic measurements were collected for analysis.

Results: At latest follow-up, the average arc of motion for patients treated with the Dobbs method was 43.7° compared to 11.8° for patients treated with extensive surgery ($p<0.0001$). The average PODCI normative pain score was superior in the Dobbs treatment method group compared to the extensive soft-tissue release treatment group (51.0 vs. 36.4, $p=0.05$). Greater correction of the anteroposterior talar axis-first metatarsal base angle was achieved in the minimally invasive treatment group compared to surgery (38.8° vs. 26.8°, $p=0.01$), though all other radiographic values were similar between the two groups ($p>0.2$ across all variables).

Conclusions: The noninvasive vertical talus treatment method results in better long-term range of motion and pain scores compared to extensive soft-tissue release surgery. Improved outcome with the Dobbs treatment method for vertical talus may result from decreased scarring, similar to with the mechanism proposed for the Ponseti method of clubfoot treatment. Longer-term studies are necessary to determine if the improved outcomes are maintained into adulthood.

♦ 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 9.

The Outcomes of Selective Ultrasound Screening for Developmental Dysplasia of the Hip are No Better Than Clinical Screening Alone: A Cohort Study Using A 40-Year Old Historic Control Group

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Purpose: In 1969, clinical screening of the newborn child for developmental dysplasia of the hip (DDH) was introduced in the United Kingdom (UK). In 1977, a study from our institution was published detailing the incidence of late-diagnosis DDH (defined as age at diagnosis over 3 months) and the rate of surgery for DDH over a 5-year period (1968-1972). Over the last twenty years, "selective ultrasound-screening" (hips scanned if risk factors present or abnormal neonatal examination) for DDH has become well-established in the UK. The purpose of this study was to determine the efficacy of selective ultrasound-screening for DDH in comparison to clinical screening alone, using the incidence of late-diagnosis DDH and the rate of surgery for DDH as measures of outcome.

Methods: This was a retrospective cohort study performed at a University teaching hospital. The department's neonatal DDH database was interrogated to identify all cases of DDH in newborns during the study period (2008-13). Our surgical database was used to identify all cases of closed or open reduction for DDH (over the same period). Patients born outside our region, and teratologic cases were excluded from analysis. The Obstetric database was interrogated to ascertain total number of live births over the five-year period. The resulting data was used to calculate the incidence of late-diagnosis DDH in our region, and the rate of surgery for DDH. These results were compared to the results of the study performed in 1977, using that as the historic control group. Relative risk was calculated for the two groups, and analysed for statistical significance.

Results: The incidence of late diagnosis DDH over the recent 5-year study period was 0.6/1000 live births, which was exactly the same as that reported in the historic control group. The rate of surgery for DDH was 0.76/1000, compared to 0.9/1000 live births in the control group. The relative risk for surgery for DDH in the current study population compared to the historic control was 0.85, but this difference was not statistically significant (95% C.I. 0.50 to 1.47; $p=0.57$).

Conclusion: This study shows that despite advances in screening for DDH over the last 40 years, there has been no change in either the incidence of late diagnosis DDH, or rates of surgery for DDH in our region.

Significance: Selective ultrasound-screening appears to be no better than clinical screening alone for DDH. Another approach to screening is required in order to eliminate late-diagnosis DDH.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Intramedullary Nailing of Femur Fractures in Preschool Age Children Does Not Improve Radiographic Outcomes vs. Immediate Spica Casting but Does Increase Intervention

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Purpose: There has been a recent increase in the operative treatment of pediatric fractures, often in absence of evidence demonstrating superiority over non-operative management. Flexible intramedullary nailing is a valuable tool in the treatment of femur fractures in school age children while spica casting has been standard of care in younger children. We sought to compare these treatment modalities in preschool children, aged 4-5 years.

Methods: After IRB approval, a retrospective cohort of consecutive patients age 4 or 5 years with isolated femur fractures treated by intramedullary nailing (IMN) or immediate spica casting were identified from 2 centers. Radiographic and clinical outcomes were compared between groups. Statistical methods included chi-squared analyses and Fisher's exact test for categorical variables and Mann-Whitney testing for continuous variables.

Results: 278 patients were identified with mean 35 week follow-up. 109 patients underwent IMN and 169 patients were treated with immediate spica casting at surgeon discretion. IMN patients were older (5.24 vs. 4.71, p<0.0001) and heavier (21.5kg vs. 17.9kg, p<0.0001) and more likely to have a higher energy mechanism of injury. At final follow-up, there was no difference between groups in the frequency of patients meeting Flynn's criteria of acceptable coronal angulation <15^{o}, sagittal angulation <20^{o}, and limb length discrepancy (LLD) <15mm (94.7% spica vs. 97.2% IMN, p=0.38). The rate of LLD >20mm was not different between groups (2.4% spica vs. 1.8% IMN, p=0.99). The mean time to weight bearing was not meaningfully different (spica 6.7 vs. IMN 6.3 weeks, p=0.001). While there was no difference in unplanned return to the OR (IMN 5.5% vs. spica 2.4%, p=0.1974), IMN patients required more clinic visits (5.2 vs. 4.0, p< 0.0001), longer periods of follow up (42 vs. 30 weeks, p<0.0001), and underwent more repeat procedures than spica patients (88% vs. 6.5%, p<0.0001), primarily due to elective implant removal.

Conclusion: Preschool children (aged 4-5 years) with isolated femur fractures have similar clinical and radiographic outcomes with either immediate spica casting or IMN. However, patients treated with IMN required longer periods of follow-up and a dramatically higher rate of repeat procedures due to elective implant removal.

Significance: This study demonstrates relative equipoise in non-operative vs. operative treatment methods in this focused patient population. Given the significantly greater rate of reoperation with IMN, prospective studies examining cost effectiveness as well as patient and family centered outcomes are necessary.

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Antibiotic Compliance Decreases Infection Rate in Pediatric Spine Surgery: A Retrospective Cohort Study

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Purpose: A multidisciplinary task force, designated Target Zero (TZ), has developed protocols for prevention of surgical site infection (SSI) for spine surgery at our institution. The purpose of this study was to evaluate how compliance with the TZ antibiotic bundle impacts infection rates in pediatric spine surgery.

Methods: After institutional review board approval, a consecutive series of 878 patients who underwent primary spine procedures from April 2006 to June 2012 were retrospectively reviewed to identify patients who developed SSI. Patients were followed for a minimum of one year post-operatively. Compliance data was collected prospectively and was available for 660 consecutive patients. Three criteria were required for TZ antibiotic bundle compliance: appropriate IV antibiotics completely administered within one hour prior to incision, IV antibiotics appropriately re-dosed intra-operatively for blood loss and surgical time, and IV antibiotics discontinued within 24 hours post-operatively. A Chi-square test was used to test the association between compliance and the development of an infection.

Results: The overall TZ antibiotic bundle compliance rate was 82.3%. The overall infection rate was significantly higher in the non-compliant group (7.7%) compared to the compliant group (3.5%, p=0.04). In a number needed to treat analysis, for every 24 times the TZ antibiotic protocol was adhered to, one SSI was successfully prevented. When one or more components of the TZ antibiotic compliance bundle were not met, the risk of SSI was 2.2 times (p=0.04) the risk of SSI when all three components were met. Of the non-compliant patients, 52% were not compliant due to failure to completely infuse preoperative antibiotics, 34% were due to a failure to re-dose antibiotics appropriately, and 15% were due to a failure to discontinue antibiotics within 24 hours post-operatively. Of the infected patients, non-compliant patients had shorter time to infection (36 days) than compliant patients (122 days, p=0.0174).

Conclusions: Compliance with a comprehensive antibiotic protocol developed by a multidisciplinary task force showed a statistically significant reduction in SSI rates.

Significance: Institutions should focus on improving compliance with prophylactic antibiotic protocols to decrease SSI in pediatric spine surgery.

†LOE - Level of Evidence - Please see page 20 for details.

See pages 21- 66 for financial disclosure information.

Minimizing Complications in Scoliosis Surgery in Children with Cerebral Palsy

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Purpose: Posterior spinal fusion (PSF) in children with cerebral palsy (CP) carries a high risk of complications and mortality. Complication rates have been reported as high as 45%, and infection rates typically reported at 15%. Efforts to improve efficiency by reducing operative time and blood loss could decrease these risks. The purpose of this study is to investigate the impact of utilizing two attending surgeons on blood loss, operative time, and complications in this fragile population.

Methods: This was a prospective, matched cohort analysis with a consecutive series of patients with CP who underwent PSF, with two attending surgeons, in 2012. These were matched with a control group that had a single-surgeon team (operative dates 2008-2010), assisted by a resident, PA, or RN-FA. A standardized protocol was used for anesthetic technique, wound closure, post-operative dressings, and post-operative care. Matching was based on age, gender, weight, and pre-operative Cobb angle. Outcomes measured were total operative time, estimated blood loss, blood transfusions, length of stay, complications, and infections. The groups were compared using paired Student T-tests and chi square tests (significance set a $p<0.05$).

Results: 50 patients were included in the study (25 study and 25 matched controls). Mean age in the study and control groups was 15.5 and 12.6, respectfully (NS). There was no statistical difference in the preoperative Cobb angle, the Cobb angle correction, or in the use of antifibrinolytics (e.g. TXA). The results are shown below:

	Two Surgeons	One Surgeon	P-value
Operative time	3.3 hours	5.25 hours	0.000002*
Estimated Blood Loss (ml)	865	1238	0.009*
Complications	2	9	0.02*
Infections	0	2	0.15
Length of stay (LOS)	5.35	6.5	0.02*

* Indicates Statistical Significance

Conclusion: The use of a second attending surgeon lowered the operative time, blood loss, complication rate, and LOS for PSF in patients with CP. The widespread use of two attending surgeons on these complex cases could lead to improved outcomes in this medically fragile population. Additional study is needed to determine impacts on system costs, reimbursements, opportunity loss, and ultimate quality improvement.

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Significance: The use of a second attending physician during PSF for patients with CP could be a viable solution for reducing complications in this medically fragile population.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Training Away Pediatric Cast Saw Burns via Simulation:
A Novel Simulation Trainer and Curriculum

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Purpose: Cast application and removal are essential to pediatric orthopaedics and often performed by providers of variable experience and training. Recent investigations have demonstrated cast saw burns occur in up to 1 in 50 casts, and insurers have paid upwards of $100,000 (USD) per malpractice claim in these situations. [1,2] Simulation training in cast application and removal may reduce injury rates, optimize outcomes, and reduce healthcare costs. The purpose of this educational initiative was to develop, validate, and implement a novel orthopedic simulation trainer and curriculum to improve safety during cast removal.

Methods: Thirty thermocouples were applied to a distal radius fracture model. After simulated fracture reduction and cast application, an oscillating saw was used to cut the cast with continuous temperature recording. Both "good" and "poor" cast saw technique –as established by consensus best practices - were utilized. Maximal temperatures were recorded and compared to known thresholds for thermal injury; humans experience pain at temperatures above 47°C and epidermal necrosis at temperatures above 60°C. [3,4] In addition to measuring technique-related heat generation, construct validity was evaluated by assessing novice (PGY-1), intermediate (PGY-3), and expert (pediatric orthopaedic attending) performance.

Results: Utilizing cast saw "good" technique, mean peak temperatures were 43°C $\pm$ 4.3°C. The highest recorded was 51.9°C. With "poor" technique, mean peak temperature was 75.2°C. $\pm$17.3°C. The maximum temperature recorded with "poor" technique was 112.4°. Construct validity testing showed that novices had the highest average heat generation (12.9°C). There was a decline in heat generation as experience increased with the intermediate group (9.7°C) and the lowest heat generation was seen in the expert group (5.0°C).

Conclusion: A novel task simulator and curriculum have been developed to assess competency and enhance performance in the application and removal of casts. There was a 32.2°C temperature decrease when proper cast saw technique was utilized compared to "poor" technique. Furthermore, "poor" technique consistently achieved temperatures that would cause epidermal necrosis in patients. Construct validity showed that clinical experience was a predictor of decreased heat generation during cast removal.

Significance: This task trainer allows instruction and continuous safety monitoring of proper casting technique by trainees and has been integrated into our simulation program.

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References:

1. Shore BJ, Hutchinson S, Harris M, Bae DS, Kalish LA, Maxwell W 3rd, Waters P. Epidemiology and prevention of cast saw injuries: results of a quality improvement program at a single institution. J Bone Joint Surg Am. 2014 Feb
2. 19;96(4 Halanski MA, Noonan KJ. Cast and splint immobilization: complications. J Am Acad Orthop Surg 2008; 16(1): 30-40.
3. Moritz AR, Henriques FC Jr. Studies in thermal injury. II. The relative importance of time and surface temperature in the causation of cutaneous burns. Am J Pathol. 1947;23:695-720.
4. Williamson C, Scholtz JR. Time-temperature relationships in thermal blister formation. J Invest Dermatol. 1949;12:41-7.

Long-Term Clinical Follow-Up of Arthroscopic Treatment of Discoid Lateral Meniscus in Children

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Purpose: The discoid meniscus, occurring almost exclusively on the lateral side, can lead to pain, popping, snapping, and decreased knee extension. The purpose of this study was to examine the long-term clinical outcomes of arthroscopic partial meniscectomy for the treatment of discoid lateral meniscus in children.

Methods: A previous study at our institution identified 27 consecutive patients who underwent arthroscopic meniscal saucerization by one of two surgeons between 1997 and 2002. These patients were included in this study if they were willing and able to complete the five outcomes questionnaires (IKDC Subjective Knee Evaluation, Kujala Scoring Questionnaire, Lysholm Knee Scoring Scale, Marx Activity Rating Scale and Tegner Activity Scale). Seven additional patients that were treated consecutively at least 10 years ago were also included in the study. Patients were also given the opportunity to receive a knee exam performed by one of the two treating surgeons. The exam was documented as per the IKDC knee examination protocol. Associations between outcome scores and discoid type, meniscal stability, location of instability, and age at time of surgery were identified.

Results: Of the 34 eligible patients (23 female, 11 male), 22 patients were contacted, and 21 agreed to participate. The average length of follow-up was 13.7 years, ranging from 10.3 years to 16.6 years. Average age at the time of surgery was 9.3 years. Long-term follow-up revealed average IKDC, Kujala, and Lysholm scores of 82.87, 86.63 and 83.73, respectively. Additionally, average Marx and Tegner scores were 5.36 and 5.63, respectively. Stratifying the Lysholm scores revealed outcomes that were 45.4% excellent, 18.2% good, 27.3% fair, and 9.1% poor. The average IKDC Knee Examination score was A (normal). In total, 20.6% (7 of 34) of eligible patients underwent a subsequent surgical procedure on the affected knee.

Conclusions: Numerous studies have demonstrated good to excellent short-term outcomes after arthroscopic treatment of discoid meniscus. At an average follow-up of nearly 14 years, our data suggests that clinical outcome scores decline over time. Compared to our previous study with 2-year follow-up, there is an increased rate of knee pain, mechanical symptoms, and functional limitations. Despite excellent post-operative IKDC examination scores, approximately 40% of our patient cohort demonstrated relatively low Lysholm scores (fair and poor).

Significance: Long-term follow-up of young patients treated arthroscopically for symptomatic discoid meniscus demonstrate deteriorating patient reported outcome scores over time.

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Adolescent Idiopathic Scoliosis Patients Are at Increased Risk for Pulmonary Hypertension Which Reverses After Scoliosis Surgery

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Purpose: The purpose of this study is to determine (1) the incidence of pulmonary hypertension in patients with AIS, (2) the relationship between degree of scoliosis curvature and cardiac function in AIS patients and (3) the effect of surgery on preexisting pulmonary hypertension.

Methods: Retrospective review of AIS patients with PSF from 2009 –2013 was done. 2D echos where reviewed for structural heart disease, aortic root size, and Tricuspid regurgitant jet velocity (TRV). Right ventricular systolic pressure (RVSP) was estimated using the Bernoulli's equation (4*(TRV)2 + right atrial pressure). TRV ≥ 2.8 m/s indicates pulmonary hypertension. 2D echo of 180 aged matched healthy adolescents served as control. Spearman correlation and Logistic Regression analysis was done.

Results: 202AIS patients had spinal fusion surgery in the study period and had screening 2D echos. Average age was 14.7 ± 2.5 years. Average Cobb angle was 51.5±12.2°. Two (1.0%) patients had ASD, two (1.0%) patients had VSD. Left heart anomalies included mitral valve prolapse (MVP) in 3 (2.8%) and Mitral regurgitation (mild) in 4 (3.7%).patients. There were no patients with aortic root dilation or valve defects. One patient had-anomalous coronary artery and one had abnormal pulmonary venous connection. The right heart anomalies were mild tricuspid regurgitation in 28 AIS patients compared to 15 in Control (p<0.001). 44 AIS patients had abnormalRVSP/TRVvalues (≥ 2.8 m/s) (p=0.04) indicating pulmonary HT. Spearman correlation coefficient between cobb angle and RVSP/TRV was 0.25 in AIS (p=0.05). This is a significant correlation between increasing cobb and worsening RVSP/TRV. Logistic Regression showed an odds ratio of 3.29 for elevated TRV (meaning increased pulmonary HT) in AIS (p = 0.007). 38 out of 44 AIS patients with elevated TRV/RVSP had 2D echo at follow up 2D echo post-op. All of these patients had normal RVSP/TRV (< 2.8 m/s) (mean 2.1 m/s) (range 1.4-2.37) which shows reversal of pulmonary HT to normal values.

Conclusion: Screening 2D echo identifies structural heart defects and pulm HT. Scoliosis surgery prevents progression and reverses pulm HT, avoiding potentially fatal compromise.

Significance: This is the first study to document evidence of pulmonary hypertension (pulm HT) in AIS patients, the severity of which directly correlates with the size of the curve. Pulmonary hypertension, which can potentially be fatal, reverts to normal after corrective scoliosis surgery. These findings provide direct evidence of immediate benefit of scoliosis surgery and can change the entire scoliosis treatment paradigm.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

The Effect of Compliance Monitoring on Brace Use and Success in Patients with AIS: A Final Report

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†LOE-Therapeutic - II

Purpose: Previous studies have shown poor compliance with bracing in patients with AIS. The purpose of this study was to determine if counseling using compliance monitors improves brace use and decreases curve progression in AIS.

Methods: 222 patients were prospectively enrolled in this study. All patients were Risser 0, 1, or 2, were < 1year postmenarchal, and had curves between 25 and 45° at the time of brace prescription. Patients were placed into 2 groups: Group 1 were aware of the compliance monitor in their brace and were counseled at each visit regarding the downloaded brace usage (n=121). Group 2 were not told the purpose of the monitor in their brace, and physican, orthotist, and patient were blinded to downloaded compliance data (n=101). This report analyzes the comparative data on 160 patients who have completed bracing or had surgery.

Results: 88 patients in the counseled and 72 patients in the noncounseled group completed bracing or underwent surgery. Curve magnitude at initiation was 33.1° in the counseled and 34.3° in the noncouseled groups (ns). Patients in the counseled group wore their orthoses an average of 13.6 hrs/day throughout their management, while patients in the noncounseled group wore their braces an average of 10.7 hours/day (p=0.0024) In the counseled group, 58% did not progress > 5°, while 25% underwent surgery. In the noncounseled group, 45.8% did not progress > 5°, while 37.5% progressed to 50° or surgery. Forty-nine patients who underwent surgery wore their braces only 10.6 hours/day, compared to 13.1 hours per day in the 111 patients who did not have surgery (p=0.016). The effect of counseling was seen in the Risser 0 (n=112) patients (p=0.0066) but not in the Risser 1 and 2 (n=48) patients (ns).

Conclusions: Providing patients compliance feedback and counseling improves brace wear in patients with AIS. Patients who wore their braces more hours/day experienced less curve progression. Patients in both groups who progressed to 50° or surgery wore their braces fewer hours over the course of bracing than their successful counterparts.

Significance: Compliance monitoring and counseling should become part of the clinical orthotic management of patients with AIS. Counseling is most effective in younger children.

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Assessment of Femoral Head Revascularization in Legg-Calvé-Perthes Disease (LCPD) Using Serial Perfusion MRI

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Purpose: Perfusion MRI (contrast-enhanced MRI) can assess the amount and pattern of femoral head vascularity. To our knowledge, no study has quantitatively investigated the revascularization characteristics of the necrotic femoral head in LCPD. The purpose of this study was to determine the pattern and rate of revascularization of the femoral epiphysis and to evaluate if treatment affected this rate.

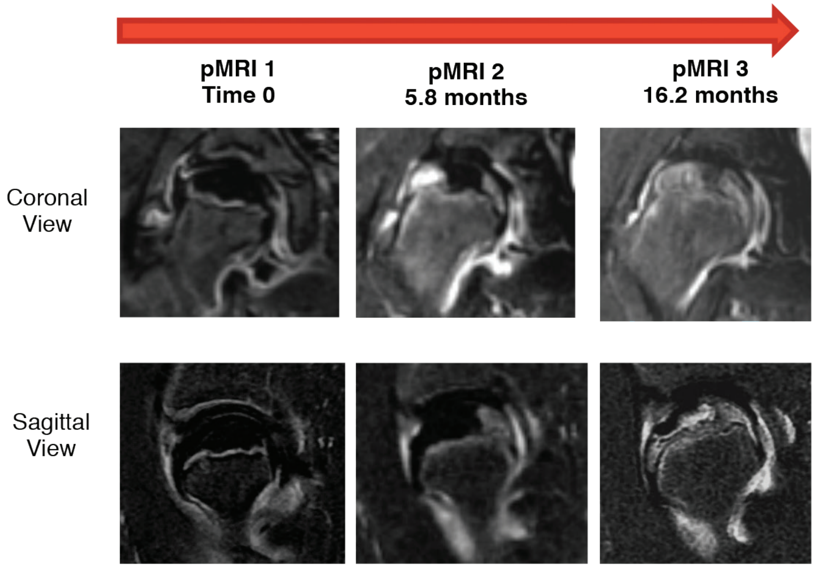
Methods: This is an IRB approved prospective study of 33 patients (33 hips; age 5-16 with mean 9.2 ± 2.3) diagnosed with LCPD during the active stage of disease (Waldenström Stage I or II). All patients had at least 2 perfusion MRIs (pMRI) and 25 patients had 3 or more pMRIs. The average duration between 1st and 2nd MRI, 1st and 3rd MRI, and 1st and final MRI was 5.7, 10.4, and 15.1 months, respectively. Perfusion percentages of the femoral epiphyses were measured by 2 independent observers using a MR image analysis software to determine the rate of revascularization over time. Statistical analyses included ICC and Mann-Whitney U test.

Results: Initial pMRIs showed various levels of % perfusion in the affected femoral heads ranging from 5% to 70%. The average % perfusion was 35 ± 16% at the 1st MRI which increased to 78 ± 13% at the follow-up MRI obtained an average of 10.1 ± 2.4 months later ($p<0.01$). In most patients, the rate of revascularization was faster at the early stage. Serial assessment showed a general pattern of revascularization starting from the periphery of the posterior, lateral, and medial aspects of the epiphysis and converging towards the antero-central region of the epiphysis. The average rate of revascularization was 4.9 ± 2.4% per month with a wide range between patients (0.5% to 10.4% per month). For the 16 patients treated operatively with either epiphyseal/core drilling or a femoral varus osteotomy, the average rate of revascularization was 5.9 ± 2.4 % per month vs. 4.5 ± 2.5 % per month for the 17 patients treated nonoperatively ($p=0.07$).

Conclusion: Revascularization of the affected femoral head increased over time but the rate of revascularization was highly variable between patients. Operatively treated patients appear to have a higher rate of revascularization with statistical analysis showing a trend.

Significance: This study provides for the first time information about the pattern and rate of revascularization of the femoral head in LCPD. Further research would help determine which clinical factors affect the rate of revascularization.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.



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Rare Coding Variants in Musculoskeletal Collagen Genes Are Associated with Increased Risk of Adolescent Idiopathic Scoliosis

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†LOE-Diagnostic - III

Purpose: Adolescent idiopathic scoliosis (AIS) is a common spinal deformity whose etiology has been elusive. In this study we describe the association of rare genetic variants in musculoskeletal collagen genes with AIS risk, scoliosis curve severity, and generalized joint hypermobility.

Methods: To explore the role of rare genetic variants in AIS susceptibility, exome sequencing was performed on 212 severe AIS cases and 258 controls. To evaluate the association between single collagen genes and AIS risk, we sequenced 5 collagen genes (*COL2A1*, *COL5A2*, *COL6A3*, *COL11A1* and *COL11A2)* with the largest number of carriers in cohort I in an independent cohort (cohort III) comprised of 524 unrelated AIS cases of European descent. We then investigated the effect of these musculoskeletal collagen rare variants on scoliosis curve severity, Beighton hypermobility score, and Ghent systemic feature score.

Results: Exome-wide analysis revealed novel nonsynonymous variants in 16 musculoskeletal collagen genes in 32% (68/212) of AIS cases compared to 11% (27/258) of in-house controls and 12% (508/4300) of NHLBI EVS controls ($P=4\times10^{-14}$, OR=3.54, CI =2.56-4.81) (Figure 1). Targeted resequencing of five collagen genes in 736 AIS cases revealed an increased frequency of *COL11A2* ($P=2\times10^{-7}$, OR=3.54, CI=2.56-4.81) and *COL5A2* ($P=1\times10^{-4}$, OR=3.72, CI=1.86-7.21) novel variants compared to controls, although a polygenic burden of rare variants in collagen genes also contributed to the association ($P=2x10^{-8}$) *a*nd correlated with spinal curve severity [Cobb angle 50° versus 57° (P=0.001)] and joint hypermobility (P=0.01). *In vitro* collagen processing defects were observed for variants identified in AIS patients.

Conclusion: Overall, approximately 10% of AIS can be explained by collagen gene variation with novel variants in these genes increasing risk by more than 3-fold.

Significance: Our study demonstrates that collagen gene variation is the largest known determinant of AIS risk.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Factors in the Necrotic Bone Stimulate Osteoclast Formation and Inhibit Osteoblast Differentiation Following Ischemic Osteonecrosis of the Femoral Head

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†LOE-Therapeutic - II

Purpose: The mechanisms responsible for increased bone resorption and decreased bone formation in Legg-Calvé-Perthes disease are unknown. The purpose of this study was to determine the effects of the necrotic bone on migration and formation of osteoclasts and osteoblasts using a piglet model of ischemic osteonecrosis.

Methods: Ischemic osteonecrosis of the femoral head was surgically induced by placing a ligature tightly around the femoral neck to disrupt the blood supply to the femoral head in piglets (n=5). The left femoral heads did not have surgery and served as normal controls. Flow cytometry was used to quantify the number of osteoclast and osteoblast precursors (i.e. mesenchymal stromal cells) present in the repair tissue at 8 weeks post-surgery. To assess precursor cell migration, transwell migration assays were performed in-vitro. For osteoclast differentiation experiments, osteoclast precursors were treated with and without the necrotic bone fluid. To study osteoblast differentiation, mesenchymal stromal cells (MSCs) were treated with necrotic bone fluid. Soluble factors in the necrotic bone fluid were analyzed by ELISA and western blotting methods. Statistical significance ($p < 0.05$) was determined by student's t-test or ANOVA and Tukey's post hoc test.

Results: Flow cytometry of the cells obtained from the repair tissue following ischemic osteonecrosis showed 2.5-fold increase in the osteoclast precursor numbers (p=0.007) and 4-fold decrease in the MSC numbers (p=0.005) compared to controls. Transwell migration assay showed that the necrotic bone fluid obtained from the necrotic femoral head increased migration and differentiation of osteoclast precursors (p=0.0001) and inhibited MSC migration compared to controls (p=0.02). Furthermore, treatment with the necrotic bone fluid inhibited the expression of osteoblast differentiation marker (Osterix) in MSCs in a dose-dependent manner (p=0.0001). Analysis of the necrotic bone fluid revealed increased levels of damage-associated molecules called alarmins which are molecules released by dying cells that trigger immune and other cell responses. HMGB1, S100A6, Cytochrome B, NADH, DNA and pro-inflammatory cytokine IL-6 were elevated.

Conclusion: Necrotic bone contains soluble factors which stimulate the migration and differentiation of osteoclast precursors and inhibit mesenchymal stromal cell migration and commitment to the osteoblast lineage.

Significance: Our study suggests that alarmins in the necrotic bone may be responsible for increased bone resorption and decreased bone formation following ischemic osteonecrosis

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by influencing cell migration and differentiation. The results provide new insight into the understanding of pathophysiology of bone loss following ischemic osteonecrosis of the femoral head.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

♦ Combination Sclerostin Antibody and Zoledronic Acid Treatment Outperforms Either Treatment Alone in a Mouse Model of Osteogenesis Imperfecta

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†LOE-Therapeutic - II

Purpose: Osteogenesis Imperfecta (OI) is a genetic disorder featuring bone fragility and decreased bone mass. Bisphosphonates in children with OI reduce bone catabolism and rely on modelling to form new bone. An anabolic treatment, Anti-Sclerostin Antibody (Anti-SOST Ab), is being investigated in clinical trials. Mixed results have been seen thus far using Anti-SOST Ab alone is mouse models. We hypothesized that combined treatment may produce superior outcomes.

Methods: Female Col1a2 G610C mice and their wild type littermates (WT) were treated from week 5 to week 9 of life with either saline (control), zoledronic acid (ZA) 0.025 mg/kg sc weekly, Anti-SOST Ab given 50 mg/kg IV weekly (Anti-SOST), or a combination of both (ZA Anti-SOST). Outcomes included weekly DEXA for areal Bone Mineral Density (BMD), μCT, mechanical testing of tibiae in 4 point bending. Data were analysed with one-way ANOVA (SPSS v11).

Results: Increases in tibial BMD were seen over time in all groups. Anti-SOST treatment alone had no effect on tibial BMD, while ZA (16%) and ZA Anti-SOST (27%) treatments produced significant increases from weeks 1-4 ($P<0.05$). μCT analysis showed increases in Tissue Mineral Density and Cortical Thickness for combined treatment over respective controls. Tibial 4-point bending showed only combined ZA Anti-SOST yielded a significant increase in strength and energy to failure in OI mice, restoring bone strength to the values of untreated WT mice. In the spine, all treatments increased compression strength over control, Anti-SOST 30%, ZA 43% and ZA Anti-SOST 91% ($P<0.05$).

Conclusion: A combination of Zoledronic Acid and Anti-Sclerostin antibody is superior over either treatment alone in the Col1a2 G610C model of OI.

Significance: Further studies are required in alternate mouse models of OI to confirm efficacy of combination ZA Anti-SOST treatment across different models, and thus to predict possible efficacy across the heterogeneous population of OI patients.

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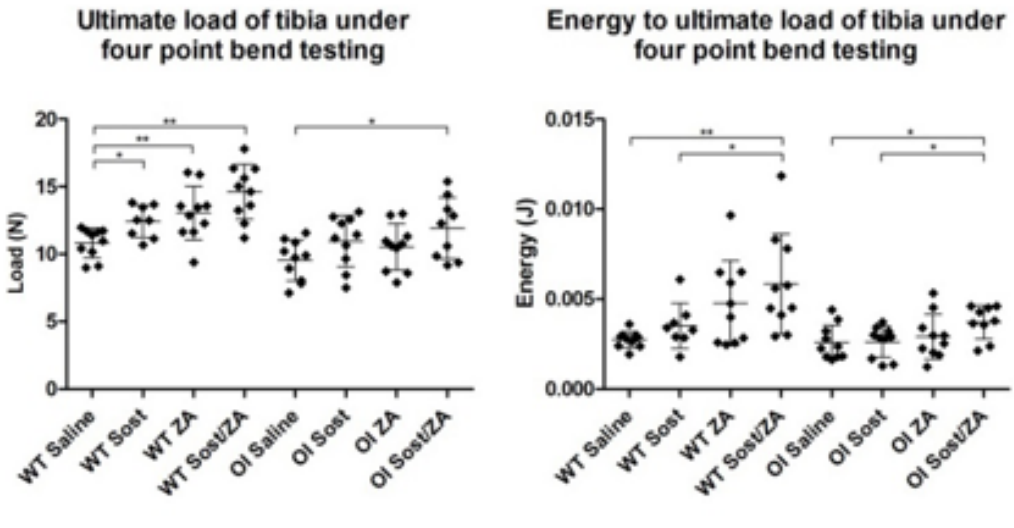

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See pages 21- 66 for financial disclosure information.

♦ Comparison of RANKL Blockade and Bisphosphonate Therapies in a Growing Mouse Model of OI – Implications of Prolonged Treatment on Bone Health

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†LOE-Therapeutic - II

Purpose: Osteogenesis Imperfecta (OI) is a type I collagen disorder, manifested as an increased bone fragility with subsequent fractures. The *oim/oim* mouse is a model of moderate-to-severe OI (OI-3) with a collagen **α**1-homotrimer. We reported that early treatment with ALN or RANK-Fc is effective at reducing fractures in adult *oim/oim* and long-term treatment increases bone-volume-fraction in both *oim/oim* and wild-type (WT; assessed by μCT). Questions persist as to how long to treat children and what treatment would benefit adults. Our study goal is to assess bone quality and strength after treatment with either ALN, RANK-Fc or both.

Methods: IACUC approved, WT or *oim/oim* mice (both sexes) were treated from 2-26 weeks (sacrifice; n=20/treatment/genotype) with: (1)saline 24wks (2)ALN (0.21 mg/kg/dose weekly) 24wks (3)RANK-Fc (1.5 mg/kg/dose biweekly) 24wks (4)saline 12wks/RANK-Fc 12wks, or (5)ALN 12 wks/RANK-Fc 12wks. Biomechanics: humeri (n=7-15/group). FTIRI and histology: femora (n=5-10/group). Significance is reported as $p<0.05$ (two-way ANOVA with post-hoc testing).

Results: FTIRI: Saline-treated WT mice had higher mineral/matrix versus saline-treated *oim/oim*. In cancellous bone, saline-treated *oim/oim* had increased collagen maturity versus WT. ALN-treated *oim/oim* had an increased mineral/matrix versus saline. ALN+RANK-Fc-treated *oim/oim* cortical bone had smaller, less perfect crystals and increased collagen maturity versus RANK-Fc, saline+RANK-Fc, and saline-treated *oim/oim*. In *oim/oim* cancellous bone, ALN+RANK-Fc increased collagen maturity versus RANK-Fc and saline. In WT cancellous bone, ALN+RANK-Fc had decreased acid phosphate substitution versus saline.

Biomechanics: Saline-treated WT were stiffer, sustained a higher load prior to fracture, were more ductile and had a greater work-to-fracture compared to *oim/oim*. WT treated post-adolescence with RANK-Fc were able to sustain a greater maximum load prior to fracture if treated with ALN pre-adolescence. WT treated with RANK-Fc, ALN, or ALN+RANK-Fc were more brittle. No treatment changed *oim/oim* mechanics; treatment did not make bones more brittle.

Histology: All treatments resulted in retention of calcified cartilage (type X collagen) in cancellous bone in both genotypes.

Conclusion: All treatments appear to principally affect cancellous bone quality. *Oim/oim* properties did not approach WT values with any treatments, though ALN+RANK-Fc seemed

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to have the most effect with FTIRI data showing reduced turnover. The reduction in fracture number is attributable to the increase in bone quantity. Neither anti-resorptive is a perfect choice for adults with OI, the Denosumab analogue RANK-Fc, however, appears to have a slight advantage.

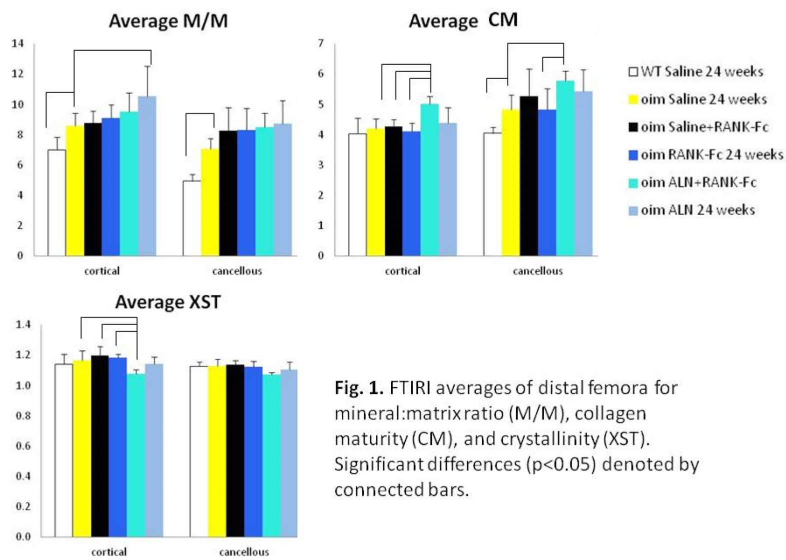

Fig. 1. FTIRI averages of distal femora for mineral:matrix ratio (M/M), collagen maturity (CM), and crystallinity (XST). Significant differences ($p<0.05$) denoted by connected bars.

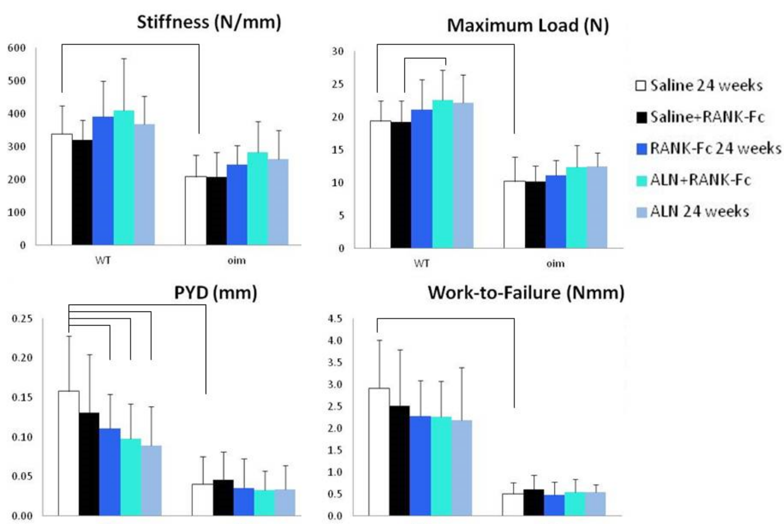

Fig. 2. Results of three-point bend mechanical testing on humeri. Significant differences ($p<0.05$) denoted by connected bars.

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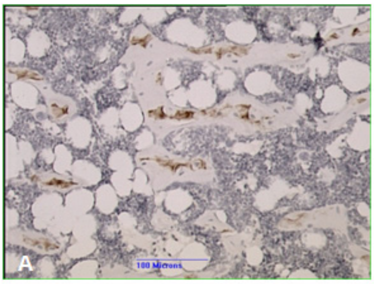

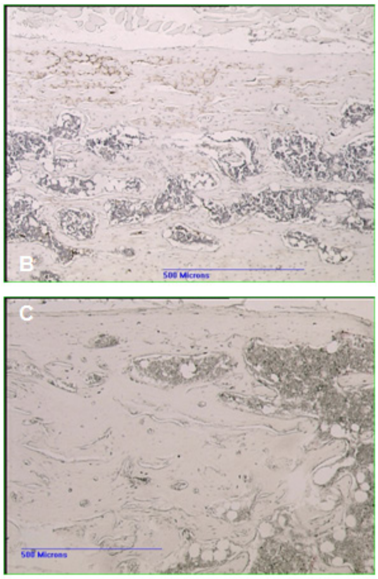

Fig. 3. Type X collagen in tibiae. **A.** Trabeculae in the mid-diaphysis of tibia (10X mag) from 6.5 month old *oim/oim* male treated with ALN+RANK-Fc. Corticalization of trabeculae (4X mag) in *oim/oim* 6.5 month old female treated with RANK-Fc for 24 week **(B)** and in *oim/oim* 6.5 month old female treated with ALN+RANK-Fc **(C).**

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Meclozine Promotes Longitudinal Bone Growth in Transgenic Achondroplasia Mice with Gain-of-Function Mutation in FGFR3 Gene

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†LOE-Therapeutic - II

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. We found that meclozine, over-the-counter drug for motion sickness, inhibited the elevated FGFR3 signaling in chondrocytic cells. The purpose of this study is to investigate the effects of meclozine on longitudinal bone growth of ACH model mice.

Methods: We used transgenic mice carrying the heterozygous *Fgfr3*^{ach} transgene, which express an activated FGFR3 in the growth plate using *Col2a1* promoter and enhancer sequences. We quantified the effect of meclozine in the bone explant culture employing limb rudiments isolated from developing embryonic tibiae from *Fgfr3*^{ach} mice. Next, meclozine was orally administrated to three week-old *Fgfr3*^{ach} mice for three weeks. Body length and weight were measured every week in each individual during experimental periods. We measured bone lengths on the reconstructed three-dimensional image from Micro-CT scan at the end of treatment. The plasma concentrations were measured after consecutive 72 hours treatment for eight week-old mice.

Results: Meclozine significantly increased the full length and cartilaginous primordia of embryonic tibia from *Fgfr3*^{ach} mice. Also, meclozine significantly increased the body length and weight of growing *Fgfr3*^{ach} mice after two weeks of administration. The bone lengths, including cranium, radius, ulna, femur, tibia, and vertebra (L1-5) were significantly longer in meclozine-treated *Fgfr3*^{ach} mice than in *Fgfr3*^{ach} mice without treatment. The average plasma concentration of meclozine after treatment was within the range of concentrations used in clinical settings for motion sickness.

Conclusion: Meclozine enhanced bone growth in ACH model mice. Plasma meclozine concentration of the present study could be clinically applicable.

Significance: This study demonstrates clinical feasibility of meclozine for improvement of short stature in ACH.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Evaluation of Periosteal Procedures to Increase Growth

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†LOE-Therapeutic - II

Purpose: Surgical manipulation of the periosteum has been used to accelerate the growth of long bones with varied results. Different surgical procedures, with varying levels of invasiveness, have been described throughout the literature with varied results. In this study, we report the effects of four reported periosteal procedures on the growth of the tibia in an animal model.

Method: Four different surgical procedures were performed on the tibiae of six to seven-week old New Zealand White rabbits. The procedures were perfomed just distal to the MCL insertion in the proximal tibial and included periosteal elevation (stripping), periosteal transection (cutting), periosteal resection (removal of a strip of periosteum), and full periosteal release (elevating the entire periosteum and transecting its fibers both proximally and distally). The right tibiae was the experimental tibia while the left served as an operative sham control. Four cohorts of eight rabbits underwent the four different procedures and were collected at two weeks. An additional three cohorts of eight animals underwent periosteal transection, resection, and full release, but were harvested at eight weeks post-procedure. Prior to harvest, fluorochrome bone labels were given to measure growth rates at the proximal and distal tibiae post mortem. After harvest the tibial lengths were measured using radiography.

Results: All four procedures resulted in statistically significant increased growth rates at the proximal and distal tibia as well as overall tibial length when comparing the operative limb and control at two weeks. An ~18% increase in growth rate at the proximal tibia and ~20% increased growth rate at the distal tibia was observed for the transection, resection, and full periosteal release cohorts. Overall, these procedures resulted in 1.5- 2%, increase in longitudinal growth of the tibia at 2 weeks. The periosteal stripping cohort demonstrated significantly less growth than the other cohorts and was not carried out to eight weeks. At eight weeks, the proximal tibia of the control limbs, were growing faster than the operative limbs in the transection and resection cohorts (data not yet available on the full resection cohort). Conversely the experimental limbs continued to grow 15% faster at the distal tibia than the controls. The periosteal resection cohort demonstrated the greatest increase in tibial length at 2.3% over controls at eight week.

Conclusions: Growth acceleration occurs following periosteal procedures in the rabbit tibia model. Rates of accelerated growth at the proximal and distal growth plates are similar following periosteal transection, resection, and full periosteal release, but appear to short-lived. Likely the difference in overall growth from these procedures is related to the duration of the growth accelerating effects and not due to a difference in actual growth rates following the procedures.

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Significance: This study demonstrates that less invasive periosteal procedures may result in final growth similar to growth following full periosteal release. Furthermore, this study shows that the periosteum of the proximal tibia can influence the growth rate of the distal tibia, the mechanism by which this occurs will require future study. These findings may be exploited to develop novel growth therapies.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Rectus Sparing Approach to Periacetabular Osteotomy in Adolescents Preserves Hip Flexion Strength at Short Term Follow-Up

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†LOE-Therapeutic - Level II

Purpose: The Bernese periacetabular osteotomy (PAO) has been shown to result in weakness of the hip flexors at 6 months in adolescents with hip dysplasia. The rectus sparing approach (RSA) preserves the origin of the rectus femoris tendon which may prevent loss of hip flexor strength and improved functional outcome

Methods: This was an IRB-approved review of prospectively recruited adolescents who underwent either a standard Bernese PAO (PAO group) or PAO with a rectus sparing approach (RSA group). Data analysis was conducted in all patients who had functional outcome scores (modified Harris Hip score [mHHS]), Biodex isokinetic hip strength and instrumented motion analysis pre-operatively and at 6 months and 1yr post-operatively. Radiographic parameters were measured pre-operatively and at 1 year post-operatively, including lateral center edge angle (LCEA), acetabular index (AI) and ventral center edge angle (VCEA).

Results: Pre-operatively, the PAO group (N=24hips/21 patients, 18 females, average age at surgery 16±4yrs) had decreased hip flexion strength (83 vs. 102 Nm/kg) compared to the RSA group (N=10 hips, 8 females, average age at surgery 16±1yrs). Therefore, a subset of PAO patients (N=13hips/12patients, 9 females, average age at surgery 15±3yrs) was selected with matched pre-operative flexion strength to the RSA group (100 vs. 102 Nm/kg). There were no differences in pre-operative deformity, post-operative correction or degree of correction between the matched-PAO and the RSA groups. Hip flexor strength decreased significantly more at 6 months in the matched-PAO group compared to the RSA group (-35 vs. -7 Nm/kg, p=0.012) as did hip flexion pull-off power (1.33 W/kg PAO vs. 1.76 W/kg RSA, p=0.010). Hip flexion strength did improve from 6 months to 1 year in the matched PAO group, and there were no significant differences in strength at 1yr between matched PAO and RSA groups (80 vs 90 Nm.kg, p=0.495). There were no differences between groups in mHHS (max 89) at any time point (matched PAO group: 67 to 79 to 75, RSA group: 63 to 71 to 79), and both groups improved significantly pre- to post-postoperatively.

Conclusion: Preserving the rectus femoris when performing a PAO leads to improved short term conservation of hip flexor strength and hip flexion pull off power. Further assessment at long-term follow-up is needed to determine if this strength leads to improved functional outcomes.

Significance: The rectus-sparing approach to the PAO preserves hip flexion strength at 6 months post-operatively in adolescents with hip dysplasia.

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Motor-Evoked Potentials to Monitor the Sciatic Nerve During Periacetabular Osteotomy

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†LOE-Therapeutic - Level IV

Purpose: Sciatic nerve palsy after periacetabular osteotomy (PAO) is a serious complication that occurs in 2% of cases with half of these leading to permanent deficit. Previously described intraoperative nerve-monitoring techniques used somatosensory evoked potentials (SSEP) and electromyography (EMG). The purpose of this study was to report our preliminary experience with a nerve monitoring protocol using a combination of Transcranial Electrical Motor Evoked Potentials (TCeMEPs) added to EMG and SSEP during PAO and to identify surgical steps that place the sciatic nerve at risk for injury.

Methods: Parallel TCeMEPs, spontaneous electromyography (EMG), and somatosensory evoked potentials (SSEPs) were monitored in a consecutive series of 34 patients (26 females, 8 males; mean age of 19 years; range 7-36) who underwent a PAO for the treatment of symptomatic acetabular dysplasia. Throughout the procedure, SSEP averages were acquired and compared to baseline data. Any recordings with a 50% reduction in amplitude or a 10% increase in latency from baseline were reported. Subdermal needle electrodes for EMG and TCeMEPs were positioned in bilateral tibialis anterior, medial gastrocnemius, and abductor hallucis muscles. Abnormal EMG activity was reported to the surgeon at the time of occurrence and TCeMEPs were elicited to verify nerve integrity. TCeMEPs were also elicited immediately following the completion of each osteotomy segment. This study was approved by our IRB.

Results: Seven patients (21%) had abnormal TCeMEPs events recorded. Two were detected during the ischium osteotomy. Two cases were attributed to deviation from the anesthesia protocol. Other causes of abnormal conduction included placement of retractors in the sciatic notch during the iliac osteotomy (1 patient), mobilization of the fragment (1 patient) and significant blood loss (1 patient). In all cases, the signal characteristics returned to baseline after a cause could be identified and corrected. There was no postoperative clinical nerve dysfunction.

Conclusion: Adding TCeMEPs to EMG and SSEP monitoring allowed for immediate effective identification of intraoperative factors that can potentially cause sciatic nerve injury and for correction of such factors, including leg repositioning and readjusting retractors at the time of occurrence. However, further studies are necessary to determine whether sciatic nerve monitoring reduces the risk of clinical nerve palsy associated with PAO.

Significance: This study identifies PAO steps that can cause sciatic nerve irritation. Hip flexion should be avoided during the ischium and posterior column osteotomy. Retractors should preferably be placed outside the sciatic notch and fragment mobilization should be carefully performed.

Level of Evidence - Level IV, Retrospective Case Series

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Demographics and Early Functional Outcomes of Combined Hip Arthroscopic Labral Repair and Periacetabular Osteotomy

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†LOE-Therapeutic - Level III

Purpose: Labral pathology is common in adolescent and young adult patients presenting with symptomatic acetabular dysplasia. The purpose of this study is to present the demographics and early clinical outcomes associated with combined hip arthroscopy and periacetabular osteotomy (PAO) for symptomatic acetabular dysplasia.

Methods: A retrospective cohort study design was utilized for this study. Patients were enrolled through our prospective hip registry from March 2010 to August 2014. Two groups were utilized: patients undergoing combined hip arthroscopy (Scope/PAO group) were compared with patients undergoing PAO alone (PAO group). Demographic data was recorded. Pre and postoperative radiographic and functional outcome scores [modified Harris Hip Score (HHS), Hip Outcome Score (HOS), and International Hip Outcome Tool (iHOT-33)] were recorded at 6 months and 1 year follow up. Exclusion criteria included less than 6 months follow up and bilateral PAO.

Results: A total of 57 patients met inclusion criteria (15 patients Scope/PAO, 42 patients PAO). Scope/PAO patients were older relative to PAO alone (29yo [range 15-41yo] scope/PAO versus 23yo [range 12-43yo PAO alone];p=0.007) and had increased previous hip surgery (0% scope/PAO versus 31% PAO). Sex was not different between the two groups. Labral repair for labral tear was performed in all scope/PAO patients. Mean preoperative and postoperative lateral center edge angle (LCEA) and anterior center edge angle (ACEA) were not different between groups. Mean difference of the change in mHHS adjusted for age was not different between the PAO versus scope/PAO groups at 6 months (mean difference [95% confidence interval (CI)]: -2 [-13, 9];p=0.72) or 1 year follow up (mean difference [95% CI]: 3 [-13, 19];p=0.71). HOS Sport subscore showed significant improvements in the scope/PAO versus PAO group at 1 year follow up adjusted for age (mean change [standard deviation]: 49 [20] scope/PAO versus 20 [25] PAO; mean difference [95% CI]: 29 [7, 51]; p=0.013]; N=7, 19 respectively). No differences were seen in HOS ADL or iHOT quality of life at any time-point. Complications and reoperations were not different between the two groups.

Conclusion: Patients undergoing combined hip arthroscopy with labral repair and periacetabular osteotomy are older in age and receive similar clinical benefit up to one year postoperatively as patients undergoing PAO alone. The improvements in higher-level activity seen in HOS Sport subscale will have to be investigated further in the future.

Significance: Combine hip arthroscopy with labral repair and periacetabular osteotomy is safe and provides clinical benefit to appropriately selected patients.

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Three-Dimensional CT Analysis Identifies Distinct Variations in Acetabular Morphology in the Dysplastic Hip

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†LOE-Diagnostic - Level III

Purpose: Acetabular dysplasia is well recognized as a cause of hip pain in young adults and is increasingly treated with acetabular reorientation via the periacetabular osteotomy (PAO). Nevertheless, efforts continue to optimize PAO surgery with specific attention to the acetabular reduction. The purpose of the current study was to characterize acetabular morphology utilizing low-dose computed tomography (CT) in patients with symptomatic acetabular dysplasia that underwent PAO.

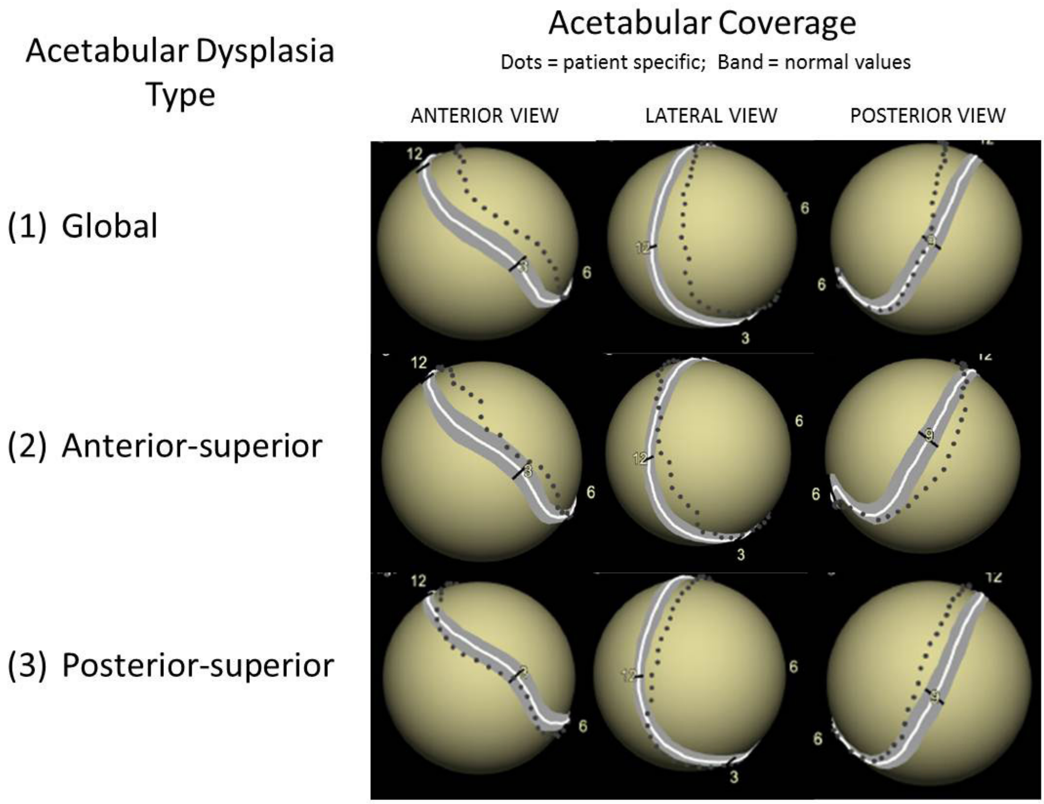
Methods: Low-dose CT scans (0.75-1.25 mSv) were obtained in 33 patients with symptomatic acetabular dysplasia prior to surgical intervention. Plain radiographs and three-dimensional CT reconstructions were utilized to characterize acetabular morphology. Severity was dysplasia was classified utilizing LCEA on plain radiographs as borderline (20-25°), mild (15-20°), and moderate-severe (<15°). CT parameters included acetabular version at 1:00/2:00/3:00, radial coverage (9:00 posterior to 3:00 anterior), and the presence / absence of the posterior wall and crossover signs (on simulated radiographs constructed from CT). The location of acetabular insufficiency was classified as global (similar anterior and posterior involvement), anterior-superior (with maintained posterior coverage), or posterior-superior (with maintained anterior coverage) utilizing three-dimensional coverage maps relative to normative data. Cranial acetabular retroversion was defined as version ≤ 0 at 1:00 or 2:00.

Results: Thirty-three hip (33 patients) including 25 females (76%) and 8 males (24%) were analyzed. Based on LCEA measurements on plain radiographs, 14 hips (42.4%) were classified as borderline, 11 (33.3%) as mild, and 8 (24.2%) as moderate-severe dysplasia. Based on novel three-dimensional CT analysis, anterior-superior insufficiency was seen in 13 hips (39.4%), while posterior superior insufficiency occurred in 11 hips (33.3%) and global insufficiency in 9 hips (27.3%). The patterns of acetabular deficiency were similar for differing severity of dysplasia. Posterior-superior acetabular insufficiency was present in 54.5% of males, compared to only 9.1% of females (p=0.008). The presence of a crossover sign was predictive of posterior-superior insufficiency (p=0.005, positive predictive value 67%), as was cranial acetabular retroversion (p<0.001, positive predictive value 88%).

Conclusion: Three-dimensional characterization of acetabular morphology in patients with symptomatic dysplasia demonstrates significant variability between patients with global, anterior-superior, and posterior-superior insufficiency patterns all occurring. Most notable is the common posterosuperior acetabular deficiency in males.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Significance: Detailed characterization of acetabular morphology may assist in preoperative planning of acetabular reorientation to optimize surgical correction and avoid secondary femoroacetabular impingement.



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Majority of Patients Who Have Confirmed Normal Physical Exam Upon Initial Referral to the Orthopaedic Provider Have No Evidence of Dysplasia Through 2 Years of Age

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†LOE-Prognostic - Level II

Purpose: The natural history of infants initially referred for concerns of developmental dysplasia of the hip (DDH) but who have a confirmed stable hip exam has not been studied prospectively. The purpose of this study was to determine the incidence of residual dysplasia through 2 years of age in patients who had confirmed stable clinical exams by the orthopaedic provider.

Methods: This is an IRB approved prospective cohort study of infants less than 1 year of age referred to a tertiary pediatric orthopedic institution for concerns of DDH from 2008 to 2013. Participants enrolled had subsequent clinical and radiographic follow-up through 2 years of age. Patients with a confirmed normal/stable clinical evaluation were analyzed to determine the frequency radiographic dysplasia at 1 and 2 years.

Results: 1064 patients had a stable clinical exam after initial referral. The average age at initial presentation was 8 weeks (range, 4 days to 12 months). The physical exam was confirmed normal at an average age of 4 months (range, 4 weeks to 2.5 years). Five patients (0.47%) were referred back to their initial orthopaedic provider for mild radiographic dysplasia. All patients were female. Of these patients, 3 (60%) were initially referred for breech presentation and 2 (40%) for hip clicks. Two patients made unscheduled visits in their respective clinicians' office after initial visit for concerns of limited abduction and continuing to hear a hip click. Three patients were noted with evidence of residual dysplasia at 1yr.or 2yr. follow-up; average AI of 31 Left 28 Right and AI 25 Left and 24 Right, respectively. The average age at time of referral back to orthopaedic MD was 2 years (range, 7 months to 5 years). To date, only one patient has received non-operative treatment for their residual dysplasia which included bracing for 9 months.

Conclusion: The majority of patients who have a confirmed normal hip exam at initial referral to the orthopaedic provider have no evidence of dysplasia through 2 years of age. Patients who may warrant additional observation, including those with breech presentation may be evaluated at 2 years of age instead of the 1 year mark when walking milestones and bony development may be better assessed.

Significance: The majority of patients with normal hip exams after initial referral have no evidence of residual dysplasia through 2 years of age, which highlights the value of a thorough and accurate hip examination by the orthopaedic provider.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Arthroscopic Treatment of Traumatic Hip Dislocations in Children and Adolescents

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†LOE-Therapeutic - Level IV

Purpose: Evaluate results of arthroscopic treatment of traumatic hip dislocations in children and adolescents with incongruent reduction and/or retained intra-articular osteochondral fragments following closed reduction.

Methods: After obtaining IRB approval, we identified patients by searching our surgical database. We performed a retrospective review of clinical data to identify patients under the age of 19 who were treated with hip arthroscopy following hip dislocation reduction at a single children's hospital from 2006-2013. Clinic notes, operative reports, radiographic images, and arthroscopic photos were reviewed.

Results: Seven patients were identified from ages 8-17 years old that underwent hip arthroscopy after a traumatic posterior hip dislocation. Six patients presented with acute dislocations and underwent urgent closed reduction with conscious sedation. One patient presented late after a subluxation or transient dislocation from performing traumatic splits in gym class. All patients had a post-reduction CT scan. Intra-articular fragments were found in 6 of 7 patients and 5 of 7 patients had an incongruent hip joint identified by imaging prior to surgery. A predominant pattern of avulsion of a small bony fragment attached to the capsular labral soft tissue complex which became enfolded and blocked concentric reduction was identified in 5 of 7 patients. In all cases, the enfolded soft tissue was reduced without suture or bone repair. Remaining loose osteochondral fragments were removed and in two cases an avulsed ligamentum teres was debrided. Average follow up was 10 months (range 6-18). No AVN or recurrent instability was identified in any case. Six patients reported no pain and one patient reported occasional discomfort, none limped.

Conclusion: Arthroscopic evaluation of incongruent hip joints following traumatic dislocation revealed a consistent pattern of interposed labral capsular complexes attached to bony fragments within the hip joint. Traditionally, open treatment has been performed. Contrary to one prior report of open reduction and repair through a surgical dislocation approach, simple reduction of the capsulolabral complex without repair provided satisfactory short term outcomes.

Significance: Arthroscopic treatment of non-concentric traumatic dislocations results in acceptable short term results and may lead to considerably less surgical morbidity than open methods.

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Imaging Overestimates the Screw Tip-Subchondral Bone Distance in Slipped Capital Femoral Epiphysis

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Purpose: Intraoperative imaging plays a key role in screw placement for SCFE. Complications and worse outcomes have been associated with inadequate screw position. There are no studies comparing imaging studies to direct anatomic measurement in SCFE. The purpose of this study was to evaluate the use of CT and fluoroscopy to determine final screw position in a cadaveric SCFE model. We hypothesized that CT would be more accurate when compared to fluoroscopy.

Methods: Twelve cadaveric hips were utilized. After an anterior approach, an osteotomy was created at the physeal scar and in-situ pinning performed. The known pitch of the screw (2.9 mm) was used to facilitate consistent screw placement. C-arm images were taken at 0, 15, 30, 45, 60, 75, and 90 degrees. We also obtained a CT scan of each hip. The screw tip-subchondral bone distance was measured on digital imaging software. The proximal femur was then resected and the femoral head cut in plane with the screw to expose the screw tip. A digital micrometer was used for cadaveric measurements. Statistical analysis included T-tests and Fischer's exact test.

Results: Moderate SCFE osteotomies were achieved with a mean Southwick angle (40.5±7.38). The 60 degree fluoroscopic image was found to be the most representative image (41% of the time). In contrast, the AP and lateral images were less likely to be the most representative image (8% and 25%, respectively). Screw tip-subchondral bone distance was less in cadaveric measurements (0.94±0.51) when compared to either fluoroscopy (3.34±0.53, p=0.00) or CT (1.59±0.84, p=0.01). Two-thirds (67%) of CT measurements were within 1 mm of the cadaveric measurement, while only 20% of C-arm measurements fulfilled this criteria (p=0.03).

Conclusion: While CT provided a more accurate representation, both imaging studies overestimated the screw tip-subchondral bone distance compared to direct measurement in a cadaveric model of SCFE.

Significance: Surgeons should be aware that imaging studies may overestimate the screw tip-subchondral bone distance. We noted that the screw pitch can aid intraoperative interpretation of imaging studies. Caution is warranted if the screw tip appears < 3mm from subchondral bone on C-arm imaging. CT may play a role in difficult SCFE cases.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Perioperative Psychological Intervention Contributes to Improved Outcomes of Adolescents Treated With Hip Preservation Surgery

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Purpose: Adolescent candidates for hip preservation surgery (HPS) typically present with chronic pain, which can negatively affect psychological function and surgical outcomes. A previous study demonstrated a high rate of at-risk or clinically significant psychological symptoms and maladaptive behaviors in this population. The purpose of this study was to quantify psychological and functional improvements in these pts from pre-op presentation to 1yr post-op follow-up following perioperative psychological intervention.

Methods: 67 patients (40 females; average age: 18.2 years, range 12-21) undergoing HPS for the following diagnoses: femoroacetabular impingement (FAI; 20); acetabular dysplasia (23); Perthes disease (13); SCFE (8); other (3) were evaluated pre-operatively and post-operatively at one year by staff psychologists. Perioperative psychological intervention consisted of education, counseling and administering self-reported measures, which included: Behavioral Assessment System for Children, 2nd Edition (BASC-2), Beck Youth Inventory, 2nd Edition (BYI-II), Resiliency Scales for Children and Adolescents, modified Harris Hip Score (mHHS) and UCLA activity score. Psychological and functional scores were compared pre- and post-op and between medical diagnoses. Frequency analysis, correlational analysis and ANOVA were conducted.

Results: Psychological function improved significantly at 1yr follow-up: decreased anxiety (49.6 to 45.8, p=.000), school problems (46.6 to 44.7, p=.035), internalizing problems (46.3 to 44.1, p=.015), social stress (44.5 to 42.3, p=.024), sense of inadequacy (49.0 to 46.0, p=.004), and increased self-concept (51.1 to 54.1, p=.003). Resiliency factors also significantly improved: increased mastery (50.3 to 52.9, p=.001) and resourcefulness (49.7 to 52.0, p=.046); decreased emotional reactivity (46.3 to 42.9, p=.001) and vulnerability (47.7 to 44.7, p=.011). Increased physical function and return to activity also significantly improved (UCLA: 7.1 to 8.7, p=.017; mHHS: 67.3 to 83.8, p<.001). Return to activity positively correlated with increased optimism and self-efficacy (p=.041). FAI and hip dysplasia pts reported feeling less depressed (p=.036), having fewer somatic complaints (p=.023) and exhibiting fewer atypical behaviors (p=.036) at 1yr follow-up. SCFE pts did not demonstrate improvements in psychological functioning post-op.

Conclusions: Perioperative psychological education and counseling, in combination with HPS, contributed to improvement in self-reported psychological symptoms and self-concept between pre- and 1yr post-HPS. Pats reported reduced anxiety, fewer school problems and less social stress with marked increase in resiliency factors. Increased mobility and return to activity significantly correlated with improved optimism and self-efficacy. Future studies

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are indicated to evaluate interval and long-term follow-up psychological and functional outcomes.

Significance: Perioperative psychological intervention correlates with improvement in post-operative psychological and functional outcomes of adolescents treated with HPS.

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Health-Related Quality of Life Following Staged Containment for Legg-Calve- Perthes Disease

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Purpose: Legg-Calvé-Perthes Disease (LCPD) is the most common pediatric hip disorder in children between the ages of 4-12. The worst subgroup of these patients is one with poor containment and poor range of motion. The purpose of our study was to assess and compare quality of life (QOL) to radiographic outcomes following a staged containment protocol.

Methods: Sixty-six patients who underwent the staged containment protocol (medial release with Petrie casting, followed by Salter osteotomy and/or shelf acetabuloplasty) were retrospectively reviewed. Mean age at treatment was 7.0 years (range: 3-12 years). Preoperative radiographs were used for Herring's lateral pillar classification. The most recent postoperative radiographs were used to assign hips under the Stulberg classification system for outcomes. Mean radiographic follow-up was 7.4 years (range: 2-13 years). The PedsQL survey was administered to patients to assess their current quality of life. Mean QOL follow-up time was 13.7 years (range: 7-25y). Analyses included two-tailed linear regressions and ANOVAs with pairwise comparisons. Statistical significance was set at p=0.05. P-values were adjusted for multiple comparisons.

Results: Forty-five patients had lateral pillar type B, and twenty-one had C hips. According to the Stulberg classification for final evaluation, 2 hips (3%) were included in class I, 28 (42%) in class II, 20 (30%) in class III, 16 (24%) in class IV, and 0 in class V. Subgroup analysis revealed no significant difference in outcomes between B and C hips (p=0.21). Thirty-seven patients responded to the PedsQL survey and had a mean score of 82±18. Stulburg class I and II hips combined had a mean PedsQL score of 86±12 (range: 65-100), class III hips had a mean score of 77±20 (range: 36-99), and class IV had a score of 78±22 (range: 35-100). The three groups did not significantly differ in PedsQL score either before or after controlling for Herring type (p>0.05).

Conclusion: Based on Stulberg's classification, the staged containment protocol resulted in good radiographic outcomes, with 45% of patients in class I or II and no differences between lateral pillar types B and C. Good long-term quality of life (PedsQL=82/100) was also reported after an average of 14 years, with no difference between Stulberg groups.

Significance: Based on these long-term results, the medial release, Petrie casting, and pelvic containment surgery protocol appears to be an effective treatment for pediatric patients with LCPD, specifically lateral pillar types B and C.

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Percutaneous Multi-Planar Subtrochanteric Osteotomy with External Fixation for Developmental Coxa Vara

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Objective: Developmental coxa vara (DCV) develops in early childhood between the age of independent walking and 6 years. It remains relatively uncommon, with an incidence of 1 in 25,000 live births. Bilateral involvement occurs in 30% to 50% of patients. The pathoanatomy includes a decrease in the neck–shaft angle, with associated decrease in the articulo-trochanteric distance (ATD) and increased femoral retroversion. Despite well-executed osteotomies, recurrence is cited in the literature as ranging from 30 to 70 %. Recently, good results have been reported using external fixator systems for the correction of proximal femoral deformities secondary to slipped capital femoral epiphysis (SCFE), Perthes' disease in children and percutaneous proximal femoral osteotomy for coxa vara.

This prospective study is performed to evaluate the results of percutaneous subtrochanteric osteotomy in restoring the normal alignment and orientation (radiographic outcome), thereby restoring the normal mechanics of the hip joint, overcoming shortening of the limb, and reestablishing the length–tension relationship of the abductor muscles (functional outcome).

Design: In the period between January 2009 and January 2012, a prospective study was conducted involving 30 patients (33 hips) with DCV and a preoperative H-E angle of 60 degrees or greater on coronal radiographs. Clinical and radiological (Antero-posterior radiograph of the pelvis) evaluation of patients was done preoperatively and biweekly postoperatively till union is achieved and fixator removal, then at 6 month, and at the final follow up with a minimum of 12 and a maximum of 33 months after surgery with an average of (20.8 months).

Intervention: We used the technique described by Sabharwal et al. (2005) to perform an acute, opened wedge subtrochanteric valgus-flexion-derotation femoral osteotomy using a percutaneous multiple drill hole technique. A low-profile Ilizarov external fixator was applied in each case.

Outcome: The average operative time following induction of general anesthesia (including positioning and obtaining Intraoperative portable radiographs) was 74 (range 60–130) minutes. The average time spent in the external fixator till union was 11 (range 7–15) weeks. The average intraoperative blood loss was 35(range 10-150) mL, and no patient developed hemodynamic instability or required any postoperative blood transfusion. The hospital stay averaged 1.2 (range 1–2) days. Hilgenreiner's epiphyseal (H-E) angle preoperative averaged 70.6 degrees (ranging from 55 to 90 degrees). At 6 months averaged 40.6 degrees (ranging from 15 to 60 degrees). At final follow up averaged 41.16 degrees (ranging from 15 to 60 degrees).

†LOE - Level of Evidence - Please see page 20 for details.
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Conclusion: Percutaneous subtrochanteric osteotomy with external fixation appears safe and effective in treating multiplanar proximal femoral deformities associated with DCV in children

Level of Evidence: Level IV

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Long-Term Functional Outcome of Forearm Rodding in Children with Osteogenesis Imperfecta

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Purpose: To assess the long-term impact of corrective forearm surgery on functional ability, ambulation, grip strength, joint range of motion and cosmetic appearance in children with osteogenesis imperfecta.

Materials and Methodology: A retrospective chart review was conducted on 22 children with osteogenesis imperfecta who underwent corrective forearm surgery stabilized with intramedullary rodding at our institution between 1996 and 2013. Functional ability was assessed using the self-care and mobility domains of the Pediatric Evaluation and Disability Inventory (PEDI). Ambulation was assessed using the modified Bleck score. Grip strength was measured using a dynamometer and joint range of motion was measured with a goniometer. Deformity was measured on antero-posterior (AP) and lateral radiographs of the forearm. Outcome measures were assessed pre-operatively and every year post-operatively. Differences between pre-operative and 1-year post-operative outcomes were compared using paired T-tests. All tests were 2-tailed and a p-value of 0.05 was considered significant. In 18 patients with a minimum of 2 years follow-up, outcome measures at 1-year post-surgery were compared to those at the latest clinic visit (mean follow-up time is 8.9 years, range = 2.0 – 16.4 years).

Results: Corrective forearm surgery resulted in a significant improvement in PEDI self-care score (mean change = +6.77, p= 0.0017) and mobility score (mean change =+7.21, p=0.020) at 1 year post-surgery. There was a significant improvement in the Bleck ambulation score (mean change = +0.57, p=0.007) and grip strength (mean change = +6.13N, p=0.015) at 1-year after surgery. Over 80% of improvements were maintained at a mean of 8.2 years follow-up. There was a significant improvement in the radiographic angular deformity of the radius (mean change on AP view =39.7° p=<0.0001, mean change on lateral view =38.2° p=<0.0001) and the ulna (Mean change on AP view =24.7° p=0.0016, mean change on lateral view =27.2° p=<0.0001) following surgery. Elbow and wrist range of motion did not change following surgery. There were post-operative complications: 8 cases with prominent K-wires (all of which required further surgery) and 2 cases of non-union. There was no deep infection, compartment syndrome or physeal growth arrest.

Conclusions: Corrective forearm surgery in children with osteogenesis imperfecta leads to long-term improvement in functional ability, mobility, grip strength and cosmetic appearance. Elbow and wrist range of motion do not change.

Significance: This is the first case series reporting long-term improvement in function following corrective forearm surgery in children with osteogenesis imperfecta.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Long-Term Functional Outcome of Humeral Rodding in Children with Osteogenesis Imperfecta

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Purpose: To assess the long-term impact of humeral rodding on functional ability, grip strength, joint range of motion and cosmetic appearance in children with osteogenesis imperfecta.

Materials and Methodology: A retrospective chart review was conducted on 35 children with osteogenesis imperfecta who underwent humeral rodding at our institution between 1995 and 2013. Fassier-Duval rods were inserted in 19 cases, K-wires in 13 cases and rush rods in 3 cases. Functional ability was assessed using the self-care and mobility domains of the Pediatric Evaluation and Disability Inventory (PEDI). Grip strength was measured using a dynamometer and joint range of motion was measured with a goniometer. Deformity was measured on antero-posterior (AP) and lateral radiographs. Outcomes were assessed pre-operatively and every year post-operatively. Differences between pre-operative and 1-year post-operative outcomes were compared using paired T-tests. In 26 patients with a minimum 2-year follow-up, outcome measures at 1-year post-surgery were compared to those at the latest clinic visit (mean follow-up time = 7.0 years, range = 2.0 – 18.5 years).

Results: Humeral rodding resulted in a significant improvement in PEDI self-care score (mean change = +5.75, p= 0.028) and PEDI mobility score (mean change =+3.59, p=0.008) at 1 year post-surgery. The PEDI self-care score was maintained or improved further in 92% of children at the latest clinic visit. The PEDI mobility score was maintained or improved further in 73% of children at the latest clinic visit. Shoulder forward flexion and elbow flexion significantly improved following surgery (p=0.039 and p=0.024 respectively). This movement was maintained or improved further in 85% of children at the latest clinic visit. There was no significant change in shoulder abduction or elbow extension following surgery. There was a significant improvement in the radiographic angular deformity of the humerus (mean change on AP view =43.7° p=<0.0001, mean change on lateral view =45.0° p=<0.0001) following surgery. There was no significant improvement in grip strength at 1-year after surgery. There were post-operative complications: 7 cases with prominent metalwork, 3 cases of non-union, 1 case of recurrent deformity and 1 case of superficial infection. There was no deep infection, compartment syndrome or physeal growth arrest.

Conclusions: Humeral rodding in children with osteogenesis imperfecta leads to long-term improvement in functional ability, range of joint motion and cosmetic appearance. Grip strength does not change.

Significance: This is the first case series reporting long-term improvement in function following humeral rodding in children with osteogenesis imperfecta.

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Combined Elbow Release and Humeral Rotational Osteotomy in Arthroygryposis

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Purpose: Surgical procedures to improve function in patients with arthrogryposis commonly include elbow releases to improve elbow flexion and humeral rotational osteotomies to improve external rotation. Joint releases are commonly followed by occupational therapy, whereas osteotomies are commonly immobilized after surgery. These procedures are typically done as separate procedures. At our institution we have combined these two procedures in order to minimize the number of surgeries. The purpose of this study is to determine whether this combination of procedures impacts outcome. A concern is that by adding the osteotomy, we will see decreased improvement in elbow flexion. We hypothesize that patients with combined procedures will have similar results to patients who are staged.

Methods: All patients at our institution from 2001-2013 that were treated by elbow release (triceps lengthening, posterior capsulotomy, and ulnar nerve transposition) for arthrogryposis were reviewed retrospectively. Patients were excluded with less than six months of follow-up. Data collected included preoperative and postoperative elbow flexion and extension as well as complications.

Results: A total of 43 patients fulfilled the inclusion criteria. 14 patients underwent elbow release in combination with humeral rotational osteotomy and 29 patients were treated by elbow release alone. Preoperative arc of motion was 39.4º in the combined group (flexion-extension arc 5.7º to 45.2º) and 28.4º in the release only group (flexion-extension arc 2.1º to 30.5º). Postoperative arc of motion was 52.5º in the combined group (flexion-extension arc 45.0º to 93.9º) and 64.23º in the release only group (flexion-extension arc 33.5º to 96.4º). The postoperative arc of motion was significantly different between the two groups ($p=0.03$). The difference was largely due to loss of extension in the patients treated with combined humeral rotational osteotomy and elbow release. Three patients with combined procedures developed hardware complications including one case of delayed union and two of periprosthetic fracture.

Conclusion: Elbow release improves not only the amount of flexion but also increases the total arc of motion in patients with arthrogryposis. Combining rotational osteotomy with elbow release decreases the gains in total arc of motion, primarily due to loss of passive elbow extension.

Significance: Caution should be undertaken when combining humeral osteotomy with elbow release in patients with arthrogryposis. Future research will explore whether more rigid fixation will allow earlier rehabilitation and improved range of motion.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Multi-Center Evaluation of Pediatric Supracondylar Humerus Fracture Practice Patterns Based on the ABOS Performance Improvement Questionnaire

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Purpose: The study uses survey information based on the American Board of Orthopedic Surgery (ABOS) performance improvement questionnaire (PIQ) for pediatric supracondylar humerus fractures (SCHF). Survey responses were obtained from the on-call faculty at three large pediatric orthopedic surgery groups around the country. The survey results were reviewed to identify consensus and variations between the groups and within the groups.

Methods: A comprehensive survey was developed based on the PIQ for supracondylar humerus fractures. Each surgeon answered questions regarding the pre-operative assessment, intra-operative treatment and assessment, and post-operative management and assessment of these injuries. All surgeons taking call for the three groups were surveyed. The results were reviewed to determine areas of consensus (defined as >80% agreement) and no consensus (<80% agreement).

Results: Uniform consensus across all three sites was identified in 21 areas. These included clinical decisions (how to evaluate sensation pre-operatively, no oral antibiotics on discharge, etc.) as well as technical decisions (place lateral pins first, do not bury pins, evaluate fracture stability under live fluoroscopy, etc.). Consensus within a particular group but not across all three groups was identified in 39 areas. For example, one group had 100% consensus regarding the choice of post-operative immobilization (cast with foam) that was different from each of the other groups. No consensus within a particular group or among the groups was identified in 19 areas. Some of these areas included what position to splint the injured elbow, how long to wait before operating on a Type III SCHF, managing Type II SCHF non-operatively, how to treat draining pin sites, how to manage a post-operative nerve injury, and the number of visits and radiographs necessary after surgery.

Conclusions: The survey identified areas of potential research to improve the quality, safety and value of SCHF care. Areas of consensus were identified that should allow for standardization of care. Identified areas of no consensus offer research opportunities. Areas of consensus within a particular group should be evaluated to determine if there is increased quality and value compared to other institutions.

Significance: Variations in care for pediatric SCHF between institutions are known to occur. Analysis of these variations can help to identify areas that improve outcomes and cost and those that do not. This study provides a platform for future research into quality, safety and value for SCHF. Systematic clinical assessment and management plans (SCAMPs) can be coordinated to address and study the variations in care.

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The Utility of Postoperative Radiographs After Pinning of Pediatric Supracondylar Humerus Fractures

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Purpose: To determine the frequency that postoperative radiographs resulted in a change in management following closed reduction and percutaneous pinning (CRPP) of pediatric supracondylar humerus fractures (SCH).

Methods: A retrospective, IRB-approved review of a clinical database organized by CPT was performed between January 2008 and December 2013. Operatively-treated SCH fractures (modified Gartland type II, III, IV) with adequate radiographic follow-up were included. The imaging protocol at the institution comprises intra-operative fluoroscopic images or immediate postoperative radiographs, one-week postoperative radiographs, three or four-week postoperative radiographs prior to pin removal. Patient demographics, fracture type, mechanism, associated injuries, fixation construct, complications, and changes in management were collected and radiographs were reviewed.

Results: 418 patients with 419 fractures with a mean age of 5.75 years met inclusion criteria: 144 type II, 259 type III, and 16 type IV fractures. Fixation constructs comprised of two lateral pins (238 fractures), three lateral pins (126 fractures), constructs including lateral and medial pins (58 fractures), and four lateral pins (1). Four (1%) patients required revision surgery - one was decided after an immediate postoperative x-ray and three were decided at the first postoperative visit. All patients requiring revision surgery sustained type III fractures and were initially stabilized with a 2-pin configuration. The 3 or 4-week postoperative radiographs resulted in zero reoperations but did affect a change in management in the form of longer immobilization for 33 (7.9%) based on surgeon's interpretation. Radiographs obtained after the pin pull date did not result in any changes in management.

Conclusion: After CRPP of pediatric SCH fractures, clinically significant displacement requiring revision surgery is rare (1%) but is noted on early postoperative imaging, thus supporting the need for these radiographs at a one-week visit. Imaging at the time of pin pull may be useful to assess fracture healing and the potential for continued cast immobilization. This decision, however, was based on physician experience and not well elucidated in the medical record marking it as an area of future research. Radiographs following pin pull were not used for decision making and thus should be eliminated as a routine practice.

Significance: As we limit radiation exposure to the children under our care and decrease overall healthcare expenditures, defining the need of every x-ray we order is paramount. This study demonstrates the utility of early postoperative imaging of percutaneously treated supracondylar humerus fractures but calls into question the efficacy of all others obtained.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Annular Ligament Reposition Instead of Reconstruction on the Management of Missed Monteggia Fractures

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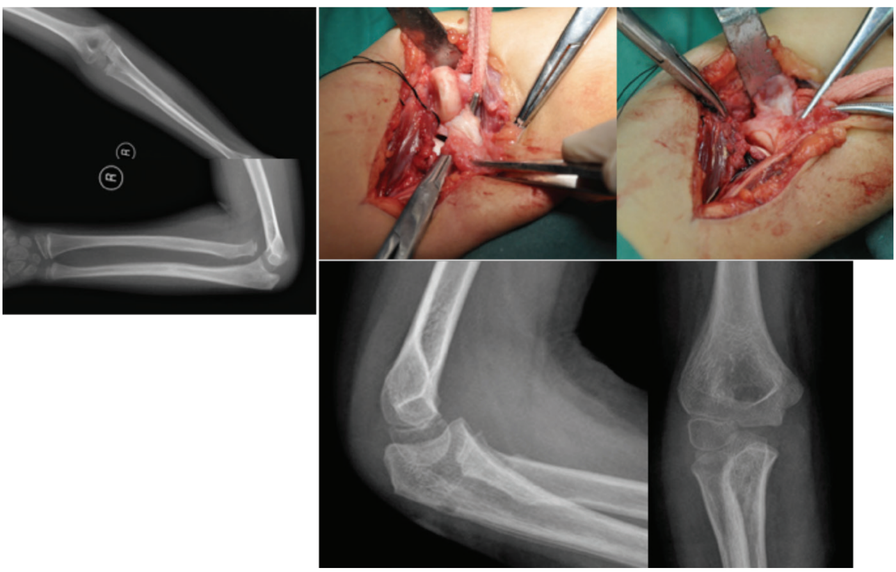
†LOE-Therapeutic - Level IV

Background: The treatment of missed Monteggia fractures usually requires open reduction of the radial head and ulnar osteotomy with reconstruction of the annular ligament to maintain radial head stability. Interestingly, we have observed that in many cases the annular ligament looks intact although displaced into the joint. The purpose of this study was to report our experience in the reposition of the annular ligament at the time of the open reduction instead of its reconstruction for the management of missed Monteggia fractures.

Methods: We retrospectively reviewed 23 patients with missed Monteggia fractures treated by reposition of the annular ligament at the time of open reduction and ulnar osteotomy if required. There were 16 males and 7 females with an average age of 6years (range: 4 to 9 years) . The average time from injury to definitive treatment was 7 months (range: 6 weeks to 16 months). Average follow up was 18 months (range: 8 to 36 months). Clinical examination, Kim score and radiographs were used for evaluation.

Results: All patients have nearly normal elbow function at the latest follow up with 7 cases demonstrating improved elbow flexion as compared to pre-op. There was no significant difference in the Kim score pre and post-operatively. Radiograph at the latest follow up demonstrated maintenance of the radial head reduction is all cases.



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Conclusion: This study demonstrates that reposition of an intact annular ligament can be used instead of its reconstruction to stabilize the radial head in missed Monteggia fractures. This procedure is much simpler and should be considered as a feasible option for the treatment of these challenging fractures.

Significance: firstly, the annular ligament remains intact although it has been pushed into the joint when Monteggia fracture occurs. Secondly, as a kind of new procedure, annular ligament reposition combined with ulnar osteotomy can offer more reliable reduction of the radial head without functional restriction of the elbow.

†LOE - Level of Evidence - Please see page 20 for details.

See pages 21- 66 for financial disclosure information.

Tendon Transfers for C5-7 Brachial Plexus Birth Palsy Patients: Is One Tendon Enough?

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†LOE-Therapeutic - Level IV

Purpose: Brachial plexus birth palsy (BPBP) can be a devastating injury resulting in substantial morbidity to the patient. Secondary surgeries, including tendon transfers, are commonly performed in order to improve function. However, transferring two tendons in patients with C5-7 injuries has been shown to have the potential complication of loss of midline function. The purpose of this study was to investigate if single tendon transfer (1TT) versus the traditional two tendon transfer (2TT) resulted in any differences in outcomes in patients with C5-7 BPBP.

Methods: A retrospective review of all BPBP patients that underwent tendon transfers over a 4 year period was performed at 2 institutions. All patients who had tendon transfer surgery and were C5-7 injuries were included. Outcomes were assessed utilizing the Modified Mallet (MM) scores.

Results: 103 patients underwent tendon transfers over the 4 year period, including 29 C5-7 patients. 22 had complete records of pre and post-operative MM scores, including 11 patients in both the 1TT and 2TT groups. The average age at surgery was 3.6 (1-5.4) years in the 1TT and 4.1(2.1-12.7) years in the 2TT group.

Pre-operative total MM score for the 1TT group was 14.6 and 15.1 for the 2TT group. The average MM internal rotation score was 3.55 for the 1TT group and 3.82 for 2TT group preoperatively ($p=0.19$) and 2.73 and 2.64, respectively, post-operatively ($p = 0.27$).

When comparing pre and post-operative MM categories, there were significant improvements in both the 1TT and 2TT groups for global abduction ($p<.05$ and $p<.01$) and external rotation ($p<0.00001$ for both). MM hand to neck was significantly improved in the 2TT group ($p<.05$) but not in the 1TT group ($p=.053$). Internal rotation significantly decreased in both groups ($p<0.001$).

Final follow-up MM sum averages for 1TT and 2TT groups were 17.1 and 16.9, respectively ($p=0.83$). Both were significantly increased from the pre-operative MM values ($P<.01$).

Conclusion: 1TT and 2TT procedures result in substantial gains in upper extremity functions for patients as measured by the MM score, specifically within the global abduction and external rotation subcategories, however a significant loss occurs in internal rotation for both groups.

Significance: 1TT and 2TT procedures have similar outcomes and therefore one can perform 1TT surgery in C5-7 patients if there is concern about maintaining midline function.

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Ulnar Distraction Osteogenesis for Treatment of Ulnar Based Forearm Deformities in Multiple Hereditary Exostoses

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†LOE-Therapeutic - Level IV

Purpose: MHE is a rare genetic disorder that is characterized by multiple osteochondromas. Forearm deformities are found in 30-60% of those affected with the condition. The vast majority of forearm deformities result from a relative shortening of the ulna due to growth disturbance of the distal ulnar physis resulting in a varus bow. At our institution we retrospectively identified 19 children over the past 10 years with a progressive deformity of one or both of their forearms, who had undergone distraction osteogenesis of the ulna to treat an ulnar based forearm deformity. The purpose of this study was to publish outcomes of distraction osteogenesis in a rare deformity for which treatment is not well studied so as to add to the knowledge currently available.

Methods: We identified 19 MHE patients over the past 10 years at our institution that had distraction osteogenesis of the ulna through an external fixator for progressive forearm deformity. We used radiographic parameters to compare preoperative and postoperative radiographs at non-standardized time intervals. We used medical records to collect demographic data, identify range of motion and subjective patient measures preoperatively and then postoperatively.

Results: A total of 24 operations were performed on 19 patients. There was a statistically significant improvement in a number of the radiographic parameters: ulnar and radial radius of curvatures, ulnar variance, carrying angle of the elbow, angle of the radius relative to the shaft, and radiocapitellar congruency postoperatively. There was a trend towards improvement in pronation, supination, and total arc of motion, although not statistically significant. There was 1 case of premature consolidation, 8 cases of minor pin site infection, and 1 case of a major pin site complication that required admission to the hospital for IV antibiotics.

Conclusions: Ulnar lengthening osteotomy through distraction osteogenesis is an effective surgery for those with MHE and ulnar based forearm deformities. Looking retrospectively at our results, a number of radiographic parameters improved without harming forearm function. These included a trend towards radiocapitellar reduction and restoration of the carpal bones axis to an anatomic normal position. There was only 1 major pin site infection, the rest of the infections were effectively treated with antibiotics as an outpatient. We believe our results support the use of this treatment.

Significance: The results at our institution further support the efficacy of distraction osteogenesis in the treatment of forearm deformities in patients with MHE.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Soft-Tissue Release with Bilobed Flap for the Treatment of Severe Wrist Deformity in Radial Deficiency: Does Not Affect Ulna Growth

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†LOE-Diagnostic - Level IV

Purpose: Centralization is the most commonly utilized procedure for the treatment of the severely deviated wrist in Radial Longitudinal Deficiency (RLD). Individuals with RLD have a congenital shortening of the ulna and it has been previously shown that traditional centralization, in particular centralization with notching of the carpus results in additional ulnar growth retardation. At our institution we employ a technique of soft-tissue release with bilobed flap and wished to examine if this technique preserves the growth potential of the distal ulna and will therefore avoid an additionally foreshortened forearm.

Methods: We recalled and retrospectively reviewed serial radiographs of 16 patients with 18 wrists who had at least 3 years follow up after a soft-tissue release with bilobed flap for the treatment of severe wrist deformity in RLD. Radiographic lengths were measured using the method described by Heikel. Percentage of normal growth was calculated using normative data published by Maresh. Comparisons were made with pre operative, post operative and final follow up studies.

Results: The average length of follow up was 9.2years (range, 3-16.3y) with an average age of 11.6years (range 5.2-17.5y). The average age at the time of surgery was 27months (range, 14-48m). A minimum of three radiographic studies were available for each subject. The average ulna length pre operatively was 63.9% of age matched normal length (range, 51.4-75.3%). The average ulna length at final follow up was 61.9% of age matched normal length (range, 48.5-70.3%). The difference was not clinically significant. There were no distal ulnar physeal arrests.

Conclusion: Soft-tissue release with bilobed flap for the treatment of the severely radial deviated wrist does not affect ulna growth like traditional centralization procedures can. This procedure has previously been shown to retain motion and have similar recurrence rates to formal centralizations and we therefore advocate that it be considered more widely for use in patients with RLD and significant wrist deviation in order to maximise growth whilst providing improved hand position.

Significance: Soft-tissue release with bilobed flap can be safely used on young children and preserve ulnar growth.

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Functional Workspace of Normal and Reconstructed Hypoplastic Thumbs

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†LOE- Economic & Decision - Level II

Purpose: Determine whether: (1) A three-dimensional (3D) kinematic model validated in adults can be used to measure volume of thumb functional workspace in children; (2) this model differentiates between normal thumbs, reconstructed hypoplastic thumbs, and pollicized index fingers; (3) thumb functional workspace correlates with results of validated hand function tests.

Methods: 67 children (5-18 years) underwent 3D kinematic measurement of thumb workspace, and measurements of impairment (grip and pinch strength) and activity (Jebsen Taylor Hand Function Test [JTHFT] [6 activities]; Box and Blocks; and Functional Dexterity Test [FDT]). 11 children had a reconstructed hypoplastic thumb (Group 1); 9 had an index pollicization (Group 2); and 47 had normal thumbs (Group 3). Functional workspace volume was normalized for hand length. One-way analysis of variance (Group comparisons) and Pearson Correlation Co-efficients (workspace correlation with function tests) were used to analyze the data.

Results: Normalized functional workspace volume was larger for Group 3 (1663 cm^3) than Group 1 (619 cm^3) or Group 2 (904 cm^3) ($p=0.001$), but Groups 1 and 2 were not different from each other. Group 3 subjects had stronger grip and pinch than Groups 1 and 2 ($p<0.001$), which did not differ from each other. For the JTHFT, Group 3 subjects were faster than Group 1 subjects for 5 of 6 activities and faster than Group 2 subjects for 1 of 6 activities ($p <0.001$); the 3 Groups did not differ for 1 of 6 activities. Box and Blocks test results showed that Group 3 subjects moved more blocks than Group 1 subjects ($p=0.001$) but Groups 3 and 2 and Groups 1 and 2 did not differ from each other. FDT test results showed that Group 3 performed in-hand manipulation faster than Groups 1 or 2 ($p<0.000$) and Groups 1 and 2 did not differ from each other. The correlation between functional workspace size and function test results was moderately strong (0.5 to 0.75) for all tests.

Conclusions: 3D kinematics can be used to measure thumb workspace volume in children aged 5-18 years. This technique measures differences between normal thumbs, reconstructed hypoplastic thumbs, and pollicized index fingers. Thumb workspace volume correlates with grip and pinch strength, JTHFT results, and the Box and Blocks and FDT tests.

Significance: This study provides evidence that thumb workspace volume may be a useful measure of prehension in children, and may be useful for examining and comparing the results of various thumb reconstruction procedures.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Health Related Quality of Life and Caregiver Impact Following Orthopaedic Surgery in Children with Severe Cerebral Palsy

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Purpose: Cerebral Palsy (CP) is the leading cause of childhood physical disability. Non-ambulatory children with severe CP, Gross Motor Function Classification System (GMFCS) IV-V, have multiple complex medical problems and frequently develop hip instability and spinal deformities that require femoral and/or acetabular osteotomies and spinal fusions. The post-operative trajectory is costly, resource intensive, and fraught with potential complications. Outcomes analysis needs to extend beyond anticipated physiologic and radiographic improvements and include patient-centered outcomes such as health-related quality of life (HRQOL) and caregiver impact. Prospective studies to evaluate these outcomes in children with severe CP are limited. The purpose of this study was to elucidate changes in parents' perceptions of HRQOL and caregiver impact in children with severe CP following reconstructive surgery of the hip or spine.

Methods: Prospective longitudinal cohort study using repeated measures analysis of parent reported changes in patient HRQOL and caregiver impact before and at 6 weeks, 3months, 6 months and 12 months after surgery. The study took place at a pediatric academic tertiary care referral center and data were collected from March 2011-Feruary 2014. Parents were included in the study if their child was between the ages of 3-25 years old, had GMFCS IV-V CP, and was scheduled for orthopaedic surgery to correct a hip or spine deformity. Parents were asked to complete the Child Health Index of Life with Disabilities (CPCHILD©) and the Assessment of Caregiver Experience with Neuromuscular Disease (ACEND) at baseline and at the 4 time points post-operatively. Both measures are valid and reliable.

Results: Parents of 44 children with GMFCS IV-V CP participated in the study. At one year after surgery, parents' perceptions of their child's HRQOL demonstrated a statistically significant improvement in mean score from baseline to 12 months in both the spine ($P < 0.000$) and hip ($P < 0.006$) groups. Improvements were noted in all HRQOL domains except overall quality of life. However, caregiver burden was unaffected by the surgery.

Conclusion: Children with severe CP who undergo orthopaedic surgery to correct hip and spine deformities experience improvements in HRQOL, however changes in the caregiver burden remain unaffected. These children still rely on their parents for all aspects of their activities of daily living.

Significance: Healthcare providers play a critical role in assisting families in peri-operative decision-making. Our study will help healthcare workers to provide guidance to families contemplating surgery for their child as to realistic expectations, risks and benefits.

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Helping Families Make Difficult Choices: Implementation of a Decision Aid for Neuromuscular Scoliosis Surgery

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†LOE-Economic & Decision- Level IV

Purpose: Decision aids serve to prepare families for a meaningful discussion with their physician during the shared decision making (SDM) process. While SDM processes have been used primarily in adult health care settings, we sought to develop a decision aid for use in pediatric patients. The treatment of neuromuscular scoliosis was selected due to the complexity of decision-making when surgery is considered. Our objective was to determine if this tool would improve families' knowledge, increase satisfaction, decrease decisional conflict, and gain physician acceptance.

Methods: The decision aid was created using a multi-step process to provide unbiased, evidence-based information about the risks, benefits, and treatment options for neuromuscular scoliosis. The initial draft was written by an orthopaedic surgeon and then formatted by a multidisciplinary group to meet international decision aid standards. The document underwent local, national, and international peer review prior to prospective implementation by four orthopedic surgeons at a single institution. Families and clinicians evaluated the decision aid using surveys designed for SDM processes.

Results: 11 nonambulatory children, mean age 12 years (range, 8-17) with neuromuscular scoliosis > 50 degrees, were included in the study. 9 of 11 families opted for surgery. The mean scores on the knowledge test increased from 3.0 (range, 2-5) to 4.0 (range, 3-5) of a possible 5 points after reviewing the decision aid ($p = 0.067$). The mean item score on the parent SDM satisfaction scale was 3.77 (range, 3.5-4.0) of a maximum score of 4. The mean score on the SURE test for decisional conflict was 3.7 (range, 3-4) of a possible 4 points. The mean total score on the clinician SDM satisfaction scale was 22.5 (range, 17-25).

Conclusion: The decision aid created for this complex condition resulted in improvements in knowledge gained, parental satisfaction, and decisional conflict, while gaining the acceptance of the physicians. The results allowed for revision of the decision aid for further use. Consideration should be given towards developing additional decision aids within professional societies to maximize efficiency and consensus.

Significance: This study provides a detailed description of the production, implementation, evaluation, and revision of a decision aid consistent with international standards, in order to assist with the SDM process in the pediatric orthopaedic setting.

†LOE - Level of Evidence - Please see page 20 for details.

See pages 21- 66 for financial disclosure information.

A Long Term Follow-Up of Young Adults with Idiopathic Clubfeet Using Pedobarography: Does Foot Shape Matter?

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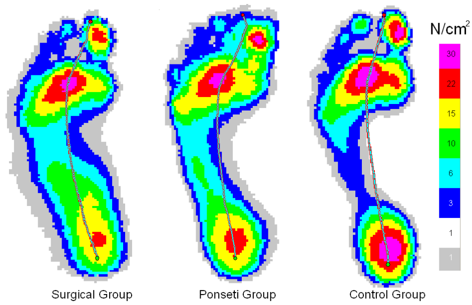
†LOE-Therapeutic - Level III

Introduction: The Ponseti method and comprehensive surgical release have both been used to treat children with idiopathic clubfeet. In this study pedobarography was used to quantitatively compare the foot's interaction with the floor during gait for these two groups and controls to see if there were any differences in shape and loading characteristics.

Methods: Pedobarographic data was collected from three groups during comfortable walking. There were 24 treated with comprehensive surgical release (Surgical-Group), 18 with Ponseti method (Ponseti-Group), and 48 controls (Control-Group). Assessment parameters include peak pressure, subarch angle and duration of foot segment loading (hindfoot, midfoot, forefoot).



Results: Subarch angle was greatest in the Surgical-Group signifying an abducted forefoot or increased midfoot contact area associated with pes valgus. Peak pressures revealed high values in the medial midfoot for the Surgical-Group but low peaks in the medial forefoot compared to the Ponseti and Control-groups. The center of pressure progression (COPP) through the foot showed the duration of loading the forefoot was reduced in the Surgical-Group and increased in the midfoot and hindfoot compared to the Ponseti-Group.

Discussion: With clubfeet, foot pressure and shape in adults differ from controls. The greatest difference is in the midfoot. The Surgical-Group had higher midfoot pressures and loading duration compared to the Ponseti-Group. The presence of increased medial midfoot loading indicated more frequent overcorrection and diminished medial longitudinal arch. The Ponseti-Group more closely resembles the normal foot morphology and pressure distribution, but increased midfoot loading compared to controls shows normal foot mechanics are still not restored.

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Table 1. Subarch Angle and Center of Pressure Progression (COPP) - % of stance phase the Center of Pressure is within each segment.

	Surgical Group	Ponseti Group	Control Group
Subarch Angle	**131.7*†**	**107.8*†**	**100.2**
Center of Pressure Progression (COPP)			
Forefoot (% of Stance)	**30.2*†**	**43.5**	**46.5**
Midfoot (% of Stance)	**35.1***	**31.2***	**23.0**
Hindfoot (% of Stance)	**34.5*†**	**25**	**29.6**

*Denotes significant difference from Control Group ($p<0.05$)
†Denotes significant difference between Ponseti Group and Surgical Group ($p<0.05$)

Identification of Gait Pathologies in Children with Spina Bifida and the Role of Gait Analysis

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Purpose: The purpose of this study was to characterize gait deviations in children with spina bifida and evaluate the effects of gait analysis on pathology identification.

Methods: This study included 44 children with spina bifida (27 males; 11.0 ± 3.7 years) who were previously seen for clinical gait analysis at two pediatric hospitals. Two pediatric orthopaedic surgeons and two therapists (physical therapist or kinesiologist) from gait labs at different institutions who are experienced in the use of gait analysis in this population identified primary gait pathologies based on retrospective review of videos and physical therapy evaluations alone and again with the addition of gait analysis data including kinematics and kinetics. Each side was assessed separately for each subject (88 sides). The frequency of pathology identification was compared between video/physical therapy evaluation only versus video/physical therapy evaluation plus gait analysis data using the 2-sided Fisher's exact test.

Results: Crouch (41% for surgeons, 63% for therapists), tibial rotation (40%, 45%), and pes valgus (24%, 40%) were the pathologies most commonly identified by both surgeons and therapists before gait analysis. Gait analysis increased the identification of crouch among surgeons (41% to 53%, p=0.03) and decreased the identification of genu valgum among therapists (36% to 20%, p=0.001). Gait analysis also increased the identification of excessive hip flexion (10% to 44%, 13% to 23%) and abnormal femoral rotation (7% to 29%, 16% to 28%) for both surgeons and therapists (p≤0.02).

Conclusion: Excessive hip flexion and abnormal hip rotation were often identified only after gait analysis. Hip rotation is difficult to assess due to complex rotational profiles that may include large transverse plane rotations of the pelvis during a single gait cycle. Moreover, visual assessment of hip flexion is challenging because of the difficulty appreciating pelvic sagittal plane motion, which may be significant and changing throughout a single gait cycle. Crouch, tibial rotation, and pes valgus could often be recognized based on physical exam and visual assessment, although the assessment of crouch may benefit from gait analysis data.

Significance: Gait abnormalities in spina bifida are complex and often interrelated, making it difficult to determine primary pathologies using only visual assessment. Gait analysis can assist clinicians in accurately and objectively determining primary pathologies which will guide therapeutic and surgical decision-making.

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Recurrence of Knee Flexion Deformity After Hamstrings Surgical Lengthening – Can Semitendinosus Transfer Improve the Results?

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†LOE-Therapeutic - Level III

Purpose: The aim of this study was to evaluate if distal transfer of semitendinosus to distal femur (TxST) is related to lower recurrence rate than medial hamstrings surgical lengthening.

Methods: Patients with diplegic spastic CP, GMFCS levels I to III, without previous surgical procedures at knee, undergone to bilateral medial hamstrings lengthening or semitendinosus transfer to distal femur and with complete documentation at gait laboratory were included in this study. Thirty-nine patients matched the inclusion criteria and they were divided in 2 groups according surgical procedures at knees: Group A (22 patients / 44 knees), including patients who received medial hamstrings surgical lengthening as part of multilevel approach; Group B (17 patients / 34 knees), represented by patients who underwent orthopedic surgery including a TxST instead of semitendinosus surgical lengthening (STL). Clinical and kinematic parameters were evaluated at baseline and at follow-up for all groups. The primary outcome was to compare the number of fixed knee flexion deformity (FKFD) at both groups before and after intervention and the secondary outcomes included evaluation of mean knee flexion at physical examination and during gait.

Results: The two groups matched at gender distribution (Group A - male 68.2% and female 31.2% / Group B – male 82.4% and female 17.6%), age at surgery (Group A- 10.6 years and Group B-11.5 years) and follow-up time (Group A-5.9 years and Group B-7.2 years). GMFCS level III was more frequent in Group B (70.6%) than Group A (31.8%). FKFD before surgery was observed at 9.1% of knees in Group A and at 50% in Group B (p<0.001). At final follow-up, 25% of knees in Group A and 20.6% in Group B had FKFD (p=0.647). FKFD increased in Group A (p=0.047) and decreased in Group B (p=0.011) after treatment, and patients from Group A received more additional surgical procedures up to final follow-up than those of Group B (p=0.002). Reduction of mean FKFD (from 7.3° to 4.4°, p= 0.04) and of knee flexion during gait stance phase (from 34.2° to 20.2°, p< 0.001) were observed only in Group B after surgical treatment.

Conclusion: In the present study, patients who received TxST shown less recurrence of FKFD than those with STL.

Significance: The knee flexion deformity is frequent in cerebral palsy and it is related to crouch gait. Hamstrings surgical lengthening has been used frequently as an option to treat it; however, recurrence can be a problem during growth.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

The Effect of Selective Motor Branch Block of The Rectus Femoris as Indication for Transfer of the Muscle

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†LOE-Diagnostic - Level IV

Purpose: Stiff knee gait in cerebral palsy is defined as decreased knee flexion in the swing phase of gait, combined with EMG activity in the rectus femoris muscle and/or tightening of the muscle, clinically demonstrated by a positive Ely´s test. The treatment in ambulatory patients with increased activity in rectus femoris during initial phase is often subcutaneous transfer of the muscle to the distal medial or lateral side of the femoral bone. The effect of the transfer is probably brought about by uncoupling of the muscle and/or by the changing of the muscle to a knee flexor.

The effect of a transfer of a spastic rectus femoris can be predicted by a selective motor branch block of the femoral nerve supply to this muscle. A gait anaysis following a nerve block will predict the patient's gait 6 months after the operation.

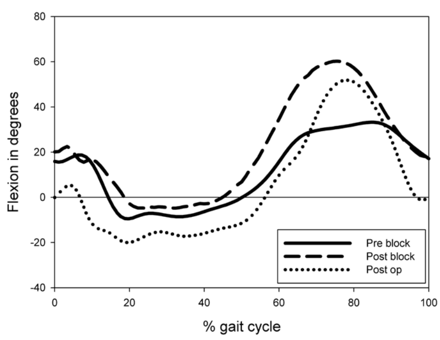
Methods: Seven patients with hemi- or diplegic cerebral palsy and with stiff knee gait, age 11-55, 3 males and 4 females were included in the study. Gait analyses using a Vicon gait analysis system were performed before and after the block of the rectus femoris using a local anaesthetic (Lidocain). The injection method has been described by Sung DH et al (1) using an anatomical algorithm and ultrasound guidance.

Results: In one patient the nerve block acted on the entire femoral nerve, this patient was therefore excluded from this study. The remaining six patients showed generally better gait function in the gait laboratory following the block and at follow up six months after transfer surgery. The range of motion in swing phase increased significantly from mean 14.3 to 19.9 degrees (p=0.046) after block and six months after transfer surgery to 28.4 degrees (p=0.046) (Wilcoxon test).

Conclusion: In patients with stiff knee gait where rectus femoris tranfer is considered as a treatment, a selective motor branch block of the muscle combined with gait analysis can imitate the effect of surgery.

Significance: Selective motor branch block of the rectus femoris is a promising diagnostic tool ensuring the correct selection of patients for rectus transfer surgery.

Example of knee flexion during gait for one participant



Sung DH et al. Arch Phys Med Rehabil 2003;84:1028-31.

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The Pros and Cons of Operating Early vs. Late in the Progression of CP Scoliosis

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†LOE-Therapeutic - Level II

Purpose: When is the right time to intervene surgically in CP patients with progressive scoliosis? The purpose of this study was to evaluate the 2 year outcomes following surgical correction based on the preoperative curve severity in an attempt to guide future surgical recommendations.

Methods: A prospectively collected CP scoliosis surgical registry was queried for patients with a minimum f/u of 2 yrs. Three groups were delineated based on the distribution of preop curve magnitudes: <70º, 70-90º, and >90º. Radiographic, surgical, and quality of life outcome data were compared between the three groups using ANOVA and chi-square analyses.

Results: There were 38 patients in the <70º group, 44 in the 70-90º group, and 42 in the >90º group. They were similar in age. The >90º group had significantly longer operative times ($p<0.001$), likely secondary to the increased percentage of anterior/posterior procedures (31%) compared to the other two groups (5%; Table). The % blood volume loss was also significantly higher in the >90º group compared to the <70º. The infection rate requiring I&D was significantly higher in the >90º group (17%) than the <70º (5%, $p=0.03$) and the 70-90º groups (7%, $p<0.05$). Preop, the CPchild QOL score was significantly higher for the <70º group. Interestingly, at 2 years postop the <70º and 70-90º group reached similar QOL scores (72 and 71, respectively), while the >90º trended toward a lower postop QOL (63.5). There was no difference in length of hospitalization or ICU stay.

Conclusion: When recommending surgery for CP scoliosis, being proactive (Cobb <70º) has no advantage in terms of decreasing risks or improving outcomes compared to curves 70-90°. However, delaying surgery to a curve greater than 90° increases the risk of infection, blood loss, and the need for anterior/posterior procedures.

Significance: While there is no advantage for proactively recommending surgery in CP scoliosis patients with curves less than 70°, there is clear risk in waiting until the curves become greater than 90°. Therefore, in the absence of earlier problems or symptoms, 70-90° is an acceptable "trigger" for surgery that reduces the risk of complications.

†LOE - Level of Evidence - Please see page 20 for details.
See pages 21- 66 for financial disclosure information.

Table 1: Descriptive statistics for patient demographic and operative data.

	<70° Cobb	70-90° Cobb	>90° Cobb
Age (years)	13.6 ± 2.5	14.4 ± 2.4	13.8 ± 3
Operative Time (minutes)	**372 ± 113**	**356 ± 107**	**480 ± 235**
Combined Anterior/Posterior	**1 (3%)**	**2 (5%)**	**12 (31%)**
EBL (as a % of blood volume)	**73%**	**98%**	**115%**
Infections requiring I&D, wound vac, or return to OR	**5%**	**7%**	**17%**
Length of hospitalization *(median)*(days)	8.5	7	8
Length of ICU stay *(median)*(days)	3	3	3
Percent Correction of Cobb at 2 years	64%	65%	66%

Bold values represent statistically significant differences (p≤0.05).

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Respiratory and Radiographic Effects of Growing Rods in Children with Spinal Muscular Atrophy

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Introduction: Respiratory weakness and spinal deformity are common in patients with Spinal Muscular Atrophy (SMA). Posterior (distraction type) growing rods have been the treatment of choice for spinal deformities in growing children with SMA (Types 1 and 2) at our institution. The respiratory status and radiographic findings of this cohort are presented.

Materials: A single center, retrospective review was performed on SMA patients treated with growing rods, inserted between 2004-2010, with minimum two-years of follow-up. SMA type, changes in the route of positive airway pressure respiratory support (none, non-invasive mask, tracheostomy), and the time receiving respiratory support (none, night and naps, >18 hours/day) were recorded. Available pulmonary function tests (PFTs) and radiographs were reviewed. Data were evaluated pre-insertion, post-insertion, and at latest follow-up.

Results: Sixteen SMA children (five Type 1, eleven Type 2) met inclusion criteria. Average age of insertion was 5.8 (range 3.7-8) years, average number of lengthenings was 4, and average time between insertion and last clinical review was 5 years. 8/16 had finished lengthening and only one required conversion to definitive fusion. None of the 16 required more than non-invasive mask support and only one had a clinical worsening of their route of respiratory support, requiring the addition of noninvasive BiPAP use at night. Except for this one, none of the sixteen experienced significant changes in their positive pressure respiratory support needs. All required support only at night and naps. One with SMA type I recently died. Serial PFTs were available for six SMA type 2 patients. PFTs demonstrated significant improvements in absolute FVC, minimal changes in the Maximal Inspiratory (MIP) and Maximal Expiratory Pressures (MEP), and a gradual worsening of % predicted FVC. Radiographic review demonstrated significant ($p<0.05$) improvements in the following: Cobb Angle, Pelvic Obliquity, Thoracic and Lumbar Heights, Space Available for the Lung (SAL), Rib Vertebral Angle Difference (RVAD), and Thoracic Kyphosis following growing rod implantation. Thoracic and Lumbar Height, Chest Width, and Depth increased significantly ($p<0.05$) over the lengthening process.

Conclusion: Clinical respiratory support requirements appear to stabilize following the insertion and lengthening of posterior based growing rods in SMA. Similar to previous studies, increased spinal height and thoracic cavity size were noted throughout the process. Despite an increasing absolute FVC, stabilized MIP and MEP, the % predicted FVC diminished over time.

Significance: Stabilization of clinically relevant pulmonary function appears to occur following growing rod insertion in children with SMA.

See pages 21- 66 for financial disclosure information.

Rate of Lower Limb Angular Correction in 8-Plate Hemiepiphysiodesis in Children with Varying Skeletal Pathologies

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Purpose: The immature skeleton is amenable to guided growth techniques. Both lower limb length discrepancies and angular deformities can be corrected. Longitudinal growth rates in children are well documented; however, angular growth rates are less understood. This study aimed to define the rates of angular correction using temporary hemiepiphysiodesis (8-plate, Orthofix) in differing skeletal pathologies.

Methods: A retrospective review of 61 children (36M:25F) with angular deformities about the knee who underwent 8-plate hemiepiphysiodesis (mean age 10.8y) was undertaken. The children were divided into 9 groups based on their underlying pathology (lower limb post-axial hypoplasia, Blount's disease, skeletal dysplasia, rickets, metabolic disease, acquired growth disturbance, vascular malformation, steroid use and other genetic disorders). Each limb segment was analysed separately. Radiographic measurements of the mechanical lateral distal femoral angle (mLDFA), mechanical medial proximal tibial angle (mMPTA) and mechanical axis deviation were calculated using the TraumaCad® digital templating software based on standing long-leg anteroposterior radiographs. The rate of correction of each radiographic parameter was calculated from pre-operative and the first post-operative radiograph that showed complete correction of the mechanical axis (or evidence of failure of continued mechanical axis correction).

Results: A total of 144 limb segments (80 distal femoral /64 proximal tibial physes) were analysed. 62.5% of children had mechanical axes outside the knee joint at the time of operation; 63.2% achieved full correction (zone 1). The rate of angular correction at the distal femur was quickest in those with acquired growth disturbance (1.15°/month), complex genetic disorders (1.12°/month) and rickets (0.93°/month). It was slowest in those with vascular malformation (0.40°/month), post-axial hypoplasia of the lower extremity (0.44°/month) and metabolic disease (0.49°/month). At the proximal tibial physis, the rate of angular correction was quickest in those with acquired growth disturbance (0.77°/month) and skeletal dysplasia (0.57°/month); whilst being slowest in those with metabolic disease (0.22°/month) and Blount's disease (0.29°/month).

Conclusion: The rate of angular correction about the knee varies with the underlying pathology. Both the distal femoral and proximal tibial physes show correction rates that vary up to 3-fold. As expected, those with metabolic disease show a slow rate of correction at both physes, whilst hypoplasia of the lower extremity differentially show a slow rate of correction at the distal femur and Blount's at the proximal tibia.

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Significance: This study demonstrates the differential rate of correction of angular deformities in children with different skeletal pathologies, which should help with timing of hemiepiphysiodesis.

See pages 21- 66 for financial disclosure information.

Clinical Outcome of the Lower Limb Lengthening Using Culture-Expanded Bone Marow Cells and Platelet Rich Plasma

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Purpose: Since 2002, we have performed the lower limb lengthening using culture-expanded bone marrow cells (BMC) and platelet rich plasma (PRP) for patients with significant limb length discrepancy or severe short stature associated with FGFR3 disorders. In the present study, the efficacy of this cell therapy on new bone regenerates was retrospectively analyzed in patients with achondroplasia (ACH) and hypochondroplasia (HCH).

Methods: The transplantation technique of BMC and PRP was described previously (Bone 40:522-528, 2007). Inclusion criteria of this study were the ACH or HCH patients who underwent lengthening of the lower limbs at out hospital and followed up at least 12 months after removal of the fixation pins. A total of 37 patients (112 legs) was included and these patients were separated into two groups; the BMC group that was treated with BMC and PRP transplantation, and control group that had no additional cell therapy. Clinical outcome was defined as either good outcome (healing index of 50 days/cm or less with no adverse events that required any additional treatment) or poor outcome (healing index of more than 50 days/cm or needed additional procedures with or without surgical intervention). Age at surgery, the amount of length gained, and clinical outcome was compared between the two groups.

Results: The BMC group consisted of 70 legs in 24 patients while the control group consisted of 42 legs in 13 patients. There were no significant differences in the age of surgery (15.2±4.2 years in the BMC group and 16.4±4.2 years in the control group) and the length gained (9.1±1.3 cm in the BMC group and 8.7±1.7 cm in the control group). The rate of good outcome, on the other hand, was significantly higher in the BMC group (83%) than in the control group (62%) (P=0.0132).

Conclusion: Transplantation of BMC and PRP provided better clinical outcome in lower limb lengthening in patients who had homogeneous etiology.

Significance: This autologous cell therapy is easy, safe and effective in excessive limb lengthening, which is occasionally associated with significant time and efforts.

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Parallel Proximal Fixation in Rib Based Growing Rod System: A Novel Approach to Deal with Proximal Hook Migration

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Purpose: Proximal anchor failure continues to be a significant problem of VEPTR instrumentation with rates of failure reported as high as 40%. In an effort to decrease proximal anchor failure, many have adopted a parallel proximal anchor construct which allows independent pre-loading of the hooks on the ribs. This study evaluated Cobb correction, maintenance of spinal growth, sagittal balance, and complications associated with parallel proximal anchor VEPTR constructs when compared to traditional in-line constructs.

Methods: This is a retrospective review of a prospectively collected multicenter database. Patients who had undergone VEPTR instrumentation with at least 2 years of follow-up, a minimum of three lengthenings, and rib-spine and rib-pelvis constructs were included. Initial and final Cobb correction, T1-T12/T1-S1 height, sagittal balance, and complications were reviewed and compared between cohorts.

Results: Thirty-one in-line and 25 parallel patients were matched by diagnosis, age, and baseline Cobb angle. The parallel construct demonstrated significant improvement in initial Cobb correction (56.4 vs. 43.4, p=0.03). Final Cobb correction, spinal height, and sagittal correction was similar in both groups. There were 43 complications in the in-line cohort and 14 in those with parallel constructs (p=0.04). 29 patients required surgical intervention in the in-line group and 6 in the parallel construct cohort (p=0.01). There were 15 (48%) hardware related failures in the in-line group and 4 (16%) in the parallel (p=0.04). The most common hardware related complication was device migration.

Conclusion: While in-line and parallel proximal fixation constructs demonstrate similar efficacy in major Cobb correction, maintenance of spinal growth, and sagittal balance, there were significantly fewer complications, device related failures, and subsequent surgical interventions in the parallel proximal anchor group.

Significance: Although several studies have evaluated the failure rates associated with VEPTR, none have differentiated between the failure rates of different types of proximal anchor constructs. This study suggests parallel constructs provide alternative proximal fixation with fewer complications while offering equivalent correction, maintenance of spinal growth and sagittal balance.

See pages 21- 66 for financial disclosure information.

♦ Age at Initiation and Deformity Magnitude Influence Complication Rates of Surgical Treatment with Dual Growing Rods in Early Onset Scoliosis

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Purpose: Surgical treatment for early onset scoliosis (EOS) is associated with high complication rates. The purpose of this study was to analyze the variables most associated with complication rates in EOS patients treated with dual growing rods (DGR).

Methods: A multicenter EOS database was used to analyze a cohort of 126 patients who completed DGR treatment. Complication rates were determined for medical and implant-related complications. Classification and regression tree (CART) and multivariable logistic regression analyses were used to determine the variables most associated with complication rates. The American Society of Anesthesiologists (ASA) Physical Status Classification was used to assess patient health status relative to complication rates.

Results: 126 patients (53 boys, 73 girls) with a mean age at initial surgical intervention of 6.9 ±2.4 years (range: 1.3 to 12.0 years) were studied. 95 out of 126 patients (75%) experienced at least one medical or implant-related complication. Multi-variable analysis determined that age at implantation and pre-op major curve magnitude were the only two significant independent predictors of complication. For each year increase in age, the odds of complication decreased by 21% (OR=0.79; p=0.02). For each one degree increase in major curve magnitude, the odds of complication increased by 3% (OR=1.03; p=0.02). Multi-variable regression determined that patients less than 8 years at implantation had more than 4 times the odds of complication compared to older subjects (OR=4.4;p<0.001). Patients with pre-op major curves greater than 82 degrees had more than 6 times the odds of complication (OR=6.6; p=0.02). Of note, patients under 8 had significantly greater curves compared to older patients at time of index surgery (p=0.02). There was no significant difference in the magnitude of curve correction between age groups (p=0.15). There were no significant differences in the magnitude of change in thoracic height, spinal height or chest width between age groups at any of the study time points. Univariate analysis demonstrated that the incidence of medical complications was significantly correlated to ASA level (p=0.02), while the incidence of implant complications was not (p=0.33).

Conclusions: EOS patients who had DGR surgery before age 8 had greater complications rates; however, they also had significantly greater curves compared to older patients. Patients with curves greater than 82 degrees had a significantly greater risk of complication irrespective of age. ASA level may be used as a surrogate marker to pre-operatively identify patients at increased risk for medical complications.

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Significance: These data provide insight that may help guide the discussion regarding early versus delayed surgical intervention for the initiation of DGR treatment. It provides valuable information for patients and their families regarding the important factors that influence complication rates.

See pages 21- 66 for financial disclosure information.

Proximal Junctional Kyphosis Associated with Magnetically Controlled Growing Rod Surgery

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Purpose: Early reports suggested favourable clinical results for MCGR surgery in the treatment of EOS. However, their complication rate has not been widely reported. PJK is one of the causes of postoperative complications associated with TGR surgeries. As MCGR allows more frequent non-invasive distractions and the implant has a long straight portion which cannot be contoured, it is not known whether these may contribute to the incidence of PJK. The purpose of this study was to determine the incidence of PJK and examine possible associations in a series of patients treated by MCGR with a minimum of 2 year follow-up.

Methods: Patients from 6 spine institutes that are part of a multicentre study with prospectively collected data were assessed. Only those that had a minimum of 24 months follow-up were included.

Results: Twenty-six patients met the inclusion criteria. The mean age at the time of surgery was 7.3 years (range, 4 to 14) and the mean follow-up period was 35 months (range, 24 to 50 months). PJK occurred in 5 of 26 patients (19.2%). The clinical and radiographic parameters for these patients were studied. 3 of 5 patients had proximal anchor dislodgement. All constructs were revised, 4 of which were due to problems of rod distraction, while one patient had implant breakage. At the time of revision surgery, 2 cases were found to have autofusion at the apex, and were converted to definitive fusion, and 3 had new MCGR rods and anchors implanted and distraction was continued. Risk factors for PJK in TGR including proximal thoracic scoliosis, thoracic kyphosis, and proximal pedicle screws were not present in these cases. There was no difference in the frequency of distraction (range, 1 to 3 months) between those that developed PJK (n=5) and those that did not (n=21).

Conclusion: This is the largest series with the longest follow-up to date that describes PJK in MCGR patients. The incidence is 19.2%. All experienced failure of rod distractions due to failure of the distraction mechanism, proximal implant failure or rod breakage. While it is not possible to determine causation and risk factors in this relatively small series, surgeons using such techniques should be aware of potential issues related to MCGR.

Significance: Surgeons using MCGR for the surgical treatment of early onset scoliosis should be aware of the occurrence of PJK.

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Correction of Pelvic Obliquity After Spinopelvic Fixation in Cerebral Palsy Patients: A Comparison Study

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Introduction: The optimal choice for spinopelvic fixation in cerebral palsy (CP) scoliosis with pelvic obliquity is controversial. This study aims to compare outcomes among three different instrumentation types: unit rod, iliac screws and sacral alar iliac (SAI) screws in terms of pelvic obliquity correction in children with CP.

Methods: Single institution cohort data were collected prospectively and reviewed retrospectively. Patients with minimum 2 year follow up were divided into three groups according to instrumentation type and matched based on preoperative pelvic obliquity and coronal major curve magnitude. Demographic and functional information were reviewed. Radiographic measurements included horizontal pelvic obliquity angle (PO), spinopelvic angle (SPA), coronal and sagittal Cobb angles and T1 pelvic angle (T1PA to evaluate sagittal plane reconstruction). Implant related complications were recorded. Procedures were done by four surgeons in one pediatric institution between 2004 and 2012. All measurements were done by a single independent reviewer who was not involved in the procedures.

Results: Seventy seven patients (42 unit rod, 14 iliac screw and 21 SAI screw) were included. Gender, age and functional status (GMFCS) distribution was similar across all groups (56% males and 44% females, mean age 13.5 years (6.3-18.6 years), 84% GMFCS V). Mean follow up was 3.6 years. Comparing pre- and postoperative measurements (Results Table), there was a significant decrease ($p<0.05$) in PO and SPA in all groups. No significant loss of correction occurred during follow up. T1PA improved similarly as PO and SPA in the unit rod and SAI groups, but not in the iliac screw group. Postoperatively, coronal major Cobb angle and kyphosis decreased significantly in all groups with no change during follow up. Lordosis did not change significantly. Nonsymptomatic loosening was noted in 59% of unit rods, 57% of iliac screws and 52% of SAI screws. One prominent iliac screw needed removal. One nonsymptomatic rod fracture, one infected pseudarthrosis and one rod malposition occurred in unit rod group.

Conclusion: In patients with CP scoliosis, significant correction of pelvic obliquity, as measured by PO and SPA, was achieved using each of the three reported methods of spinopelvic fixation. This correction was maintained at midterm follow up. All three methods were comparable with no significant differences in correction between them.

Significance: This study suggests that, for correction of pelvic obliquity in children with CP scoliosis, iliac and SAI screws were similar to unit rod in comparative effectiveness and implant safety profile.

See pages 21- 66 for financial disclosure information.

	Unit Rod		Iliac Screws		SAI Screws	
	Mean	*Range*	*Mean*	*Range*	*Mean*	*Range*
Preoperative Major Coronal Curve	85	(19-138)	75	(10-95)	87	(58-133)
Postoperative Major Coronal Curve	22	(2-48)	22	(5-51)	20	(5-48)
Last Follow up Major Coronal Curve	23	(5-58)	23	(5-54)	22	(5-52)
Preoperative PO	15	(2-43)	16	(2-37)	18	(3-40)
Postoperative PO	3	(0-14)	4	(1-10)	4	(0-10)
Last Follow up PO	5	(0-14)	6	(1-13)	5	(1-14)
Preoperative SPA	24	(3-48)	27	(6-52)	25	(2-59)
Postoperative SPA	4	(0-20)	6	(0-16)	4	(0-11)
Last Follow up SPA	5	(0-25)	6	(0-17)	6	(1-13)
Preoperative Kyphosis T2-T12	54	((-22)-108)	50	(17-82)	43	(5-77)
Postoperative Kyphosis T2-T12	34	(16-51)	38	(18-55)	35	(20-53)
Last Follow up Kyphosis T2-T12	35	(9-65)	34	(19-59)	32	(16-46)
Preoperative Lordosis T12-S1	48	(11-101)	56	(10-102)	45	(8-86)
Postoperative Lordosis T12-S1	52	(28-76)	50	(33-74)	54	(30-77)
Last Follow up Lordosis T12-S1	53	(31-79)	46	(22-64)	53	(20-76)
Preoperative T1PA	16	((-30)-53)	13*	((-30)-56)	16	((-36)-58)
Postoperative T1PA	5	((-14)-30)	5*	((-25)-42)	2	((-16)-22)
Last Follow up T1PA	3	((-13)-25)	5*	((-16)-37)	3	((-18)-21)

Results Table: Preoperative, postoperative and last follow up radiographic measurements. PO: horizontal pelvic obliquity, SPA: spinopelvic angle, T1PA: T1 pelvic angle.

***In the iliac screw group, there was no significant difference ($p<0.05$) in T1PA between preoperative, postoperative and last visit measurements.**

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Performing a Definitive Fusion in Juvenile CP Patients is a Good Surgical Option

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Purpose: While a definitive fusion in juvenile idiopathic scoliosis is rarely indicated, we believe the juvenile CP patient is different. In juveniles with progressive curves, there is debate regarding the use of growth friendly implants vs definitive fusion. This study presents outcomes of juvenile CP scoliosis patients who underwent definitive fusion before age 11.

Methods: A review of a prospective, multi-center registry identified patients 10 years and younger who had a definitive fusion for their CP scoliosis. Preoperative and postoperative demographic and radiographic changes were evaluated with descriptive statistics. Repeated measures ANOVA were utilized to compare outcome scores.

Results: Fifteen children with a mean age of 9.7 years (8.2-10.7 yrs) and a minimum of 2 years follow-up (range 2-3yrs) were identified. The mean preop curve magnitude and pelvic obliquity was 87 ± 27° (range 63-144°) and 28 ± 14°, respectively. All patients were skeletally immature with open triradiate cartilage. Fourteen patients underwent posterior only surgery and 1 patient had an anterior/posterior fusion. Three patients had unit rods with wires while the rest incorporated pedicle screws. Immediately postop, the average major Cobb was 25 ± 16° ($p \leq 0.001$, 72% correction rate). At most recent follow-up, the average major Cobb increased to 29 ± 17° ($p \leq 0.001$) for a 67% correction rate. Pelvic obliquity improved to 4 ± 4° (86% correction; $p \leq 0.001$) immediately postop and to 8 ± 7° ($p \leq 0.001$) at latest follow-up for a 71% correction rate. None of the patients required revision surgery for progression. From pre to most recent follow-up, the CPchild Health outcome scores improved from 45 to 58 ($p=0.004$). One patient had a deep infection, and one patient had a broken rod that did not require any further treatment.

Conclusions: Progressive scoliosis in juvenile CP patients requires the surgeon to balance the need for further growth with the risks of progression or repeated surgical procedures. Our study demonstrates that definitive fusion once the curves approach 90° results in significant radiographic and QOL improvements, but further follow-up is needed to determine whether those results remain after skeletal maturity.

Significance: Surgical options for juvenile CP patients with progressive scoliosis generally include growing treatment or definitive fusions. Performing a definitive fusion to halt and correct scoliosis progression in these skeletally immature patients resulted in good correction with improved HRQOL.

See pages 21- 66 for financial disclosure information.

♦ Rigid Fixation Improves Outcomes of Spinal Fusion for C1-C2 Instability in Children with Skeletal Dysplasias

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Purpose: To compare outcomes of upper cervical spinal fusion for C1-C2 instability in children with skeletal dysplasias using rigid and non-rigid fixation.

Methods: A retrospective, multicenter study identified 28 pts (mean age at surg 6.7yrs; mean FU 5.6 yrs) operated for C1/C2 instability (mean BL 130mL; OR time 3.4 hrs) with skeletal dysplasias (Morquio 9, SED 9, Kniest 2, SEMD 2, metatropic dysplasia 2, metaepiphyseal chondrodysplasia 1, Hunter disease 1, Maroteau-Lamy 1, chondrodysplasia punctata 1) between 2000-2011 with minimum 2-yr FU. 14 patients underwent either non-instrumented or instrumentation with wires/cables (group 1) and 14 patients with screws/hooks and rods (group 2). All patients received autograft, 22 were immobilized with halo-body jacket (mean 3.0 mths; 12/14 in group 1 and 10/14 in group 2).

Results: Leading reasons for C1/C2 instability diagnosis was screening (12 pts), neurologic deficit (7 pts), and neck pain (8 pts). Mean AAD in ext-flex was 7.8 mm, SAC at C1/C2 8.8 mm, and 10pts showed a high signal area of SC in preop MR. 7 (29%) patients showed neurologic deficit preop (mean preop JOA UE score 2.3; LE score 2.1). 26 (93%) patients had a dysmorphic dens. 14 pts underwent C1/C2 fusion and 14 pts occipitocervical fusion. 12 (43%) pts had spinal cord decompression. 6 (21%) patients needed revision surgery for pseudoarthrosis. The risk of pseudoarthrosis was significantly higher in group 1 (6/14) than in group 2 (0/14; p=0.0057). No new neurologic deficits were observed and 5/7 pts with neurologic deficit preop showed partial recovery (mean JOA UE score 3.0; LE score 2.6 at FFU, p=0.047). CSF leaks and vertebral artery tears during C2 pedicle screw insertion each occurred in two patients.

Conclusion: Risk of pseudoarthrosis is relatively high in patients undergoing C1/C2 spinal fusion with non-instrumented or wire/cable instrumentation, even with halo-vest. Rigid fixation with screws and rods seems to be beneficial although

6-yr-old boy with metaepiphyseal chondrodysplasia and C1/C2 instability. 2-yr FU radiograph demonstrates solid fusion after C1/C2 instrumented fusion (Harms).

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sometimes technically demanding. Dysmorphic dens is a typical finding in these patients needing C1/C2 instrumented spinal fusion.

Significance: Rigid fixation improves outcomes of instrumented fusion for C1/C2 instability in children with skeletal dysplasias.

See pages 21- 66 for financial disclosure information.

Delay to Surgery Greater Than 6 Months Leads to Significant Deformity Progression in Risser 0, Pre-Menarchal Adolescent Idiopathic Scoliosis (AIS) Patients: A Retrospective Cohort Study

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Purpose: Multiple factors can lead to delay in treatment of AIS once surgical treatment is recommended. This study sought to ascertain whether commonly used patient variables are predictive of increased spinal deformity when surgery is delayed greater than 6 months.

Methods: After institutional review board approval, a retrospective cohort of 170 AIS patients whose date of surgery exceeded six months from the date of surgical recommendation were identified from two centers. Deformity progression (major curve Cobb angle change) was analyzed by Risser grade and menarche status. Statistical methods included use of ANOVA for continuous variables and Fisher's exact test for categorical variables.

Results: Risser 0 patients (n=40) progressed more rapidly than Risser 1-5 patients (n=130): mean 14.3 degree change (range: 4-47) vs. mean 3.8 degree change (range 0-37), p<0.0001. The mean monthly rate of increase was also significantly higher for Risser 0 patients vs. Risser 1-5 patients (1.35 degrees/month vs. 0.44 degrees per month, p<0.0001). Further, there was more variability and less predictability in the Risser 0 patients' progression indicated by larger standard deviation. Pre-menarchal patients (n=32) had a significantly greater increase in Cobb angle measures than their post-menarchal counterparts (12 degrees vs. 4 degrees, p<0.00001).

Conclusion: AIS patients who are pre-menarchal or Risser 0 who delay surgery greater than 6 months after recommendation has been made for surgery have a mean increase in curve magnitude of 12-14 degrees (or 1.35 degrees per month) which is clinically and statistically greater than their post-menarchal, Risser 1+ peers.

Significance: Families and surgeons can utilize this information for decision making on timing of elective surgery, while resource-limited health care systems may need to prioritize surgical treatment for less mature patients with surgical magnitude scoliosis. Prolonged time to surgery for immature patients may increase surgical complexity and risk due to increased deformity.

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Table 1. Comparisons between Risser Groups			
	Risser 0 (N=40)	**Risser 1-5 (N=130)**	
	Mean ±sd, (range)	**Mean ±sd, (range)**	**pValue**
Major Cobb at decision for surgery	59.2 ± 13.8 (34-97)	56.7 ± 10.1, (25-83)	0.4712
Major Cobb at surgery	73.5 ± 15.2, (42-110)	60.4 ± 11.9, (29-105)	<0.0001
Major Cobb increase	14.3 ± 11.1, (0-47)	3.8 ± 7.5, (0-37)	<0.0001

See pages 21- 66 for financial disclosure information.

Minimally Invasive Surgery in Adolescent Idiopathic Scoliosis: Lessons Learned at Mean Two-Year Follow-Up

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Purpose: Minimally Invasive Surgery (MIS) is becoming increasingly popular in the surgical management of patients with Adolescent Idiopathic Scoliosis (AIS). Previous reports have found favorable outcomes in the early post-operative period with this technique. Longer-term follow-up data however is limited. The aim of this study was to compare peri-operative outcomes as well as radiographic and clinical outcomes between MIS and standard open posterior spinal instrumentation and fusion (PSIF) at mean 2-year follow-up.

Methods: After institutional IRB approval, a retrospective chart review of patients with AIS who underwent MIS was performed. MIS cases were matched for age, sex, Lenke classification, curve size, date of procedure, and single-surgeon with conventional open PSIF. Pre-op, peri-op and most recent follow-up data were evaluated. SRS-22 scores were available pre-op and at final follow-up.

Results: 55 cases (27 MIS and 28 PSIF) with an average 2.5-year follow-up were included in the analysis. Preoperatively, the MIS group had a lower mean major Cobb compared to PSIF group (52.9° compared to 61.6°). Operative time (ORT) was significantly less in the PSIF group compared to the MIS group on average by 149.1 ±4.7 ($p=0.000$). Estimated blood loss (EBL), cell saver volume transfused, and length of hospital stay (LOS) were all significantly reduced in the MIS group compared to the PSIF group ($p<0.05$). At average 2 years post-op, % curve correction was significantly better in the PSIF group (73.2%) compared to the MIS group (60.9%) ($p=0.000$). In addition a total of 8 reported complications (2 hardware failure, 4 delayed infections, and 2 pseudarthrosis) were noted in the MIS group compared to 3 complications (2 delayed infections, 1 adding-on) in the PSIF group. SRS scores at average 2-year follow-up were not significantly different between the groups ($p=0.524$).

Conclusion: Advantages of MIS over standard PSIF for AIS relate to intra-operative blood loss, transfusion rates, and LOS; this needs to be carefully weighed against the significant increase in ORT, limited % curve correction and a higher noted complication rate of MIS in AIS compared to standard PSIF. Despite these variations, no clinical differences in SRS-22 scores were found at mean 2-years post-op in this comparative study.

Significance: Although previous reports have focused on the positive early post-operative results of MIS in AIS, longer-term follow-up is critical to evaluate any true clinical benefits of MIS in this setting. We found MIS to have a very limited scope in providing significant advantages over standard PSIF procedures at 2-year follow-up.

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Table 1.

Patient Demographics	MIS (n=27)	PSIF (n=28)	
Gender M:F	3:24	4:24	
Lenke Class Classification (n)	1 (23) 2 (3) 4 (1)	1 (24) 2 (3) 5 (1)	
Mean Follow-up (yrs)	2.6 (0.6-4.3)	2.4 (1.0-4.7)	
Mean Age	16.9 ±0.4	15.8 ±0.3	
Mean Weight (kg)	58.7 ±1.5	54.4 ±2.3	
Mean Preop Major Cobb (°)	52.9 ±1.4	61.6 ±1.9	
Mean Preop Lat (T5-T12)	20.0 ±1.8	23.0 ±2.2	
Outcome Variables of Interest			**p-value (α=0.05)**
Mean Postop Major Cobb at Most Recent Follow-up	20.8 ±1.5	16.3 ±1.0	0.060
Mean Postop Lat (T5-T12) at Most Recent Follow-up	21.7 ±1.4	20.3 ±1.4	0.479
% Major Cobb Correction	60.9 ± 2.4	73.2 ±1.7	0.000*
Mean OR Time (mins)	462.5 ±13.8	313.4 ±9.1	0.000*
Mean LOS (days)	4.6 ±0.2	5.4 ±0.2	0.001*
Mean EBL (mL)	246.9 ±19.3	313.4 ±9.1	0.000*
Mean volume of Cell Saver Blood Transfused (mL)	0 ±0	71.4 ±17.0	0.000*
Complications (n)	8	3	
Mean Postop SRS-22 scores	4.2 ±0.1	4.3 ±0.1	0.524

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The Effects of The Three-Dimensional Deformity of Adolescent Idiopathic Scoliosis on Pulmonary Function

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Purpose: Utilizing 2D measurements, previous studies have found that in AIS, increased thoracic Cobb angles and decreased thoracic kyphosis contribute to pulmonary dysfunction. Recent technology has improved our ability to measure and understand the true 3D deformity in AIS. The purpose of this study was to evaluate which 3D radiographic measures predict pulmonary dysfunction.

Methods: Surgically treated AIS patients with preoperative PFTs and EOS® imaging were identified at a single center. Each spine was reconstructed in 3D to obtain the true coronal, sagittal, and apical rotational deformities. These were then correlated to the patient's corresponding preop FEV, FVC, and TLC measurements. Regression analysis was performed to determine the relative effect of each radiographic measure.

Results: 163 subjects met criteria--124 thoracic and 39 lumbar major curves. The range of preop thoracic and lumbar coronal angles was 11-115° and 11-98°, respectively. The range of preop 3D thoracic kyphosis (T5-T12) and thoracic apical vertebral rotation was -56-44° and 0-29°, respectively. Increasing thoracic Cobb and thoracic vertebral rotation and decreasing 3D thoracic kyphosis most significantly correlated with decreasing pulmonary function, especially FEV (Table). In patients with the largest degree of thoracic deformity (Coronal Cobb >80°, thoracic lordosis >20°, and absolute apical rotation >25°), the majority had moderate to severe pulmonary impairment (≤65% predicted). Regression analysis found loss of thoracic kyphosis to be the most consistent predictor of FEV (r^2=0.087), FVC (r^2=0.069), and TLC (r^2=0.098) impairment.

Conclusion: Larger thoracic coronal, sagittal, and axial deformities increase the risk of pulmonary impairment in patients with AIS. Of these, a reduction of thoracic kyphosis is the most consistent predictor. This information may help guide surgeons in the decision making process for determining which surgical techniques to utilize and which component of the deformity to focus on. It is also important to realize that conventional 2D methods of measuring kyphosis preop overestimate the true 3D thoracic kyphosis. Further analysis is needed to determine the value of improvement in these radiographic measures following surgery on the potential for improved pulmonary function.

Significance: This analysis of 163 AIS patients found that larger 3D thoracic coronal, sagittal, and axial deformities increase the risk of pulmonary impairment in patients with AIS, with decreasing thoracic kyphosis as the most consistent predictor.

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Table. Correlation of Radiographic and Pulmonary Measurements.

	% Predicted FEV	% Predicted FVC	% Predicted TLC
T1-T5 Kyphosis	0.026	0.065	-0.002
T5-T12 Kyphosis	**0.444**	**0.298**	**0.327**
T10-L2 Kyphosis	**0.173**	*0.132*	*0.148*
T12-L5 Lordosis	-0.088	-0.086	-0.136
Upper Thoracic curve	**-0.224**	**-0.166**	-0.142
Thoracic curve	**-0.401**	**-0.298**	**-0.212**
Lumbar curve	0.015	-0.026	0.032
Thoracic apex rotation (Absolute value)	**-0.408**	**-0.256**	-0.175
Lumbar Apex Rotation (Absolute value)	**0.233**	0.067	**0.197**

*bold values represent statistical significance, $p<0.05$.

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Relationship Between Seat Restraints and Thoracolumbar Fracture Patterns in Pediatric Occupants in Motor Vehicle Crashes

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Purpose: Thoracolumbar (TL) spine injury patterns in the pediatric population differ considerably from adults. Very few studies have investigated the relationship between vehicle safety restraints for children and TL spine fracture patterns.

Methods: We used the Crash Investigation Research & Engineering Network (CIREN) database to obtain data on TL spine injury patterns, associated extra-spinal injuries and overall injury severity in pediatric occupants (up to 18 years of age) and correlated with the type and use of seat restraints and crash characteristics. Occupants in child safety carriers (car seats) were excluded.

Results: We found 821 pediatric occupants, of which 57 had TL spine injuries (21 minor, 36 major)(age range:39 to 213 months). Age distribution showed a bimodal pattern with a majority of the patients in the 12-18 years age group and 3-6 years age group. Lower lumbar levels (L2-3 to L5-S1) were most frequently involved (63%), compared to the TL junction (T11 to L2) (24%) and thoracic (T1 to T10-11) levels (13%). The most common associated systemic injuries in occupants with major TL spine injuries were abdominal injuries (53%). 'Suboptimally-belted' pediatric occupants, defined as those wearing either a two-point seat belt or a three-point seat belt with the shoulder belt inappropriately worn behind the back or underarm (n=14, age range: 61 to 158 months), showed the highest likelihood of sustaining TL spine injuries (21%). Suboptimally-belted children were most likely to sustain flexion-distraction injuries (73%), while appropriately belted children were most likely to sustain compression fractures (47%), followed by flexion-distraction injuries (35%) and burst fractures (18%). The likelihood of neurological injury was highest in the suboptimally belted group (36%), followed by the unbelted group (33%) and appropriately belted group (16%). Side impact collisions were more often associated with a higher overall injury severity score (ISS) and fatality as compared to frontal impacts, irrespective of use of seat belts.

Conclusion: Transition from child safety carriers to booster seats may be responsible for the spike in the 3-6 years age group. The classic "seat belt injury" described in association with 'lap-belt only' configuration is still common in children in spite of universal change to 3-point seat belts in vehicles manufactured in the last few decades. Certain morphologic features in children (immature iliac bones, flexible lumbar spine, and a higher center of gravity) allow 'submarining' under the lap belt more readily than in adults, making them prone to flexion-distraction injuries of the lumbar spine. Inappropriate use or lack of use of the shoulder belt is common in children, and can lead to a higher likelihood of flexion-distraction TL spine injuries, neurologic deficits, and associated abdominal injuries.

Significance: Understanding the mechanisms of spinal injuries in children is important to stimulate further advances in child safety restraints.

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MRI Evaluation of the Epiphyseal Vascular Supply – Insights into the Etiology of Knee OCD

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Purpose: Research on the etiology of OCD in animals demonstrates a zone of vascular vulnerability, which correlates to knee OCD regions. Developmental milestones of epiphyseal cartilage vascularity during maturation in children have not been studied in detail, largely due to lack of imaging techniques and available specimens. The purpose of this study was to evaluate the vascular supply of the femoral condyle in children, to determine if vascular distribution can offer insight into the etiology of knee OCD.

Methods: Seventeen cadaveric knees of children ranging in age from 1 month to 10 years were imaged at 7.0 T (Siemens, Germany). A 3D-GRE sequence was used for Susceptibility Weighted Magnetic Resonance Imaging (SW-MRI), a technique that allows for detailed evaluation of vessel architecture. For proof of principle SW-MRI was added to a clinical MRI of an 8-year-old boy (3.0 Tesla, Siemens) under a current IRB protocol.

Results: Epiphyseal cartilage vascularity was visualized on SWI-datasets in all imaged specimens. Shortly after birth the epiphyseal cartilage is densely vascularized and a small central secondary ossification center is present. There are two distinct vascular beds arising from the central intercondylar notch and the peripheral aspects of each femoral condyle with an intervening nearly avascular zone. By age 8-10 years, only a small rim of remaining peripherally vascularized epiphyseal cartilage surrounds the secondary ossification center. At this developmental stage the vascular supply through the central intercondylar notch has undergone involution. The predilection sites for OCD, the central aspect of the medial or lateral femoral epicondyles are most distant to the remaining peripheral vascular supply provided by the non-articulating lateral aspect of the femoral epichondral soft tissues, creating a central vascular zone “at risk”.

Conclusion: In this study, MRI utilizing tissue inherent contrast enabled visualization of epiphyseal cartilage vascularization in cadaveric specimens from growing children and in an 8-year old boy. These findings demonstrate a potential vascular zone of vulnerability that correlates to the regions of pediatric OCD development.

Significance: A better understanding of the development of the epiphyseal cartilage vascularity during skeletal maturation may shed light on the etiology of diseases such as Osteochondritis Dissecans and Legg-Calve-Perthes, both of which might be associated with vascular distribution creating zones “at risk” which may fail when exposed to biomechanical or other stressors.

See pages 21- 66 for financial disclosure information.

Catcher's Knee: OCD of the Knee in Baseball and Softball Catchers

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Background: Osteochondritis dissecans (OCD) of the knee is an idiopathic condition that often leads physicians to recommend against at-risk children playing catcher in baseball/softball. A variety of etiologic theories have been proposed.

Hypothesis/Purpose: To determine whether clinical evidence supports (1) the recommendation to avoid playing catcher and (2) the currently prevailing etiologic theory of repetitive overuse and microtrauma.

Study Design: Cohort study

Methods: Medical records from 1990-2014 of a large tertiary care center were searched to find patients who had OCD of the knee, played baseball/softball at the time of presentation, had a specified field position, and had magnetic resonance imaging. Ultimately, 98 knees (78 patients) were identified: 33 knees (29 patients) in catchers and 65 knees (49 patients) in non-catchers. Points of comparison to test the first hypothesis were position played (catcher/non-catcher), demographics (age, unilateral/bilateral, and gender), and lesion severity by Hefti stage. Points of comparison to test the second hypothesis were sagittal and coronal lesion location.

Results: When compared to non-catchers, catchers were more likely to present with knee OCD ($P=0.001$) and presented at a younger age ($P=0.035$) but were similar with respect to bilateral involvement ($P=0.115$), gender ($P=0.457$), and lesion severity ($P=0.484$). Thus, the recommendation for at-risk children to avoid playing catcher was supported. When compared to lesions in non-catchers, lesions in catchers were more posterior on the femoral condyle ($P=.004$) but similar in coronal location ($P=0.210$). Combined with the biomechanics of the knee's position while squatting in the catcher position, this finding lends support to the repetitive overuse and microtrauma theory.

Conclusions: Catchers had a higher risk of developing OCD of the knee at a younger age than athletes playing other positions. The posterior location of lesions in catchers may be the result of the repetitive stress placed on that aspect of the condyle.

Clinical Relevance/ Significance: Recommendations to avoid playing catcher and other positions that repetitively stress osteochondral surfaces can now be considered evidence-based medicine.

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The Use of Bone Marrow Concentrate and Demineralized Bone Matrix in the Treatment of Osteochondritis Dissecans

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Purpose: The treatment of osteochondritis dissecans (OCD) remains controversial and unproven in the current literature. The current research investigates a minimally invasive method utilizing biologics to enhance healing in osteochondritis dissecans.

Methods: This is an IRB approved, prospective, one arm pilot study. Twenty nine patients who had symptoms for at least 5 months and failed non-operative treatment underwent diagnostic arthroscopy and ante grade drilling with grafting of the OCD using bone marrow concentrate and demineralized bone matrix. All patient's articular cartilage was intact at arthroscopy. Each patient was followed with serial radiographs: AP, lateral and tunnel views at six weeks, three, six, twelve and twenty four months, and MRI at one year postoperatively. All patients had preoperative Lysholm and IKDC knee scores and at final follow up. Patients were also evaluated for location and size of the lesion, length of non-operative treatment and status of growth plate at treatment.

Results: The average patient age was 14 (range 11-17). There were 16 right knees and 13 left. Twenty four lesions were on the medial femoral condyle and five on the lateral femoral condyle. The average length of symptoms preoperatively was 13 months (range 5-48). Twelve patients had closed growth plates at the time of surgery and seventeen had open growth plates. Twenty eight patients were considered healed based on clinical symptoms, MRI, x-ray and IKDC and Lysholm scores. One patient failed this treatment and required subsequent osteochondral transplant. This was the only patient who demonstrated an undermining fluid signal on follow up MRI. All other patients demonstrated either partial or complete revascularization of the lesion and resolution of preoperative bony edema on MRI. Serial plain radiographs revealed increasing bony incorporation of the lesion in all cases. No case was exuded in the joint as a loose body. The average Lysholm score improved from 56 to 93 and the IKDC from 51 to 91.

Conclusion: Definitive treatment modalities for OCD are still evolving. Non-operative treatment results in a healing rate of 50 to 60 percent in patients with open growth plates and no healing in patients with closed growth plates. This technique introduces an option to provide reproducible results for this condition.

Significance: Providing a method utilizing biologics and a minimally invasive technique that routinely stimulates healing without articular cartilage violation is beneficial in the management of OCD. This technique realizes this goal.

See pages 21- 66 for financial disclosure information.

Pediatric ACL Injury is Associated with Increased Lateral Tibial Slope: A Case-Control Study with MRI Measurements of 152 Patients

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Purpose: Previous research evaluating tibial slope and pediatric ACL injury is limited to date due to small cohort sizes and characterization of the developing proximal tibial chondroepiphysis with plain radiography. The purpose of this case-control study was to use MRI to determine if alterations in posterior tibial slope are associated with ACL rupture in pediatric and adolescent patients as well as to quantify changes in tibial slope by age.

Methods: Knee MRI scans were reviewed by three blinded raters in a 1:1 sample of cases and age/gender matched controls. Seventy-six skeletally-immature ACL-injured knees were compared to 76 knees without ACL injury. The mean age was 14.8±1.3 years old. 46% of both groups were male. Employing a method similar to that used in the adult literature, our technique differed in that the slope was measured at the true joint line (on the cartilage surface) using MRI, not the subchondral bone. Interrater reliability was assured prior to study completion using intraclass correlation coefficient.

Results: While the slope of the medial tibial plateau (MTS) was equivalent in the ACL-injured and control knees (5.4°±2.2° vs. 5.1°±2.3°, P=0.42), the slope of the lateral plateau (LTS) was significantly greater in those with ACL injury (5.7°±2.4° vs. 3.4°±1.7°, P<0.001). There were no differences in LTS between males and females (4.5° vs. 4.6°, P = 0.75). Receiver operating characteristic (ROC) analysis of the LTS revealed that a lateral tibial slope >4° was 76% sensitive and 75% specific for predicting ACL rupture in this population. Spearman correlation analysis revealed that medial and lateral tibial slope decreased, or flattened, by 0.18° (P=0.028) and 0.21° (P=0.009) degrees per year, respectively, as adolescents aged.

Conclusion: Our data suggests an increase in lateral tibial slope is significantly associated with an increased risk of ACL injury in pediatric and adolescent patients. Posterior slope was also found to decrease, or flatten, with age. A lateral tibial slope >4° was 76% sensitive and 75% specific for predicting ACL rupture in this population.

Significance: Increased lateral tibial slope, and not medial tibial slope, is significantly associated with an increased risk of ACL injury in pediatric and adolescent patients. This study improves on previous research by using a case-control design, adequately-powered sample size, MRI evaluation of the developing proximal tibial chondroepiphysis, advanced statistical analyses, and assurance of interrater reliability of the measurement method.

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Complications Associated with All-Epiphyseal ACL Reconstruction in Skeletally Immature Patients

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Purpose: Alternative ACL reconstruction techniques have been developed in order to avoid physes in the skeletally immature. To date, the complication and failure rate of the all-inside, all-epiphyseal technique (AE) is unknown. The purpose of this study was to elucidate the complication rate and identify associated risk factors for re-rupture after all-epiphyseal anterior cruciate ligament reconstruction.

Methods: We retrospectively reviewed all AE ACL reconstructions performed by a single surgeon at one institution between 2009 and 2012. Relevant outcomes data including the development of leg length discrepancy, angular deformity, re-rupture, and arthrofibrosis were recorded. Range of motion was also measured with a goniometer 6 weeks and 6 months postoperatively. Independent variables analyzed for association with re-rupture included age, BMI, graft type, graft thickness, and associated injuries addressed at surgery.

Results: 36 patients (average 12.6 years old, range:6-15) were analyzed. The mean follow-up was 22 months. The overall complication rate was 19.4% (7/36), including 5 re-ruptures (13.8%), 1 case of arthrofibrosis requiring manipulation under anesthesia (2.7%), and one re-tear of a repaired meniscus requiring surgery (2.7%). There were no cases of clinical leg length discrepancy or angular deformity. There were no associations found between age, sex, graft type, graft thickness, BMI, or associated injuries addressed during surgery and re-rupture rate. Knee flexion continued to improve by 18 degrees on average between the 6 week and 6 month post-operative visits ($p<.0001$; paired samples Student's *t*-test).

Conclusion: AE ACL reconstruction effectively protects the physis from damage and successfully avoids clinical growth disturbance. The re-rupture rate in this cohort was similar to other series of ACL reconstruction in skeletally immature patients.

Significance: This study confirms that AE ACL reconstruction is successful in avoiding clinically-relevant physeal damage, and the re-rupture rate is similar to those reported for other techniques. Knee flexion continues to significantly improve after 6 weeks and surgeons may be able to encourage patients and families that continued increases in flexion can be expected after the 6 week time point with persistent physical therapy.

See pages 21- 66 for financial disclosure information.

Does the Surgical Delay Before an Anterior Cruciate Ligament Reconstruction in Adolescents Affect the Quality of Life at a Minimum of Two Years Follow-Up?

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Purpose: The delay before anterior cruciate ligament (ACL) reconstruction surgery is known to have an impact on meniscal and cartilage injury severity at the time of surgery. Furthermore, the severity of intra- articular injuries at time of surgery can lead to lower quality of life scores. Not every country has easy access to the operating room in order to minimize surgical delays especially in an adolescent population. The main objective of this study was to evaluate the impact of the surgical delay on the quality of life score in an adolescent population. The secondary objective was to evaluate the impact of the surgical delays on meniscus and cartilage injury at the time of surgery in the same population.

Methods: This retrospective cohort study was conducted in a tertiary pediatric hospital. All ACL reconstruction surgeries were retrieved from a database between January 2004 and December 2011. All medical records were reviewed to collect the following information: demography, BMI, age at time of injury, surgical delay, operative findings (meniscus and cartilage status). Patients were then contacted and asked to participate in the study by completing the KOOS questionnaire. Preliminary statistical analysis consisted of a correlation analysis to evaluate the influence of surgical delay on the five different KOOS scores and between surgical delay and intra-articular injuries at time of surgery.

Results: Ninety-three patients were recruited in this cohort and analyzed for the secondary objective. The mean follow-up was 4 years. Twenty-nine patients were then successfully contacted and accepted to answer the questionnaire. There was no statistical difference between the responding patients and the non responding ones except for the follow-up time from surgery which was longer in the non responding group (48 vs 60 months). There was a negative correlation between surgical delay and ADL KOOS score ($r=-0.620$, $p<0.05$). There was a positive and statistically significant correlation between surgical delay and severity of medial meniscus injury and lateral femoral condyle cartilage injury, respectively $r=0.394$ ($p<0.05$) and $r=0.215$ ($p=0.039$).

Conclusion: The results of this study confirmed that there is an association between surgical delay and meniscus and cartilage injuries at time of surgery based on 93 adolescents ACL reconstructions. At a mean follow up of 4 years, a longer surgical delay could be related to a significant lower score in ADL.

Significance: These results emphasize the importance of improving the access to operative care for adolescent ACL tears in order to improve the outcome of this surgery.

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Outcomes of Operatively Treated Non- Unions and Symptomatic Mal-Unions of Adolescent Diaphyseal Clavicle Fractures

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Purpose: The purpose of the study was to review the clinical characteristics and outcomes of adolescent diaphyseal clavicle fractures treated surgically for non-union, impending non-union, or symptomatic mal-union, which are rare complications of primary non-operative treatment.

Methods: Records of all patients 10-18 years-old who underwent surgery at a tertiary-care children's hospital between 2003-2013 for a symptomatic mal-union, non-union (no bony bridging >6 mo post-fx), or impending non-union (no callus 1-6 mo post-fx) of a clavicle shaft fracture were reviewed. Demographic data, radiographic features, operative details, and post-operative course were analyzed and compared to an age-matched, sex-matched, and fracture pattern-matched control group of adolescents who underwent plate fixation as primary fracture treatment.

Results: Sixteen patients (56% male; mean age 15.4 years, range 12.4-17.7 years) met inclusion/exclusion criteria, most of whom (87.5%) were initially treated at an outside hospital. Plate fixation, with or without osteotomy, was performed in 14 cases (87.5%), with bone grafting in 13 cases (81.3%), including iliac crest autograft (n=4), local bone graft (n=4), cancellous allograft (n=1), or local graft + cancellous allograft (n=4). Two mal-union cases (12.5%) underwent ostectomy only. Comparisons of mean time between injury and surgery, time to healing, duration between surgery and return to sports, and rate of removal of hardware (excluding the two ostectomy patients) are detailed in Table 1.

Conclusion: Adolescents who underwent surgery for diaphyseal clavicle fracture non-union, impending non-union or symptomatic mal-union demonstrated bony healing and returned to sports within 2-4 months, with a comparable post-operative course and rate of subsequent hardware removal to patients treated with plate fixation for their primary clavicle fracture.

Significance: To address the rare instance of slow, failed, or painful healing following non-operative management of diaphyseal clavicle fracture in adolescents, surgical treatment, which may be more technically challenging and often requires bone grafting, has clinical and radiographic results that are comparable to primary fracture fixation.

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(Mean values, in months)	**All (1+2+3)** (n=16)	**1. Non-union** (n=6)	**2. Impending** (n=6)	**3. Malunion** (n=4)	CONTROL (n=15)	**p-value**
Injury to Surgery	**9.3**	9.4	2.2	19.8	**0.4**	**<0.001**
Time to union	**2.8**	4.1	2.7	2.9	**2.9**	**0.99**
Surgery to Sports	**3.6**	4.3	3.6	2.6	**--**	**--**
Rate of ROH	**21% (3/14)**	0% (0/5)	50% (3/6)	0% (0/2)	**20% (3/15)**	**1.00**

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Medial Patellofemoral Ligament (MPFL) Reconstruction with Hamstring Autograft Improves Patella Alta in Children

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Purpose: Patellofemoral instability has previously been associated with patella alta. The purpose of this study was to evaluate adolescents undergoing medial patellofemoral ligament reconstruction (MPFL-R) for standardized indices of patellar height on pre- and postoperative radiographs to determine if these radiographic parameters change after MPFL-R.

Methods: Twenty-seven children (mean age 14.9 years old) who underwent MPFL-R without a distal realignment procedure at a tertiary care orthopaedic hospital were evaluated pre- and post-operatively for Insall-Salvati Ratio, Modified Insall-Salvati Ratio, and Caton-Deschamps Index by three blinded raters. Intrarater and interrater reliability was calculated for each index, and means of each were compared pre- and postoperatively to determine if MPFL-R was associated with improved patellar height.

Results: All three indices of patellar height indicated that there was patella alta present in this cohort preoperatively. Furthermore, all three measures were significantly improved postoperatively (Paired t-tests, $P<0.001$ for all) to within normal childhood ranges.(Table 1) Interrater reliability was excellent for both the Insall-Salvati ratio (ICC=0.89) and Caton-Deschamps index (ICC=0.78), and adequate for the modified Insall-Salvati ratio (ICC=0.57); intrarater reliability was excellent for all three (ICC's: 0.91, 0.82, 0.80 respectively).

Conclusion: Surgical reconstruction of the MPFL in children using hamstring autograft consistently lowered patella height for all three indices to within normal childhood ranges. The etiology of this finding is likely multifactorial. Medialization and a slightly distally-oriented graft may contribute to decreases in patellar height. Interrater reliability was best for the Insall-Salvati ratio and Caton-Deschamps index, and acceptable for the modified Insall-Salvati ratio.

Significance: There is modest correction of patella alta in children undergoing MPFL-R. These results are useful to surgeons performing MPFL-R, as the improvement of patella alta in the absence of a tibial tubercle distalization may avoid of an unnecessary additional surgical procedure.

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Table 1. Improvements in three indices of patellar height after MPFL reconstruction in children.

Patella Height Measurement	Normal Range	Mean Preoperative Value	Mean Postoperative Value	Mean % Improvement	p-value
Insall-Salvati Ratio	<1.25[a]	1.41	1.25	11.3%	<0.001
Modified Insall-Salvati Ratio	<2.00[a]	2.24	1.97	12.1%	<0.001
Caton-Deschamps Index	<1.27[b]	1.39	1.17	15.8%	<0.001

Legend:

[a]. Reported values in literature [1,2]
[b]. Mean normal value reported in literature plus 1 standard deviation [3]

References:

1. Insall J, Salvati E. Patella position in the normal knee joint. Radiology 1971 Oct;101(1):101-4.
2. Grelsamer RP. Meadows S. The modified Insall-Salvati ratio for assessment of patellar height. Clin Orthop Relat. Res. 1992 Sept;(282):170-6.
3. Thevenin-Lamoine C, Ferrand M, Courvoisier A, Damsin JP, Ducou le Pointe H, Vialle R. Is the Caton-Deschamps index a valuable ratio to investigate patellar height in children? J Bone Joint Surg Am. 2011 Apr 20;93(8):e35.

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Does Isolated Gastrocnemius Tightness Predispose Children to Lower Extremity Injury?

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Purpose: Gastrocnemius tightness is known to exacerbate a variety of pediatric orthopaedic foot and ankle conditions. It is unclear whether isolated gastrocnemius tightness can increase the risk of lower extremity injury in an otherwise healthy child.

Methods: We prospectively studied 207 consecutive walking age children presenting to a county orthopaedic clinic with new upper or lower extremity complaints. Exclusion criteria included neuromuscular conditions such as cerebral palsy, children with combined upper and lower extremity complaints, children with spine complaints, or children previously seen by the orthopaedic clinic for any other problem. Passive ankle dorsiflexion was measured based on the lateral border of the foot versus the lower leg with the knee fully extended and the foot in inversion. In the case of lower extremity injuries contralateral ankle dorsiflexion was utilized; otherwise the two sides were averaged.

Results: Average age was 10 ± 5years. Ninety patients presenting with lower extremity complaints had ankle dorsiflexion of $9^o \pm 13^o$, while 117 patients presenting with upper extremity complaints had ankle dorsiflexion of $15^o \pm 12^o$ (P=0.0006). Of the lower extremity patients 49 presented with trauma, with dorsiflexion of $7^o \pm 12^o$, while 41 presented with no trauma with dorsiflexion of $12^o \pm 14^o$ (P=0.05). 12% of upper extremity patients had 0^o or less of dorsiflexion, as compared to 24% of lower extremity non-trauma patients and 41% of lower extremity trauma patients (overall Chi Squared P<0.0005).

Conclusion: Patients presenting with lower extremity complaints had more gastrocnemius tightness than patients presenting with upper extremity complaints, and within the lower extremity group patients with trauma had more tightness than patients without trauma. Isolated gastrocnemius tightness correlates with lower extremity complaints in general, and with lower extremity trauma in particular.

Significance: Isolated gastrocnemius tightness is associated with increased lower extremity complaints, and particularly with lower extremity trauma. Preventative stretching programs may be beneficial towards reducing lower extremity issues and merit further study.

See pages 21- 66 for financial disclosure information.

Assessment of Side-Step Cutting in Pediatric Athletes with Recent ACL Reconstruction Compared to Those with No ACL Surgical History

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Purpose: This study used the side-step cut to evaluate differences between pediatric athletes' anterior cruciate ligament (ACL) reconstructed limb and non-reconstructed limb compared to limbs with no lower extremity surgical history.

Methods: The study included 28 limbs with an ACL reconstruction within the 12 months prior to testing (operative limbs), 28 contralateral limbs (non-operative limbs) and 56 limbs with no lower extremity surgical history (control limbs; 28 individuals). Lower extremity kinematic and kinetic 3-dimensional data was recorded during the deceleration phase of a 45 degree cut. Outcomes were evaluated at initial foot contact and between initial foot contact and maximum knee flexion of the cutting limb. Differences between operative and non-operative limbs and control limbs were assessed using analysis of variance with Bonferroni post-hoc tests.

Results: Operative limbs had higher peak hip adduction (p=0.01) and higher average external knee valgus moments (p=0.02) compared to control limbs. In terms of shock absorption, operative limbs had lower peak ground reaction forces (p<0.0001) and peak ankle dorsiflexion (p=0.002) compared to control limbs with lower peak external knee flexor moments (p<0.0001) and less power absorption at the knee (p=0.05) and ankle (p=0.01). Though non-operative limbs had lower knee valgus (p=0.04) at initial contact, they had higher peak knee valgus (p=0.04) and higher average external knee valgus moments compared to control limbs. Non-operative limbs also had less pelvic obliquity compared to control limbs (p=0.04). Lower peak ground reaction forces (p=0.005), increased power absorption at the hip (p=0.005), and decreased power absorption at the ankle (p=0.09) was seen in non-operative compared to control limbs.

Conclusions: Limbs with ACL reconstruction exhibited poorer hip stability compared to control limbs. ACL reconstructed limbs also had less energy absorption at the knee and lower peak vertical ground reaction forces, likely reflecting an avoidance strategy when performing a cut using an ACL reconstructed limb. Contralateral limbs of ACL reconstructed patients also demonstrated reduced ground reaction forces and altered neuromuscular control. These changes may reflect overall tentativeness in performing a cut. It is also possible that the biomechanical strategies present on the operative side could be putting the non-operative limb at risk for injury.

Significance: Deficits in coronal plane hip and knee control in ACL reconstructed limbs during side-step cutting may contribute to risk of re-injury, while alterations in sagittal plane shock absorption strategies and coronal plan knee control may place the contralateral limb at risk for future injury.

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Flexible Intramedullary Nails for Femur Fractures in Pediatric Patients Heavier Than 100 Pounds

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Purpose: The utility of flexible intrameduallary nailing (FIMN) for fixation of femoral shaft fractures in children greater than 100 pounds remains controversial. The purpose of this study is to assess the relationship between patient weight and alignment at radiographic union following FIMN of pediatric femoral shaft fractures.

Methods: An IRB approved, retrospective review of all patients who sustained a femoral shaft fracture treated by retrograde, stainless steel FIMN was performed at a single level 1 pediatric trauma center from 2005-2012. Preoperative radiographs were analyzd to determine fracture pattern, location, and isthmic canal diameter. Patient weight was measured on initial presentation to the ER. Radiographs at the time of bony union were reviewed to measure shortening, coronal angulation and sagittal angulation. Data was analyzed in 10 pound increments beginning at 100 pounds to assess the impact of weight on final radiographic outcome.

Results: 274 children underwent stainless steel retrograde FIMN for femoral shaft fractures during the study period. There were 25 patients who weighed ≥ 100 lbs and 249 patients <100 lbs. There were no significant differences in gender (76% vs. 73% male), fracture stability (40.0% vs. 41.8% length unstable), or fracture patterns between the two groups. The ≥100 lbs. group was significantly older (10.7 vs. 8.1 years, $p<0.01$). There were no significant differences in final coronal angulation (1.5 vs. 2.9 degrees), sagittal angulation (3.0 vs. 3.0 degrees) or shortening (3.4 vs. 3.4 millimeters) between the two groups. There were significantly more nail removals in the <100 lbs group (79.9% vs. 68%, $p=0.02$). Four percent of the population (11 patients) weighed ≥120 lbs. Aside from age (11.6 vs. 8.2 years, $p>0.01$), there were no significant demographic or fracture differences between this group and the remaining population. This group demonstrated no significant difference in shortening (3.3 vs. 3.4 millimeters), coronal angulation (0.7 vs. 2.9 degrees) or sagittal angulation (1.0 vs. 3.1 degrees) at radiographic union. There was a significant increase in the use of a fracture table over a flat-top table in the heavier population ($p=0.01$).

Discussion: Stainless steel FIMN is an effective treatment modality for pediatric femoral shaft fractures in patients >100 pounds with excellent radiographic outcomes and no increased risk for complications. There was an increased incidence of nail removal in patients weighing <100 lbs.

Significance: Stainless steel flexible IM nails are able to maintain fracture alignment without an increase in complications in a population weighing more than 100 lbs.

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Titanium Elastic Nailing for Pediatric Tibia Fractures: Do Older, Heavier Kids Do Worse?

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Introduction: Poor outcomes of titanium elastic nails (TENs) for femoral shaft fractures have been associated with increasing patient age and weight, especially patients weighing more than 50 kg. Our objective was to determine if there is a similar upper weight or age limit to the safe and effective use of titanium elastic nails for tibial shaft fractures in the pediatric population.

Methods: We performed a retrospective review of patients with tibial shaft fracture treated with TENs at a large pediatric trauma center. Data collected included patient demographics, weight, fracture pattern and alignment, and time to union. Weight groups were stratified as ≥50 kg and <50 kg, and age groups as ≥14 years old and <14 years old. Malunion was defined as 10° of angulation, in either plane, at the final visit prior to nail removal. Union was defined as bridging of at least 3 cortices on orthogonal radiographs. A significant delay in union was considered to be a difference of 3 weeks between groups.

Results: 95 patients were included in this study with a mean age of 12.1 years (range 6-16, SD = 2.5). Malunion rate was similar in each weight cohort (13.3% (6/45) in the ≥50 kg group and 10% (5/50) in the <50 kg group [p=0.61]) and in each age group (17.6% (6/34) in the ≥14 year olds and 8.2% (5/61) in those <14 year of age [p=0.17]). Mean time to union was 92.5 ± 24.0 days in the ≥50 kg group, and 89.8 ± 35.9 days in the <50 kg group; this difference was not statistically significant (p=0.67). When comparing our younger and older age cohorts, we also did not find a significant difference in time to union (89.6 ± 33.4 days vs. 93.6 ± 25.9 days, p = 0.54). In sum, we did not find a significant difference in the rate of malunion or time to healing between younger and older patients or between lighter and heavier patients.

Conclusions: The use of titanium elastic nails for tibial shaft fractures, unlike for other long bone fractures, seems not to be precluded in older and heavier patients.

Significance: To our knowledge, this is the first time that the age and weight limits of TENs for tibial shaft fractures have been explored; dissimilar to data in femoral shaft fractures, this study did not demonstrate poorer outcomes in older or heavier patients.

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Physeal Bar Formation After Pediatric Medial Malleolus Fractures

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Purpose: Pediatric medial malleolus fractures are commonly Salter-Harris (SH) III or IV fractures of the distal tibia and are associated with a risk of physeal bar formation and subsequent growth disturbance. The reported incidence of physeal bar formation varies from 6 to 50%. Previous studies have demonstrated SH classification, fracture displacement, adequacy of reduction, and time to treatment as predictive factors of bar formation. The purpose of this study was to determine the incidence of physeal bar formation following pediatric medial malleolus fracture and evaluate for patient and fracture characteristics predictive of physeal bar formation.

Methods: We retrospectively reviewed 79 consecutive pediatric patients from 2007-2013 that sustained either an isolated medial malleolar or a bimalleolar ankle fracture. Forty-two of seventy-nine patients had greater than 3 months of radiographic follow-up and comprised out study population. Medical records were reviewed to determine age, sex, weight, mechanism of injury, method of treatment, and need for further surgery. Radiographs were reviewed to assess for initial fracture displacement, adequacy of fracture reduction, SH type, presence of an associated fibula fracture, percentage of the physeal disruption from the fracture, and physeal bar formation. Mann-Whitney U and chi-squared tests were used to compare variables between those injuries that developed a physeal bar and those that did not.

Results: Twenty-two of 42 patients (52.4%) developed a physeal bar. The average time to diagnosis of physeal bar was 4.9 months (1.6-11.8 months). Twenty-seven percent (6/22) of bars were diagnosed at greater than 6 months from injury. Four of 22 physeal bars (18.2%) required further surgery. Adequacy of reduction was predictive of physeal bar formation ($p=0.03$). All other studied variables were not predictive including SH type and amount of initial fracture displacement ($p>0.05$).

Conclusion: Pediatric medial malleolus fractures resulted in a high incidence of physeal bar formation. Within our study, adequacy of reduction was the only predictive factor of bar formation. However, obtaining fracture reduction of less than 2 mm still results in a high rate of bar formation.

Significance: Given the high incidence of physeal bar formation and frequent diagnosis beyond 6 months from injury, we recommend radiographs on all pediatric medial malleolar fracture patients at one year following injury.

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Closed Reduction and Percutaneous Pinning vs. Open Reduction Internal Fixation of Mildly Displaced Humeral Lateral Condyle Fractures

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Purpose: The optimal treatment for pediatric lateral condyle fractures that are mildly displaced is unclear. The purpose of this study was to assess clinical and radiographic outcomes and complication rates of patients undergoing open reduction internal fixation (ORIF) versus closed reduction and percutaneous pin fixation (CRPP) of mildly displaced lateral condyle fractures.

Methods: A retrospective review of all children with acute lateral condyle fractures with 2-5mm of displacement measured at the lateral cortex and no significant rotational displacement or joint surface incongruity treated at a single level 1 trauma center from 2006 to 2014 was performed. A total of 74 patients were treated who met inclusion criteria; 51 underwent ORIF and 23 underwent CRPP. No differences existed between the two groups with respect to age, gender, extremity, mechanism of injury, time to treatment, fracture displacement, or fracture classification. Charts and radiographs were reviewed and the following parameters were documented: OR time, time to union, return to activities, magnitude of lateral spurring, and complications. Major complications were defined as those with presumptive long-term effects or required reoperation.

Results: The average follow-up for the entire cohort was 6 months. All fractures healed within 12 weeks of surgery, regardless of treatment type and no differences were observed in time to union between the groups. OR time averaged 30 minutes faster for the CRPP group ($p<0.001$). Nearly 10% of patients in each group developed elbow stiffness, requiring formal therapy. The overall complication rates were 25% for the ORIF group and 13% for the CRPP group ($p=0.36$). No major complications were observed in the CRPP group, whereas 3 (6%) were observed in the ORIF group, including one case of avascular necrosis with a fishtail deformity, one case of osteomyelitis requiring two surgical debridements complicated by a premature physeal closure and angular deformity, and one refracture requiring surgery.

Conclusion: Surgical treatment of lateral condyle fractures mildly displaced 2-5 mm has good outcomes regardless of treatment. CRPP, however, minimizes surgical time, is more cosmetic, and potentially reduces complications. Further studies with additional patients, better assessment of articular surface displacement, and longer follow-up will be necessary to collaborate these findings.

Significance: Our results provide guidance to physicians treating mildly displaced lateral condyle fractures requiring surgery.

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Outcomes of ORIF More Than Seven Days After Injury in Displaced Pediatric Lateral Condyle Fractures

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Purpose: The purpose of the present study was to evaluate the effects of surgical timing on the outcome of pediatric lateral condyle fractures (LCF), with the hypothesis that performing an ORIF for a LCF seven or more days after the occurrence of injury does not result in significant changes in outcome.

Methods: A total of 181 pediatric LCFs treated with ORIF, with a mean follow-up of 35 weeks (11-150) and a mean age of 5 years (1-14) were included. All information related to the patient's elbow injury, including the time elapsed from injury to surgery, the type of fracture, the presence of neurological or vascular deficiency, associated injuries, and clinical outcomes was prospectively collected. We identify 2 specific groups: 133 LCFs were treated within the first 7 days after injury (Group 1), and 48 were treated 7 or more days after their injury (Group 2). A satisfactory outcome was defined as one in which a range of motion (ROM) of at least 85% of the normal, contralateral side was achieved at the latest follow-up, with no evidence of complications (neurological, vascular or otherwise), loss of fixation, infection, or avascular necrosis of the lateral condyle.

Results: Overall, the mean time from injury to surgery was 5 days hours (0-14). Initial fracture displacement was slightly larger in Group 1 vs. Group 2 (10 vs. 8 mm; p=0.004). There were no iatrogenic nerve injuries or vascular complications in either group. There was no difference in the mean surgical time between groups 1 and 2 (54 vs. 47 min; p=0.004). At the latest follow-up appointment, elbows in groups 1 and 2 had similar range of motion (143 vs. 144 degrees; p=0.4), a low and similar rate of complications that included avascular necrosis of the lateral condyle (3% vs. 2%; p = 0.57), pin-site granuloma (1.5% vs. 4%; p = 0.3) and non-union (1.5% vs. 0%; p = 0.5), with comparable rates of satisfactory outcomes (87% vs. 88%; p = 0.5).

Conclusions: Our study suggests that performing an ORIF for a displaced pediatric lateral condyle up to 14 days after the original injury does not adversely affect the outcome of the procedure.

Significance: To our knowledge, this is the first study evaluating the effect of surgical timing on the outcome of pediatric LCFs.

See pages 21- 66 for financial disclosure information.

Rate and Risk Factors for Delayed Healing Following Surgical Treatment of Lateral Condyle Humerus Fractures in Children

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Purpose: The purpose of this study was to evaluate the rate and risk factors for delayed healing of pediatric lateral condyle fractures after surgical fixation.

Methods: In this retrospective study of all operatively treated lateral condyle fractures at a single institution from 2006 to 2013, radiographic evaluation included: measured fracture displacement at presentation and after surgical fixation, fracture classification, and multiple parameters of pin configuration. Patients who had delayed healing were defined as those not yet healed by the 8th week of follow-up. The delayed healing group was compared to fractures that healed in less than eight weeks to identify risk factors associated with delayed healing. Purposeful selection was utilized to identify factors for entry into a multivariate binary logistic regression model.

Results: 210 children were evaluated. Mean follow-up was 25 weeks (4wks – 5yrs). Distribution of Weiss et al classification was as follows: type 1 – 8 (4%), type 2 – 61 (29%), and type 3 – 141 (67%). There were 33 (16%) delayed unions, or which 7 (21%, 3% of the entire cohort) required further surgery to achieve healing. There was no significant difference in pin configuration and treating surgeon experience between the delayed healing group and the normal healing group (p=0.64), however all 7 cases that underwent secondary surgery were initially treated by surgeons in their first two years of practice. Weiss classification, intra-operative fluoroscopy time, and intra-operative displacement after fixation met criteria for entry into the regression. While Weiss classification did not remain significant within the model, its removal resulted in a 30% change in the parameter estimate for intra-operative fluoroscopy time. For each second increase in fluoroscopy time, there was a 3% increase in the risk of delayed healing. For every 0.1 mm increase in intra-operative displacement after fixation, there was an 18% increase in the risk of delayed healing. Patients with 1mm or more displacement after fixation had an increased risk of delayed healing (OR 4.78, p=0.007).

Conclusions: Delayed union of lateral condyle fractures is a matter of concern and in this series 3% required secondary surgery to achieve healing. Risks for delayed healing include amount of residual displacement after reduction and the difficulty in attaining that reduction, as defined by fluoroscopy time.

Significance: Families with children who have severe fracture patterns, particularly in cases where anatomic reduction could not be obtained, should be counseled of the elevated risk of complications related to healing.

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Pathologic Arterial Changes in Neurovascularly Intact Gartland III Supracondylar Humerus Fractures

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Purpose: This pilot study was performed to describe changes in arterial flow in completely displaced neurovascularly intact Gartland III pediatric supracondylar humerus fractures (SCHFx) using Duplex ultrasonography.

Methods: This is an IRB-approved prospective study from October 2012 through August 2013 of eleven Gartland type III SCHFx that had no cortical continuity but did have a palpable radial pulse and a normal neurologic exam. Duplex ultrasonography was performed on injured and uninjured arms, both pre-operatively and post-CRPP, and interpreted by a board-certified pediatric radiologist. Ultrasound wrist/brachial indexes (WBI) were calculated using the higher value of the radial/brachial or the ulnar/brachial index.

Results: Only 2 patients (Patients #1 and #2) had normal Duplexes with flow comparable in the brachial, radial, and ulnar arteries of the affected arm, compared to the unaffected arm, both pre-operatively and post-pinning.

Pre-operatively, 6 patients (Patients #3-8) had stenosis of the affected brachial artery at the level of the fracture site (22-60% narrowing) with elevated peripheral systolic velocity (PSV) (1.52-2.98 times higher) when compared to the brachial artery proximal to the fracture. The brachial artery in these patients demonstrated monophasic/biphasic flow, but flow of the radial and ulnar arteries was preserved. Of these 6 patients, 2 had decreased WBI in the affected arm compared to the unaffected arm, 3 had minimally lower WBI, and 1 had higher WBI. Postoperatively, for these 6 patients, 1 patient had no change in Duplex post-CRPP, 1 patient had improved artery narrowing but continued elevated PSV, 1 had both improved artery narrowing and PSV, and 3 did not have a post-CRPP Duplex performed.

Patient #9 had brachial artery narrowing with decreased PSV in the distal arm and markedly decreased WBI compared to the unaffected arm. Post-CRPP, there was improved brachial artery narrowing but with elevated PSV and minimally improved flow to the wrist.

Patient #10 had brachial artery narrowing but normal PSV and intact ultrasound wrist/brachial index, without much change post-CRPP.

Patient #11 had a pink pulseless hand after anesthesia induction. Duplex revealed narrowed brachial artery with decreased PSV of brachial, radial, and ulnar arteries and decreased ultrasound WBI with no significant improvement post-CRPP.

Discussion/Conclusion: Type III SCHFx patients with a normal neurovascular exam may

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have abnormal Duplex ultrasonography with brachial artery stenosis and elevated PSV pre-operatively although distal flow remains comparable to the contralateral side.

Significance: This study establishes a baseline of pathologic changes in the Duplex examination for these patients.

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Fracture Classification Predicts Functional Outcomes in Supracondylar Humerus Fractures: A Prospective Study

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Purpose: To prospectively evaluate the relationship between fracture classification and functional outcome in children with supracondylar humerus fractures (SCHFX) using validated outcome measures.

Methods: An IRB approved prospective enrollment of consecutive patients with operative SCHFX was performed over a 3-year period. Fracture pattern and Gartland classification were recorded by the treating surgeon at the time of surgery. Functional outcome was assessed at final follow-up using the Pediatric Outcomes Data Collection Instruments (PODCI) and the quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) Outcome Measure. Multiple regression analysis was used to determine the relationship between fracture classification/ pattern and functional outcome while controlling for other injury parameters including patient age, neurologic deficit, vascular abnormality and presence of an open fracture.

Results: 752 patients were enrolled during the study period of which 199 (average age 6.7 years) completed functional outcome measures at final follow-up. Of these, 10 patients (5%) sustained flexion injures and 189 (95%) sustained extension injuries of which 62 (33%) were Type II fractures and 127 (67%) were Type III fractures. 65 (34%) of the extension injuries were posteromedially displaced, 58 (31%) were posterolaterally displaced, 54 (29%) were posteriorly displaced without coronal plane deformity, and 12 (6%) were multidirectionally unstable. The average PODCI global functioning scale score and QuickDASH scores for the entire cohort were 93.5 and 10.5 respectively indicating excellent function. No differences in outcome scores were noted between patients with Type II fractures, Type III fractures, and those with multidirectional instability. For extension injuries, no difference in outcome was identified based upon fracture pattern. Flexion injuries demonstrated significantly lower PODCI transfer and basic mobility (93.9 vs. 98.7) ($p<0.001$), and PODCI pain and comfort scores (77.8 vs. 94.8) ($p<0.3$) than Type III extension injuries. As a whole, extension injuries demonstrated significantly higher PODCI pain and comfort scores (94.8 vs. 77.8) ($p<0.02$) than flexion injuries.

Conclusions: While children generally have excellent functional outcomes following the operative treatment of SCHFX, flexion injuries may be predictive of poorer outcomes with regards to pain and mobility when compared to extension injuries at final follow-up.

Significance: This is the first study to prospectively determine an association between fracture classification and functional outcome using validated outcome measures following the operative treatment of children with SCHFX.

See pages 21- 66 for financial disclosure information.

Recovery of Motor Nerve Injuries Associated with Displaced, Extension-Type Pediatric Supracondylar Humerus Fractures

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Purpose: Nerve injuries occur in approximately 13% of pediatric extension-type supracondylar humerus fractures, but no large-scale studies have analyzed recovery of these nerve injuries. We hypothesized that the time to recovery of motor nerve injury would vary according to: the specific nerve affected, the number of nerves involved, and whether acute nerve decompression was performed at the time of fracture care.

Methods: 217 children with traumatic nerve injuries associated with extension-type supracondylar humerus fractures treated at a single institution between 1996 and 2012 were reviewed. Fractures were treated with closed, or open, reduction and percutaneous pinning. Patients with iatrogenic nerve injuries or subjective paresthesias without motor deficit were excluded. Univariable and multivariable general linear modeling using a lognormal transformation of time to recovery was used to compare recovery times across nerve injury types and to determine the effect of injury, and treatment, characteristics on recovery time.

Results: Subjects had a mean age of 6.4 years, and 89% had single nerve injuries with 64% of these affecting the median nerve (inclusive of AIN injuries). 29% of patients had concurrent vascular injury ranging from weak pulse to brachial artery transection.

Forty (18%) patients had immediate nerve decompression at the time of fracture fixation. Three patients required later surgical intervention for poor nerve recovery (two had median nerve external neurolysis and one had tendon transfers for radial nerve palsy); none of these three had undergone nerve decompression at the time of fracture fixation.

79% of patients had motor nerve recovery by final follow-up and median time to recovery was 2.3 months. Overall, 53% of patients recovered within 3 months. Significantly more single median nerve (75%) injuries than radial nerve (51%) injuries recovered within 3 months.

Multivariable analysis demonstrated that multiple nerve injuries took 79% longer to recover than single nerve injuries and that nerve injuries that underwent immediate surgical decompression took 42% longer to recover.

Conclusion: A majority (73%) of these nerve injuries recover within 6 months, and most (53%) within 3 months. Acute nerve decompression had increased time to recovery, while potentially decreasing the chance of poorer outcome and subsequent surgery. The presence of multiple nerve injuries, was an independent risk factor for a prolonged recovery.

Significance: These findings can guide surgeons and families about the recovery of motor nerve injuries associated with displaced, extension-type pediatric supracondylar humerus fractures and the potential need for nerve-related surgical intervention.

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Is Timing of Surgery of Paediatric Supracondylar Fractures Related to Pinning Errors or Complications?

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†LOE-Therapeutic - Level III

Purpose: The aim of the study was to determine if there is a relation between timing of surgery of pediatric supracondylar fractures and the incidence of pinning errors or complications.

Materials and Methods: 454 children with a supracondylar humeral fracture were reviewed. Those that were treated surgically with closed reduction and percutaneous pinning were included, leaving a group of 320 fractures (70%). Data regarding age at the time of fracture, sex, side involved, time of admission, time of surgery, duration of surgery and complications were recorded. Radiographs were reviewed to assess type of fracture, direction of displacement, number of pins, pinning site and pinning errors. Pinning errors were classified according to Sankar et al.

Results: Mean age at the time of fracture was 6.5 years (SD 4.7). There were 78% Gartland III, 19% Gartland II and 3% flexion fractures. Patients presented at the ER department mainly during the afternoon and evening. Surgery was performed mainly during evening and nighttime. Mean time delay to surgery since admission was 6 hours (median 4 hours). Time delay was higher among patients that were admitted in the morning (8.5 hours). Mean duration of surgery was 35 minutes (median 30). A medial pin was used in 14% of the patients. Pinning configuration was as follows: divergent in 25%, parallel in 25% convergent in 36% and crossed 14% of the cases. Pinning errors occurred in 45% of the patients being type A 3%, type B 14% and type C 28%. Complications occurred in 33% of the patients: neurological injury (6%), vascular injury (2%), loss of reduction (3%), infection (1.5%), and cubitus varus (5%). Pinning errors were detected more frequently in surgeries performed at night (p=0.069). Time delay to surgery was not related to pinning errors (p=0.933) or complications (p=0.257).

Conclusion: Time delay to surgery was not related to pinning error or complications. However, pinning errors were more frequent in surgeries performed during nighttime.

Significance: These findings suggest that surgery during nighttime could involve a higher risk of making errors and maybe should be avoided in absence of contraindications.

See pages 21- 66 for financial disclosure information.

Cervical Spine Clearance in Pediatric Trauma Centers:
The Need for Standardization and an Evidence-Based Protocol

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Introduction: Cervical spine clearance protocols for children should reduce the risk of missed injuries while limiting exposure to ionizing radiation. Evidence - based and standardized protocols for pediatric cervical spine evaluation are poorly reported in the literature and do not appear to be governed by a single body of authority. It is our hypothesis that Pediatric Trauma Centers utilize non-standardized protocols and that cervical spine clearance protocols vary widely, potentially affecting quality and safety for patients with these injuries.

Methods: Members of the newly formed Pediatric Cervical Spine Study Group, all of whom are active POSNA members, were asked to complete a 10 - question electronic survey about cervical spine clearance in their institutions. The results were analyzed after a minimum of 20 responses had been logged.

Results: The survey was completed by 27 surgeons from 21 level-one centers and 4 level-two centers; only the first survey received from the institutions with 2 responses was included. With one exception, all of the institutions performed cervical spine surgery. Primary responsibility for cervical spine clearance varied widely. General/Trauma Surgery was primarily responsible in 44% of institutions; Orthopedic Surgery was primarily responsible in 7% of institutions. In 1/3rd of the hospitals there was a rotating schedule of teams responsible for primary clearance. Spine consults were performed by Orthopedics and Neurosurgery on a rotating schedule in 63% of institutions and by Orthopedic Surgery only in 30% of institutions. Ninety-six percent of institutions had 24 hour/day access to CT imaging and 80% had full-time access to both CT and MRI. The primary imaging modalities utilized for clearance were plain radiography (42%) and CT of the entire cervical spine (46%). Written, standardized cervical spine clearance protocols were utilized routinely by only 46% of the institutions that responded.

Conclusion: Cervical spine clearance protocols at Pediatric Trauma Centers vary extensively with regard to the services involved primarily in cervical spine clearance, spine team composition, radiologic modalities utilized, and the utilization of standardized guidelines. Significance: With such wide variation in practice, development of a standardized cervical spine protocol based on evidence-based information is needed to potentially improve the quality of care and safety of children with cervical spine injuries.

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Functional Outcomes Following Non- Operative vs. Operative Treatment of Clavicle Fractures in Adolescents

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Background: Superiority of nonoperative versus operative treatment of clavicle shaft fractures remains unclear. Recent research suggests functional deficits remain following nonoperative treatment in adults, particularly with significant clavicle shortening. The purpose of this study was to assess shoulder function in adolescents following clavicle fractures with shortening and to compare nonoperative versus operative treatment.

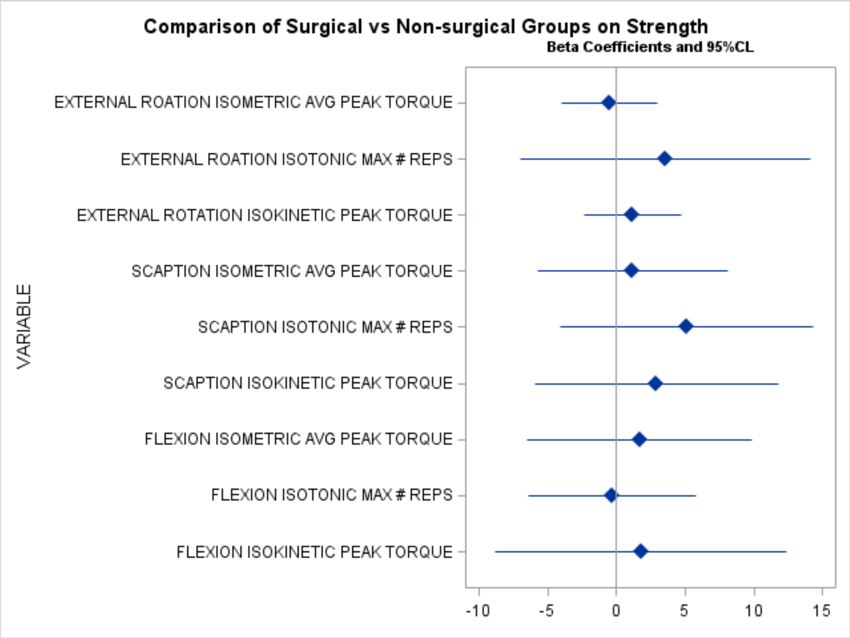
Methods: Patients aged 12-18 years at time of fracture and a minimum of 1.5 years post-injury were identified for this IRB-approved study. Patients were recruited for prospective, frequency-matched, case-control analysis. Patients were matched on age at injury, current age, gender, shortening, and activity level. Affected clavicle (dominant vs. nondominant) was controlled in the statistical model. Initial x-rays were measured to determine clavicle shortening. Isokinetic testing of the injured and uninjured shoulder was performed in flexion, external rotation, and the plane of scapular motion. Isokinetic maximum torque, maximum number of isotonic repetitions, and average isometric torque were recorded. Subjective questionnaires, including ASES and DASH scores, were recorded. Data were analyzed between the nonoperative and operative groups and between the involved and uninvolved shoulders.

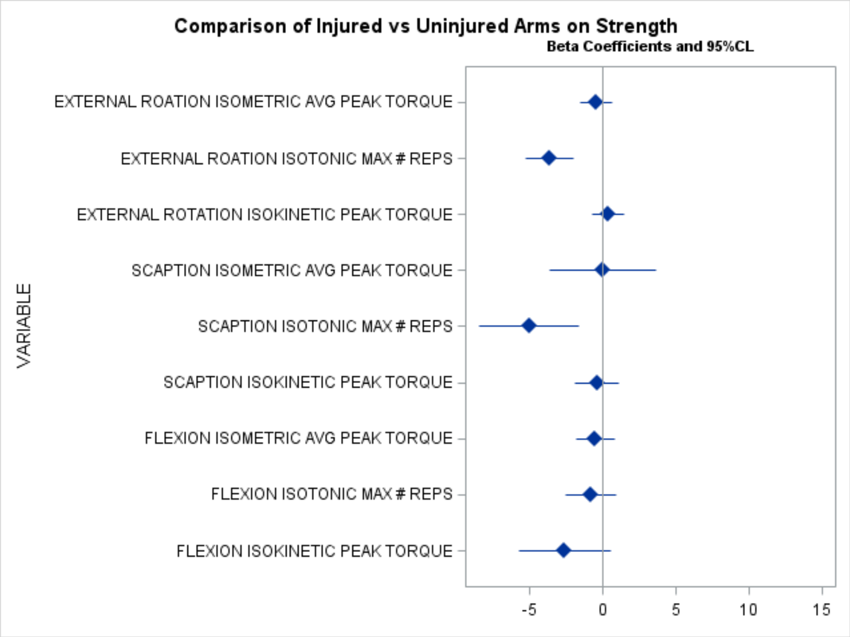
Results: 20 patients were tested, with 10 in each group. There were 18 males and 2 females. Average clavicle shortening was 17.5mm (range: 11.4-23.6mm). There was no statistical difference between groups for age at injury (p=0.2668), current age (p=0.7069), and clavicle shortening (17.8 vs.17.2mm;p=0.5725). There was no difference in ASES (97 vs 96;p=0.6640) or DASH (0.5 vs 3.0;p=0.0672) between the nonoperative and operative groups, respectively. There was a significant difference in report of cosmetic deformity with more reports in the nonoperative group (9 vs. 2;p=0.0017). Results of isokinetic testing comparison between groups (nonoperative vs operative) showed no statistical difference for any individual association; however, for between group comparisons, of the 9 strength tests per patient, 7 had means above 0 and only 2 below, indicating a possible trend toward increased strength in the operative group. For comparison of involved to uninvolved, 7 of 9 had means below 0 and only 2 above, indicating a possible trend toward decreased strength in the involved arm.

Discussion: Results of isokinetic testing of adolescents treated for shortened clavicle fractures, shows a trend for improved function with operative intervention; however, there was no statistical significance identified, likely due to small sample size.

Significance: Shortened clavicle fractures in adolescent patients may benefit from operative intervention to improve strength.

See pages 21- 66 for financial disclosure information.





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Displaced Medial Epicondyle Fractures in Children: Comparative Effectiveness of Operative vs. Non-Operative Treatment

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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.

See pages 21- 66 for financial disclosure information.

Direction of Displacement is the Strongest Predictor of the Need for Open Reduction in a Cohort of Pediatric Patients Undergoing Operative Treatment for Supracondylar Humerus Fractures

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Purpose: To indentify variables associated with the need for unplanned open reduction of pediatric supracondylar humerus fractures.

Methods: Following IRB approval, ICD-9 codes were used to identify completely displaced supracondylar humerus fractures that underwent operative treatment between January 2004 and January 2012 (N=821). Open fractures (N=7) and/or fracture with missing or unreadable pre-operative radiographs (N=418) were excluded. Clinical and radiographic variables were retrospectively collected, including: age, gender, year of treatment, presence of a concomitant fracture, time to surgery, surgeon, age, weight percentile, and direction of displacement (anterior or flexion fracture, posterior, posterolateral, or posteromedial). Univariable analyses were used to examine the association between the clinical and radiographic variables and need for open reduction. Variables significant at the alpha level of 0.10 were tested in the multivariable logistic regression analysis.

Results: The incidence of the need for open reduction was 8.67% [95% CI: 5.89 to 11.46]. The presence of concomitant fracture [p=0.4117], time to surgery [p=0.3701], surgeon [p=0.8048], year of surgery [p=0.0546], and weight percentile [p=0.6852] were not significantly related to need for open reduction. Gender, direction of displacement, and age were the only variables that remained significantly associated with the need for open reduction in the multivariable analysis (see Table 1).

Conclusions: Older age, male gender, and laterally or anteriorly displaced fractures were more likely to require open reduction. Direction of fracture displacement was the strongest predictor in both the univariable and multivariable analyses. After controlling for age and gender, the odds of open reduction among anteriorly displaced fractures were 37 times the odds of open reduction among posteriorly displaced fractures. The odds of open reduction among posterolaterally displaced fractures were 4 times the odds of open reduction among posteriorly displaced fractures.

Significance: The direction of displacement of the supracondylar humerus fracture should be considered during the pre-operative evaluation of these fractures.

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Table 1.

		OR*	95% CI*	Pvalue*	OR‡	95% CI‡	Pvalue‡
Age							
	Per Year	1.0	1.01-1.03	0.0001	1.2	1.01-1.35	0.0351
Displacement							
	Ant. vs Post.	41.0	12.07-139.31	<.0001	36.6	10.31-129.81	<.0001
	Postlat. vs Post.	4.1	1.23-13.69	0.0218	4.0	1.18-13.59	0.0260
	Postmed. vs Post.	2.8	0.76-10.05	0.1228	2.6	0.71-9.64	0.1474
Gender							
	Male vs Female	2.8	1.28-6.19	0.0104	2.8	1.16-6.95	0.0219

*Univariable analysis, ‡Multivariable analysis, OR = Odds Ratio, CI = Confidence Interval

See pages 21- 66 for financial disclosure information.

Radiographic Evaluation and Management of the Toddler's Fracture

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Purpose: Toddler's fractures have been defined as non-displaced spiral-oblique fractures of the distal tibial shaft with an intact fibula. While this appears to be a common type of diaphyseal tibia fracture, little research has been conducted regarding its characteristics associated with displacement, or appropriate management in the outpatient setting. The purpose of this study is to define the incidence of displacement and factors associated with displacement. Additionally, we seek to determine whether follow-up radiographs and clinic visits altered radiographic outcome of toddler's fractures.

Methods: We performed a retrospective chart review of children presenting to a pediatric medical center for management of tibia fractures over a ten year period. Patients aged 6 months to 8 years who presented for initial management of spiral or oblique fractures of the tibial diaphysis or distal metaphysis were included. Exclusion criteria consisted of initial displacement >5 mm, high energy mechanism of injury, associated fibular fracture, lack of follow-up x-rays, or previously diagnosed condition impacting bone quality. Data collected included basic demographics, initial displacement of fracture, displacement at last follow-up, total number of follow-up radiographs obtained, total number of clinic visits, and total follow-up length.

Results: 1202 tibia fractures were reviewed, and 472 were classified as toddler's fractures (39.3%). Of these, 306 patients were included in the study with a mean age of 2.26 years. 223 had initial displacement <1 mm, and 83 ≥ 1 mm. The mean number of total follow-up x-rays was 2.34, and the average number of total clinic visits was 2.73. Of the 306 patients studied, only 2 (.0065%) had follow-up displacement >5 mm and 25 (8.17%) had increased displacement at last follow-up visit as compared to initial presentation. Of these 25, only 1 patient had <1 mm initial displacement.

Conclusions: Children who present with low-energy spiral or oblique tibial diaphyseal or distal metaphyseal fractures with initial displacement <5 mm are unlikely to become displaced in follow-up.

Significance: There exists little evidenced-based literature on the appropriate management of toddler's fractures after they have been discharged from the emergency department. This study shows that children who present with non-displaced (<5 mm) toddler's fractures are unlikely to become displaced in follow-up (.0065%). Additionally, the subset of patients with initial displacement <1 mm never became significantly displaced. As a result, future time and resources could be saved, and additional radiation exposure avoided, as these patients almost never require intensive radiographic or clinical follow-up.

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Recurrence After Femoral Derotation Osteotomy in Ambulatory Youth with Cerebral Palsy

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Purpose: Femoral derotation osteotomy (FDO) has been shown to be an effective short term treatment for in-toeing due to dynamic hip rotation in gait. The purpose of this study was to define persistence and recurrence of hip internal rotation (IR) following FDO in ambulatory children with CP and to evaluate factors that influence outcome.

Methods: Following IRB approval, kinematic and passive range of motion (PROM) variables were retrospectively evaluated in ambulatory children with spastic CP who had a FDO to correct hip internal rotation (Level III study). Included cases had a pre-op evaluation (V_{pre}), a short term post-op evaluation (V_{short}, 1-3 years post), and a long term post-op evaluation (V_{long}, ≥ 5 years post). Persistence was defined at V_{short} as hip IR > norm+1SD and lack of improvement by 10˚, recurrence was defined at V_{long} as > norm+1 SD and > 10˚ of recurrence compared to V_{short}. Age at surgery, gait velocity, gross motor function, muscle spasticity, external tibial torsion (ETT), coronal plane pressure index, hip rotation in stance, and hip PROM midpoint were evaluated as predictors for dynamic and static recurrence using regression analysis.

Results: In 96 limbs (from 63 children) that underwent FDO, average stance hip rotation improved from 14 ± 12˚ (V_{pre}) to 4 ± 12˚ (V_{short}) and relapsed to 9 ± 15˚ (V_{long}) ($p<0.05$ V_{pre} / V_{short}/V_{long}). Hip PROM midpoint improved from 23 ± 9˚ (V_{pre}) to 8 ± 11 ˚ (V_{short}) and relapsed to 14 ± 13˚ ($p<0.01$ V_{pre} /V_{short}/V_{long}; Table 1). When considering individuals, internal hip rotation persisted in 41% (kinematics) and 18% (PROM) of limbs at V_{short}. Recurrence was seen in 40% (kinematics) and 39% (PROM) of limbs at V_{long} in children that demonstrated correction at V_{short}. Gross motor function, uncorrected external tibial torsion, and initial severity of PROM were significant factors associated with recurrence.

Table 1: Effects of FDO. (+) int, (-) ext. * V_{pre}/V_{short}, ** V_{pre}/V_{long}, *** V_{short} /V_{long} $p<0.05$.

(average age -years)	V_{pre} (9±3)	V_{short} (11±3)	V_{long} (16±3)	**Normal**
Hip Rotation stance phase (˚)	14±12 *,**	4±12 *,***	9±15 **,***	-5±7
Hip PROM midpoint (˚)	23±9*,**	8±11 *,***	14±13 **,***	5±6

Conclusion/Significance: Although FDO is an accepted form of treatment, persistence and recurrence of internal hip rotation can occur in children with CP. Recurrence is predicted by low gross motor function, ETT, and severe preoperative hip internal PROM. Predictors can be used to determine ideal children for surgery and surgical success.

See pages 21- 66 for financial disclosure information.

Reorientational Proximal Femoral Osteotomies for Arthrogrypotic Hip Contractures

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†LOE-Therapeutic - Level IV

Purpose: Hip involvement in arthrogryposis multiplex congenita occurs in 50-85% of patients. Severe hip contractures are multi planar, typically flexion/abduction/external rotational, which can preclude or greatly complicate ambulation. We developed a reorientational osteotomy at the intertrochanteric level, aligning the femoral shaft with the body axis, leaving the hip joint itself in its natural position. Pre-operative hip motion is preserved but placed it in a more functional range for sitting and ambulation. This retrospective study compares pre and postoperative hip ranges and total arcs of motions, and evaluates ambulatory abilities of patients having undergone the reorientational osteotomy.

Methods: Since 2008, 50 patients with arthrogryposis had 94 reorientational proximal femoral osteotomies (44 bilateral), with 2 years' followup. Age at surgery ranged from 14 months to 12 years (average 45 months). An intertrochanteric wedge osteotomy was performed, the proximal cut in the transverse plane with the hip in its natural position, the distal cut perpendicular to the femoral shaft. By marrying the two osteotomy surfaces, the lower limb was aligned appropriately with the body axis. A cannulated hip blade plate was used for fixation. Hip motions were recorded pre operatively, at hardware removal, and at latest followup, as was ambulatory ability.

Results: Sixty-five hips had flexion contractures greater than 20° preoperatively (average 52°), which improved an average 37°; 65 hips had less than 15° adduction (average -19°), improved an average 42°; 76 hips had less than 30° internal rotation (average -15°) which improved an average 34°, all p-values <0.0001. Flexion-extension total arc of motion (TAM) for the 94 hips improved 15° (p <0.0001), all other TAM axes were unchanged. Of the 50 patients, 31 were independently ambulatory at followup, most with braces, and 15 were walker dependent. Four were non ambulatory, of which 2 had the procedure done specifically to improve seating.

Conclusion: Hip contractures are the main lower limb deformity that prevents efficient ambulation in children with arthrogryposis. The reorientational osteotomy described allows the lower limb to be positioned appropriately for ambulation, altering the range of motion but not the TAM. Most of the walker dependent children had less than 3 years followup, from experience many of them are expected to become independent over time as well.

Significance: Children with arthrogryposis often have the potential for ambulation, if their limbs can be positioned to maximize their abilities. The reorientational hip osteotomy presents a straightforward solution to treat their hip contractures.

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Results of Early Hip Reconstructive Surgery in Severely Involved Children with Cerebral Palsy

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†LOE-Therapeutic - Level IV

Background: Hip subluxation or dislocation is frequently encountered in patients with severe cerebral palsy. Controversy exists whether bony hip reconstructive procedures should be delayed until children are older to prevent recurrence. The purpose of this study is to compare the success of hip reconstructive surgery in severely involved children based on age and procedure performed.

Methods: We performed a retrospective review of severely involved children with cerebral palsy (GMFCS IV and V) who underwent hip reconstructive surgery at a single institution from 1990 to 2010. Patients underwent proximal femoral varus derotational osteotomy (VDRO) alone or in combination with pelvic osteotomy (PO). Patients who had previously undergone soft tissue procedures were excluded. Minimum duration of follow-up was 24 months. Migration index was calculated on pre-operative, initial post-operative and final follow-up radiographs. "Failure" was defined as migration index at final follow-up greater than 50% or subsequent hip reconstructive surgery.

Results: One hundred and fifty seven hip reconstructions in 87 patients met inclusion criteria. Seventeen patients had unilateral and 70 patients had bilateral hip surgery. VDRO alone was performed on 82 hips and VDRO plus PO on 75 hips. Surgery was performed on 73 hips in patients less than six years old (51 VDRO alone, 22 combined) and 84 hips in patients six or older. At follow-up (2.0 – 15.2 years), there were 26 (16%) hips that failed. Twenty-one (81%) failures had undergone VDRO alone, while six had combined surgery. Sixteen (62%) failures were in patients younger than six, all who had undergone VDRO alone. Analysis of patients younger than six revealed that hips undergoing VDRO plus PO compared to VDRO alone had a statistically significant improvement in post-operative and final migration indices at 4.2% vs. 10.4% (p 0.0333) and 13.0% vs. 30.4% (p 0.0012) respectively. In the 22 hips undergoing VDRO plus PO in children younger than six there were zero failures. Linear regression analysis showed no relationship between age at surgery and correction of migration index from surgery to follow-up, only that combined VDRO plus PO surgery was more successful.

Conclusions: Hip reconstructive surgery in the young severely involved patient with cerebral palsy can be highly successful. Best results are obtained when VDRO is performed in combination with pelvic osteotomy.

Significance: Hip reconstructive surgery may be considered as a definitive intervention at an early age as opposed to staged soft tissue then bony surgeries in severely involved children with cerebral palsy.

See pages 21- 66 for financial disclosure information.

Correction of Tibial Torsion in Children with Cerebral Palsy by Isolated Distal Tibia Osteotomy: An Anatomic Study

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Purpose: Several surgical techniques have been described to correct excessive tibial torsion, including isolated distal tibial rotation osteotomy. The anatomic changes surrounding this technique are poorly understood. The purpose of the study was to examine the anatomic changes seen between the tibia and fibula following isolated distal tibia rotation osteotomy in children with cerebral palsy using computed tomography.

Methods: 20 patients with 29 limbs were prospectively entered for study. CT scans of the proximal and distal tibiofibular articulations were obtained pre-operatively and at 6 weeks and 1 year post-operatively. Measurements of tibia and fibula torsion were then performed. Qualitative assessment of proximal and distal joint congruency was also performed.

Results: Internal tibia torsion group (ITT, 19 limbs) showed significant changes for the tibia from pre-op to post-op to 1 year time points (means 13.21°, 31.05°, 34.84°). The fibula in the ITT group also showed statistical difference at the 3 time points (-36.77°, -26.77°, -18.54°). The external tibia torsion group (ETT, 10 limbs) showed significant differences from pre-op to post-op in the tibia, but not from post-op to 1 year (54°, 19.3°, 23.3°). The fibula in the ETT group did not change significantly between pre- and post-op, but did change significantly between post-op and 1 year (-9.8°,-16.9°, -30.7°). Nine of 10 proximal tibiofibular joints were found to be subluxated at 6 weeks. At 1 year, all 9 of these joints had reduced.

Conclusion: Correction of ITT by isolated distal tibial external rotation osteotomy results in acute external fibular torsion. The acute fibular torsion remodels over time to accommodate the corrected tibial torsional alignment and reduce the strain associated with the plastic deformity. Correction of ETT by isolated distal tibial internal rotation osteotomy results in subluxation of the proximal tibiofibular articulation in almost all cases. Subsequent torsional remodeling in the fibula resulted in correction of the subluxation in all cases.

Significance: This is the first study using CT imaging to examine how the proximal and distal articulations and fibula adapts during a tibia alone distal rotation osteotomy. We also illustrated the ability of the fibula to torsionally remodel to reduce the proximal tibiofibular joint subluxations.

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Measuring Physical Function in Children with Cerebral Palsy Using Computer Adaptive Testing (PEDI-CAT)

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Purpose: Computer adaptive testing platforms for healthcare offer an alternative to traditional, fixed-length, paper & pencil instruments. The PEDI-CAT utilizes a computer adaptive platform with an increased item bank of 276 items. The objectives of this study were to test the discriminant, concurrent and convergent validity of the PEDI-CAT (versus the PEDI, CPCHILD and PedsQL accordingly) in a diverse population of children with CP.

Methods: This was a prospective cross-sectional convenience sample of 101 families with CP between August 2013 and June 2014. Children were excluded if their diagnosis was uncertain or if they had recent surgery (<6months) or botulinum toxin (<3months). Age, gender, Gross Motor Function Classification Level (GMFCS), Functional Mobility Score (FMS), and Manual Ability Classification Score (MACS) were recorded. Items from the 4 PEDI-CAT domains (*Daily Activities, Mobility, Social/Cognitive and Responsibility*) were administered to parents via an iPad. In addition, parents were asked to complete the fixed paper version of the PEDI along with the PedsQL (GMFCS I-III) and CPCHILD (GMFCS IV & V) with the aid of a trained research assistant. Analysis of variance, Spearman and Pearson's correlations were used for our statistical analysis.

Results: Our cohort consisted of equal children according to GMFCS (GMFCS I =23, GMFCS II =19, GMFCS III =17, GMFCS IV =21, and GMFCS V =21). Mean age was 11.9 years (SD ±3.7). The PEDI-CAT showed excellent discriminant validity according to GMFCS, across all four domains (p<0.001) with Spearman correlations ranging from -0.89 (*Mobility*) to -0.55 (*Social/Cognitive*) (p<0.001). In ambulant children, the *Daily Activities* (PEDI-CAT) domain exhibited strongest correlation with *Daily Activities* domain (PedsQL) (r=0.85, p<0.001). In non-ambulant children, moderate correlations were seen between the *Daily Activities, Social/Cognitive and Responsibility* domains (PEDI-CAT) and the *Health* (CPCHILD) domain (r=0.60, 0.60, 0.53 respectively, p<0.001). The PEDI-CAT Mobility scores demonstrated strong correlation with FMS 5m (r=0.85, p<0.001), FMS 50m (r =0.84, p<0.001), and FMS 500m (r=0.76, p<0.001). Finally, the PEDI-CAT demonstrated excellent concurrent validity and agreement with the PEDI-fixed across all domains (ICCs = .84 -.95, p<0.001). Significantly shorter completion time was seen with the PEDI-CAT (10 min vs. 60 min, p<0.0001).

Conclusions: This validation analysis demonstrates that the PEDICAT is able to differentiate across functional levels in a diverse population of children with CP and demonstrates excellent concurrent and good convergent validity.

Significance: This computer administered outcome tool has the potential to change the way we measure function and outcome in children with CP.

See pages 21- 66 for financial disclosure information.

Surgical Outcomes of Valgus Extension Derotation Osteotomy (VEDO) of the Hip in Children with Spondyloepiphyseal Dysplasia Congenita: Midterm Results

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Purpose: The aim of this study is to evaluate the radiological and gait analysis outcomes of the surgical treatment of severe coxa vara in spondyloepiphyseal dysplasia congenita (SEDC).

Methods: Patients were identified who had SEDC, valgus extension derotation osteotomy (VEDO), and gait study. Clinical data included the age at surgery, sex, weight, height, PODCI score, gait kinematics and hip range of motion. Neck-shaft angle (NSA) and Hilgenreiner-trochanteric (H-T) physis angle were measured pre-op, first post-op, and last visit. Concurrent surgeries, complications and secondary surgeries were noted.

Results: 84 children had realignment osteotomies but only, 19 hips of 10 patients had pre and postoperative gait analysis and radiograph evaluation. Average age at surgery was 9.3±2 years, height was 88.5±13 cm (z= -7.8) and weight was 17.7±7.6 kg (z= -2.2). PODCI global functioning score for 4 patients stayed at average score of 68 between pre-op and post-op time periods. Femoral head ossification before surgery was complete (2, 10.5%), partial (4, 21%) and none (13, 69%). Four children that had no ossification developed partial ossification after the surgery. Average time for radiological follow up was 4.5±2 years and 2.6±2 years for the gait analysis. Hip flexion contracture decreased from a median of 20^0 to 0^0 and maximum hip abduction improved from a median of 15^0 to 30^0 (p=0.001). Preoperative median of 100^0 NSA improved to median of 134^0 postoperatively and at the final follow-up it was median of 126^0. Preoperative NSA was significantly different than postoperative and final follow-up ($p<0.001$) but there was no difference between postoperative and follow-up NSA. The preoperative median of -6^0 H-T angle improved to median of 18^0 and was 6^0 at the final follow-up with a significant difference across the groups ($p<0.001$). Preoperative to postoperative change was significant ($p <0.001$) but the difference between preoperative to follow-up was not significant. During the follow-up no statistical significant change was observed except the pelvic tilt increased. Two hips had revision surgery one for hip instability and one for unilateral recurrence. No complications occurred.

Conclusion: The outcome at 5 years demonstrated that in the severe SEDC group, VEDO surgery is an effective procedure to realign the proximal femur and preserve lower extremity function. Femoral head ossification showed no significant improvement after surgery.

Significance: Valgus osteotomy is effective in the SEDC population.

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Simultaneous Bilateral Femoral and Tibial Lengthening in Patients with Achondroplasia

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Purpose: Previous studies reported bilateral extensive (~10 cm) femoral lengthening followed two years later by bilateral extensive (~10 cm) tibial lengthening. This can be very stressful on the limb. In an effort to decrease the trauma on soft tissues and joints, we propose bilateral simultaneous *moderate* (~7 cm) femoral lengthening and *moderate* (~5 cm) tibial lengthening. A few years after this initial treatment, the same lengthening strategy is repeated. Both extensive and moderate strategies result in the same 20 cm of total lengthening. To our knowledge, the safety and effectiveness of bilateral simultaneous moderate femoral and tibial lengthening have not been previously studied.

Methods: Fifty patients (29 boys, 21 girls) with achondroplasia underwent 65 lengthening procedures. We defined a "procedure" as simultaneous bilateral femoral and tibial lengthening. Minimum required follow-up after frame removal was 12 months. Amount of lengthening of each bone, range of motion (ROM), and complications were obtained from the medical records.

Results: Mean follow-up after bone healing was 35.6 months (range, 12–102 months). Mean age at the first lengthening was 11.8 years (range, 7.1–29.3 years). Mean duration of treatment with external fixation was 6.7 months (range, 4.4–10.5 months). Mean tibial lengthening was 52 mm (range, 25–79 mm), and mean femoral lengthening was 72 mm (range, 11–105 mm). One patient experienced compartment syndrome during the second lengthening and chose not to continue lengthening after the compartment syndrome resolved. Average healing index was 1.4 months/cm for the tibia (range, 0.58–2.23 months/cm) and 1 month/cm for the femur (range, 0.57–4.56 months/cm). Sixty of the 98 complications required additional surgical procedures, and all 98 resolved by the end of treatment. Excluding pin site infections and other obstacles, the complication rate was 0.23 complications/limb segment. Mean hip, knee, and ankle ROM remained the same after treatment. The mechanical axis deviation improved from a mean of 15 mm to 8 mm. No correlation was found between the complication rate and the amount of lengthening or secondary lengthenings.

Conclusion: Simultaneous moderate bilateral femoral and tibial lengthening in patients with achondroplasia is a feasible procedure. We observed a lower complication rate than what has been reported in the literature for limb lengthening in patients with achondroplasia.

Significance: Bilateral simultaneous *moderate* femoral (~7 cm) and tibial (~5 cm) lengthening is an effective procedure. ROM recovers after treatment, and the complication rate is reasonable.

See pages 21- 66 for financial disclosure information.

Outcomes of Multi-Level Surgery with and Without External Femoral Derotation Osteotomy in Children with Cerebral Palsy

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Purpose: Ambulatory children with cerebral palsy (CP) often present with multiple deviations in all planes including increased internal hip rotation during gait. Excessive femoral anteversion is a common cause that is managed surgically with an external femoral derotation osteotomy (FDO). Previous studies have demonstrated functional improvements when an FDO is included with other appropriate multi-level surgeries. However, these studies lack control groups and focus primarily on transverse plane changes. The purpose of this study was to evaluate the outcomes (pre- to post-operative changes in gait and function) of a group of subjects with CP who underwent surgical intervention that included an FDO compared to a match group (with indications of internal hip rotation) that did not receive an FDO.

Methods: For this retrospective study, 66 subjects (98 sides) were identified from the motion analysis lab database that had single event multi-level surgery (SEMLS) which included an FDO (FDO group). A control group (retrospectively matched to the FDO group) was established from a chart review (72 subjects, 93 sides). These subjects had indications for an FDO, but it was not performed as part of their SEMLS (No-FDO group). All subjects had pre- and post-operative 3D gait analysis. Subjects categorized as GMFCS Levels I and II in both FDO and No-FDO groups were combined for analysis. Subjects rated as GMFCS Level III were analyzed separately. Pre- to post-operative kinematic and kinetic variables, Gait Deviation Index (GDI), Pediatric Outcomes Data Collection Instrument (PODCI) scores, and net oxygen cost were analyzed for each group with paired t-tests.

Results: Typical sagittal plane kinematic variables improved significantly by equivalent magnitudes for both FDO and No-FDO groups across GMFCS levels I-III. Transverse plane improvements were only seen for the FDO group. The (GDI) improved for both groups, but improvement was significantly greater for the FDO group across GMFCS levels I-III compared to the No-FDO group. Net oxygen cost improved for both FDO and No-FDO groups in the GMFCS I and II classification, but did not change for GMFCS III in either the FDO or NO-FDO groups. PODCI scores improved for both groups in GMFCS levels I-II, but only in the FDO group for GMFCS level III.

Conclusions: Overall improvements in gait outcomes were significantly greater when a femoral derotation osteotomy was included, if indicated, as a component of SEMLS for ambulatory children with cerebral palsy.

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Foot and Ankle Function at Maturity After Ilizarov Treatment for Atrophic-Type Congenital Pseudarthrosis of the Tibia (CPT). A Comprehensive Outcome Comparison with the Norms

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Purpose: Authors' fibula status-based Ilizarov treatment for atrophic-type congenital pseudarthrosis of the tibia (CPT) targets for stabilizing the ankle mortise with fibular stabilization to preserve free ankle motion. This prospective study compared the biomechanical function and clinical outcomes of the foot and ankle at skeletal maturity in children with unilateral atrophic-type CPT treated by the Ilizarov method to healthy young adults controls with normal feet.

Methods: Participants were recruited from a consecutive series of 39 children who underwent Ilizarov treatment for unilateral atrophic-type CPT between 1990 and 2013, who reached skeletal maturity. Twenty four patients (mean, 18.2 years, ranging 12 to 33) who met the inclusion criteria were compared to 24 normal controls (mean, 19.6 years, ranging 12 to 24). All participants were analyzed with validated outcome questionnaires (Oxford Ankle Foot Questionnaire, AOFAS ankle-hindfoot scale), radiograph, physical examination, 3D motion analysis of the lower limb, 3D foot and ankle motion analysis using multisegment foot model, and pedobarograph. Foot and ankle function of the affected limb was compared not only with that of the healthy young adults but also with that of patients' contralateral normal limbs.

Results: There were great variations in Oxford Ankle Foot Questionnaire (mean 17.3, ranging 0 to 45) and AOFAS ankle-hindfoot scale (mean, 89.9, ranging 76 to 100) among patients with CPT. There was no functional difference between synostosis group and intact-fibula group except the hindfoot pronation. Full gait analysis and pedobarograph showed differences in the biomechanical function of the foot and ankle on the side with the CPT, i.e., (i) walking speed was slower due to short stride length; (ii) diminished push-off power of the ankle by the affected limb; (iii) increased heel pressure and delayed heel rise (iv) mildly increased hindfoot pronation in the presence of forefoot supination; and (v) decreased dorsiflexion in hallux motion. However, sagittal range of motion of the forefoot and hindfoot was comparable between the groups of affected limbs, unaffected limbs, and normal controls.

Conclusion: This study demonstrates that well-treated atrophic-type CPT children with Ilizarov method can achieve reasonably good clinical and biomechanical foot and ankle function at skeletal maturity. Stabilization of ankle mortise with fibular stabilization and judicious care to preserve ankle mobility during and after Ilizarov treatment are crucial to improve the gait and overall biomechanics of the affected limb.

Significance: These findings indicate that authors' fibula status-based Ilizarov treatment for atrophic-type CPT is a viable option in light of its capability to preserve the foot and ankle function, allowing free ankle motion.

See pages 21- 66 for financial disclosure information.

How Important is Brace Compliance in Ponseti-Treated Idiopathic Clubfeet?

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Purpose: With Ponseti -treated clubfeet, strict adherence to bracing is considered essential for successful outcomes. The purpose is to determine the treatment outcomes relative to the amount of time bracing was actually utilized.

Methods: Infants with idiopathic clubfeet were braced with foot abduction orthoses with a temperature data logger imbedded in a shoe. Parents were not told that compliance was being monitored. The orthoses were prescribed 22 hours per day for the first 3 months followed by 12 hours per night until 2 years of age.

Compliance was monitored for time intervals: 1) 0-3 months, 2) 4-6 months, 3) 7-12 months, and 4) 13-18 months. Parents rarely returned with shoes to allow assessment of the 19-24 month interval. Compliance was defined as wear >80% of prescribed time.

The outcomes were assessed as *good* (plantigrade foot +/-TAL only), *fair* (limited procedure), or *poor* (full PMR).

Results: 53 patients with 78 clubfeet averaged 2.5 years follow-up (range 1.8-4.3 years). All feet had a Dimeglio score 0 or 1 when bracing was initiated. 36% of patients were compliant with the bracing protocol the entire time while 64% were found to be noncompliant during one or more of the time intervals. Compliance decreased over time as seen in the intervals: 1) 83%, 2) 78%, 3) 64%, and 4) 50%.

75 of the 78 feet (96%) were rated *good* when bracing was discontinued. However, during these two years of bracing, 9 feet (seven patients) relapsed. Of these 9 feet, 6 feet (5 patients) were successfully treated with recasting and TAL. Four (of these six) feet were in three compliant patients when relapse occurred while two were in noncompliant patients. The remaining 3 of the 9 relapsed feet required surgery (2 feet in a noncompliant patient had posterior releases and 1 noncompliant patient had PMR).Two more feet in brace-compliant patients that were rated good when bracing was completed required surgery at ages 3 and 4 years.

Conclusion: No clear patterns were established between objectively-measured brace compliance and outcome. Compliance decreases over time. Most patients will wear the brace <80% recommended time during some periods of the bracing protocol. Nevertheless, achieving a *good* outcome can be expected. Some will require recasting for relapses whether or not they are compliant with brace use.

Significance: Only one-third of patients will remain fully compliant with brace wear following Ponseti cast treatment. Despite this, most will complete their time of bracing with *good* outcomes.

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The Use of the Foot Ankle Orthosis After Ponseti Treatment of Idiopathic Clubfoot: How Long is Long Enough?

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Purpose: Foot ankle orthosis (FAO) noncompliance has been identified in numerous studies as a major contributing factor for recurrence in the treatment of idiopathic clubfoot. However, studies have yet to identified how long the FAO needs to be worn to decrease the risk of recurrence. The purpose of this study was determine if age at discontinuation of the FAO was associated with an increased risk of need for surgical intervention.

Methods: This was an IRB-approved retrospective review of all patients with idiopathic clubfoot treated with the Ponseti method at our institution. Patients were excluded if they did not follow-up until at least three years old. Age at discontinuation of the FAO by either the physician or the parent was noted. Need for surgical intervention, type of surgery, and age at first surgical intervention were also collected.

Results: A total of 110 patients met inclusion criteria, and data was available on the use of the FAO for 104 of these patients. Patients were followed for an average of 5.9 years (range 3-14 years). FAO was used until an average age of 2.6 years (range 0.4-5.1 years). There was a significant difference in the age at which the FAO was stopped in those patients who eventually required surgery versus those who did not (2.2 years versus 2.8 years, p=0.031). There was also a significant difference in the need for surgery for patients who used the FAO for at least two years (21.6%) versus those who did not (43%) (p=0.025) (Chart 1).

Conclusions: Patients who used the FAO until greater than two years of age were 2.77 times less likely to require surgery than those who used it less than two years.

Significance: FAO use should be continued until at least two years of age in patients undergoing Ponseti treatment for idiopathic clubfoot.

Chart 1:

Age	**FAO use**	**Surgery**	**No surgery**	**p-value**	**Odds ratio**	**Confidence interval**	**p-value**
1 year	Yes	25	70	0.25	2.24	0.56-9.01	0.26
	No	4	5				
2 years	Yes	16	58	0.03*	2.77	1.11-6.89	0.02*
	No	13	17				
3 years	Yes	9	38	0.06	2.28	0.92-5.66	0.07
	No	20	37				
4 years	Yes	3	9	0.80	1.18	0.30-4.71	0.81
	No	26	66				

*statistically significant

See pages 21- 66 for financial disclosure information.

Factors Associated with Clubfoot Recurrence in Individuals Treated with Ponseti Casting

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Purpose: Ponseti casting is the preferred treatment for idiopathic clubfoot, yet recurrence can occur in up to 45% of cases. Past studies have identified non-compliance with bracing as the main factor associated with recurrence with other demographic and clinical variables playing less of a role. The study purpose was to identify factors associated with clubfoot recurrence.

Methods: An IRB-approved retrospective chart review of patients with idiopathic clubfoot treated initially with the Ponseti technique and with a two year follow-up was completed. Patient demographics, bilateral or unilateral involvement, family history, Dimeglio grade, number of casts placed, brace compliance, and recurrence were collected. Brace compliance was determined by patient report as documented in the medical record. Recurrence was defined as additional casting or surgical intervention after the Ponseti technique achieved a plantigrade foot. Factors associated with recurrence were assessed by logistic regression, Chi-square analyses, t-tests, and odds ratio.

Results: Data from 118 patients (84 male; 96% white) with 186 clubfeet (68 bilateral; 50 unilateral) were analyzed. Patients were 2±2.2weeks at presentation, had 5.4±1.9 casts placed, 45 (38.1%) had positive family history, and 89 (75.4%) underwent initial percutaneous tenotomy. 54% of individuals (48% of involved feet) had recurrence. 66 patients (55.9%) were considered compliant with bracing. Brace compliance was the greatest factor associated with recurrence ($p<0.001$; OR=0.19 (95% CI: 0.08 to 0.43)). Number of casts placed was significantly associated with recurrence (recurrent group=5.7±2.1 casts; non-recurrent group=4.9±1.7casts; $p=0.017$). With each additional cast placed odds of recurrence increased by 31% (OR=1.31; 95% CI:1.04 to 1.65). In the subset of patients with recorded Dimeglio grades (n=97; Grade II=14; III=72; IV=11), it was related to recurrence ($p=0.0123$). No other factors were associated with recurrence.

Conclusion: This is the largest report identifying variables affecting idiopathic clubfoot recurrence after the Ponseti technique and affirms the importance of brace-wear in avoiding recurrence. Further, this is the first study to associate the number of casts placed with recurrence and possibly associate severity, as measured by Dimeglio grade, to clubfoot recurrence.

Significance: Identifying factors that contribute to clubfoot recurrence enhances the physician's ability to properly educate families and heighten awareness for difficult feet earlier in the treatment course. The introduction of number of casts placed and Dimeglio grade may be useful to the physician to identify feet with a higher chance for recurrence.

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Efficacy of Non-Operative Treatment for Symptomatic Tarsal Coalitions

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Purpose: The initial treatment for symptomatic tarsal coalitions remains controversial. Traditionally, immobilization and other nonoperative measures have been offered as first-line measures. Alternatively, surgery may be recommended due to a perceived lack of success of nonoperative treatments. We sought to evaluate the success of nonoperative treatments in preventing surgery and achieving pain relief for symptomatic tarsal coalitions.

Methods: A retrospective study of pediatric patients with symptomatic tarsal coalitions treated at a single institution was undertaken. Clinical notes were examined for treatment methods, response to treatment, and the need for additional procedures. Statistical analysis was performed using Chi Square tests.

Results: 50 patients, mean age 11.4 (range, 8.1-17.9) were treated with nonoperative measures for symptomatic tarsal coalitions. An average of 1.9 (range, 1-3) treatment types were used in each patient. Short leg casts were utilized in 31 patients, achieving pain relief in 57% and preventing surgery in 64%. Walking boots were utilized in 23 patients, achieving pain relief in 40% and preventing surgery in 68%. Other methods such as arch supports or physical therapy were used in 28 patients, achieving pain relief in 60% and preventing surgery in 83%. The differences between treatment methods did not reach statistical significance. Overall, surgery was not required in 74% of patients at a mean follow up of 13.2 months (range, 0.7-88.5). The mean age and number of treatment attempts in the patients who did not require surgery was 11.5 years (range, 8.8-17.9) and 2.6, respectively. The mean age and number of treatment attempts those who did require surgery was 12.5 years (range, 10.5-17.5) and 1.8, respectively.

Conclusion: The majority of patients treated nonoperatively for symptomatic tarsal coalitions did not require surgery. Casting, boot immobilization, and other methods of nonoperative treatment yielded similar results. In addition, there were minimal differences between patients who did and did not require surgery.

Significance: This retrospective study directly evaluates and provides success rates for nonoperative treatments of tarsal coalitions. These results can be provided to families when weighing the treatment options.

See pages 21- 66 for financial disclosure information.

Patient Reported Outcomes of Surgically Treated Tarsal Coalitions: A Prospective Review

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Purpose: Tarsal coalitions are often the cause of foot pain and deformity in children and adolescents. However, there is little patient reported data on functional outcomes, particularly prospective. The purpose of this study was to analyze treatment effective functional outcomes of tarsal coalition excision surgery.

Methods: An IRB approved prospective sample of fifty-one patients between the ages of 9 and 18 years surgically treated for a tarsal coalition between 2010 and 2013 at a single Level I pediatric center was collected. Eligible patients were consented and completed an outcome questionnaire preoperatively and postoperatively at 6, 12 and 24 months. Outcomes included a modified American Orthopaedic Foot and Ankle Society (AOFAS) score and the University of California at Los Angeles (UCLA) activity scale. Complications including infection and reoperation were reported. Student's t-test and the Mann-Whitney U-test were used to compare outcomes at each time point.

Results: Thirty-two feet in 26 patients (35% females) with a mean age of 13.1 years (range 9.8 to 18.5) and at least 12 months of follow-up were analyzed; 25 patients remain in the study with similar clinical outcomes but shorter follow-up. Talocalcaneal (TC) coalitions were present in 12 feet (38%), while calcaneonavicular (CN) coalitions were present in 20 feet. Bilateral coalitions were found in 56% (15/26) of the patients; the same type of coalition was found in both feet. Bilateral surgery occurred in 35% (6/17) of patients.

Modified AOFAS scores improved from an average of 50.4±21.0 preoperatively to 85.3±13.6 at an average of 13.4 months postoperatively ($p<0.001$). Median UCLA score improved from 9 (IQR: 6-10) preoperatively to 10 (9-10) at follow-up ($p=0.008$).TC coalitions had similar modified AOFAS scores (81.4) and UCLA activity score (10) at follow-up compared to CN coalitions (87.6 and 10, both not significant). There were no reported infections and only 2 feet (6%) had further surgical intervention. One was a revision surgery for a recurred coalition and the other was for wound dehiscence.

Conclusion: Patients treated with coalition excision showed a significant improvement from pre-operative to 1-year post-operative in their AOFAS and UCLA activity scores. There was no significant difference in outcome between the types of coalition (TC versus CN).

Significance: This presents the first patient-based outcomes on a prospective cohort of patients treated with excision of tarsal coalition. We found a remarkable improvement in their feet and activity levels at one year after surgery, thus supporting this treatment choice.

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Functional Outcomes and Health-Related Quality of Life Following Pediatric Lisfranc Tarsometatarsal Injury Treatment

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Purpose: Lisfranc injuries involve displacement of the metatarsals from the tarsus and are rare in children. This study assessed the clinical and functional outcomes of pediatric Lisfranc injuries.

Methods: This study identified 41 patients (22 male, 19 female) under age 18 (average: 11±4 years) who were treated for a Lisfranc injury between January 2002 and February 2013. Charts were reviewed for demographic, injury, and treatment information as well as complications. Displacement was measured on injury radiographs. Patients completed the Foot and Ankle Outcomes Score (FAOS) and PedsQL questionnaires by mail or phone. Both questionnaires range from 0 to 100 (higher scores indicate better function). Multivariate logistic and linear regressions were used to compare treatment groups and patients with/without complications.

Results: Lisfranc injuries occurred in 41 patients, with the second metatarsal injured most often. Two-thirds (27) resulted from a fall. 23 patients were treated non-operatively and 18 operatively. Operative patients were older (16 vs. 9, p=0.003), more likely to have bone and joint involvement (69% vs. 31%, p=0.030), and had greater second metatarsal to middle cuneiform displacement (2.6 vs 1.8 mm, p=0.006) than non-operative patients. Twenty of the 34 (59%) patients with clinical follow-up had complications, including osteoarthritis (14), osteopenia/osteoporosis (9), compartment syndrome (2), a broken screw (1), and malunion (1). Thirteen patients completed questionnaires 2 to 8 years after injury. The median FAOS score was 91 (range: 20-100), PedsQL Physical Health was 92 (range: 59-100), and PedsQL Psychological Health was 86 (range: 60-100). Operative patients had worse foot/ankle function (90 vs. 99, p=0.044), physical health (84 vs. 100, p=0.017), and psychological health (75 vs. 95, p=0.040) than non-operative patients, but only psychological health remained significant after controlling for age, bone/joint involvement, and displacement (p=0.048). Greater delay to surgery predicted worse foot/ankle function (r=-0.92, p=0.025). Patients with complications had worse foot/ankle function (92 vs. 100, p=0.010) and physical health (88 vs. 100, p=0.039) than patients without complications.

Conclusion: Non-operative treatment resulted in excellent long-term function and quality of life. Operative treatment was performed in older patients with more complicated and displaced injuries and resulted in worse but still good function and quality of life. Greater delay to surgery correlated with worse function.

Significance: Lisfranc injuries in children can be treated either non-operatively or operatively with good to excellent long-term function and quality of life. Complications such as osteoarthritis are common and can result in worse function.

See pages 21- 66 for financial disclosure information.

PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

2015 POSTER PROGRAM

Paper Poster #1 *(page 325)*
A New Radiographic Classification for DDH is More Reliable and is Predictive of Successful Closed Reduction
Brandon A. Ramo, MD*; Adriana De La Rocha, MS; Daniel J. Sucato, MD, MS; Chan-Hee Jo, PhD*

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Paper Poster #2 *(page 326)*
Change in Acetabular Index in Patients with Developmental Dysplasia of the Hip after Closed Reduction
Eduardo N. Novais, MD*; Meredith Mayo, MD; Julie Ma, BA; Patrick Thao Autruong, BA; Zhaoxing Pan*

Children's Hospital Colorado - University of Colorado Anschutz Medical Campus Aurora, CO

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June C. O'Donnell, MPH; ***Scott J. Luhmann, MD***

Washington University, St. Louis, MO

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University of Minnesota, St. Paul, MN

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Paz Kedem, MD; Saker Khamaisy Sr., MD; Ran Thein, MD; David M. Scher, MD; ***Roger F. Widmann, MD***

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Jason E. Kappa BS; Benjamin J. Shore, MD, MPH, FRCSC; Benjamin Allar, BA; Robert W. Bruce Jr., MD; Travis H. Matheney, MD; Brian Snyder, MD, MPH; ***Nicholas D. Fletcher, MD***

Emory University, Atlanta, GA

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Abnormal Static and Dynamic Descend of Cerebellar Tonsil in Adolescent Idiopathic Scoliosis – A Case-Control Study with Upright Magnetic Resonance Imaging

Ryan K.L. Lee; Tsz Ping Lam, MBBS, FRCS; James F. Griffith; Joyce H.Y. Leung; Benlong Shi; Echo Tsang; Elisa M.S. Tam, PhD; ***Winnie Chiu-Wing Chu****; Bobby Kin Wah Ng, MD; Jack C-Y Cheng, MD*

The Chinese University of Hong Kong, Hong Kong

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Rameshwar Rao PhD; ***Michelle S. Caird, MD****; Mary Ann Hayes, MSN, RN; Cathy C. Lewis, MSN, RN; Robert N. Hensinger, MD; Frances A. Farley, MD; G. Ying Li, MD*
University of Michigan, Ann Arbor, MI

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Classification of Early Onset Scoliosis has Almost Perfect Inter and Intra Observer Reliability
Micaela Cyr, BA; Tricia St. Hilaire, MPH; Zhaoxing Pan, PhD; George H. Thompson, MD; Children's Spine Study Group; Growing Spine Study Group; ***Sumeet Garg, MD***
University of Colorado, Children's Hospital Colorado

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Patrick John Cahill, MD*; Joshua M. Pahys, MD; Randal R. Betz, MD; Tracey P. Bastrom, MA; Michelle C. Marks, PT, MA; Harms Study Group; Amer F. Samdani, MD*
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A New Radiographic Classification for DDH is More Reliable and is Predictive of Successful Closed Reduction

***Brandon A. Ramo, MD**; Adriana De La Rocha, MS; Daniel J. Sucato, MD, MS; Chan-Hee Jo, PhD*
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Purpose: The Tonnis radiographic classification of DDH has been used as a prognostic indicator for patients with walking-age DDH. The International Hip Dysplasia Institute classification IHDI, a new radiographic classification system, has been proposed to be more reliable by its creators. We sought to validate it using independent observers and compare it to the Tonnis method.

Methods: A consecutive series of walking-age DDH patients were examined radiographically and classified by the Tonnis and IHDI by 3 independent observers. Inter-observer agreement was determined using the Kappa method. Clinical data was collected on patients with regard to success of closed reduction, need for later pelvic osteotomy, and presence of subsequent radiographic AVN. P The prognostic value of the Tonnis and IHDI classifications to predict these clinical outcomes was determined.

Results: 400 hips were available for analysis of the classification schemes. 235 hips underwent attempted closed reduction and were eligible for analysis of successful closed reduction, and 131 hips had greater than 4 year follow-up and were utilized for analysis of late pelvic osteotomy and AVN. There was statistically significant better reliability for the IHDI versus the Tonnis classification (0.93 vs. 0.89). In multivariate analysis, both IHDI and Tonnis classifications were found to be predictive of successful closed reduction (Table 1) and need for late pelvic osteotomy. (Both methods showed trends toward being predictive of AVN rate, without statistical significance.

Conclusion: The IHDI classification is subjectively more facile to use and has better interrelater agreement than the Tonnis classification for classifying the radiographic severity of DDH. It is also reliable in predicting success of closed reduction and need for late pelvic osteotomy.

Significance: Practitioners and researchers should consider the IHDI classification as a useful classification scheme and prognosticator when considering treatment options for late-presenting DDH.

Table 1. Prediction of Successful Closed Reduction

		No (N=87)		Yes (N=148)		
		n	%	n	%	P-value
Tonnis	1	1	14.3%	6	**85.7%**	0.0004
	2	51	31.9%	109	**68.1%**	
	3	18	41.9%	25	**58.1%**	
	4	17	68.0%	8	**32.0%**	
IHDI	2	8	18.2%	36	**81.8%**	<0.0001
	3	35	31.0%	78	**69.0%**	
	4	44	56.4%	34	**43.6%**	

Table 2. Prediction of AVN by Both Methods for Patients with >= 4Yrs F/U

		No (N=111)		Yes (N=20)		
		n	%	n	%	p-value
Tonnis	1	5	100.0%	0	**0.0%**	0.18
	2	85	85.9%	14	**14.1%**	
	3	18	78.3%	5	**21.7%**	
	4	3	75.0%	1	**25.0%**	
IHDI	2	28	93.3%	2	**6.7%**	0.07
	3	61	84.7%	11	**15.3%**	
	4	22	75.9%	7	**24.1%**	

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Change in Acetabular Index in Patients with Developmental Dysplasia of the Hip after Closed Reduction

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Purpose: Residual acetabular dysplasia after treatment of developmental dysplasia of the hip (DDH) should be reliably recognized to allow appropriate and timely intervention. The Acetabular Index (AI) dysplasia is typically measured to assess acetabular remodeling. The purpose of this study was to evaluate acetabular remodeling after closed reduction of the hip using age and gender specific standard deviation scores (Z-score).

Methods: Upon approval from local IRB, 61 hips treated with closed reduction (CR) in 57 patients (49 females and 8 males) with DDH (37 unilateral and 20 bilateral) were retrospectively reviewed. The average age at CR was 8.0 months (range: 1.0-24.1 months), and the average follow-up was 5.1 years (range: 2.1-11.2 years). Acetabular index (AI) was measured by a trained researcher (MM) on the preoperative x-ray closest to CR and all available post-operative x-rays. To account for the natural remodeling of AI, gender specific AI centile curves versus age (0 to 18 years) were developed using LMS method based on 1039 normal patients (465 females and 574 males) without hip disorders. Using this normal centile curve model, AI values for our DDH population were converted to gender and age specific standard deviation score (Z-score) and used as an outcome measure in addition to raw AI measurement.

Results: Acetabular index showed a rapid rate of improvement for the first six months after closed reduction and continued to improve over time (Table 1). Linear mixed effects model analysis using all data points also demonstrated that the post-reduction Z-score continued improving (Figure 1). The percent of patients with a Z-score between -3 to 3 (within 0.13 to 99.8 percentiles of normal population) was 68% (95% CI: 54% to 80%) at the first post-operative radiograph and 87% (95% CI: 77% to 94%) at the last radiographic evaluation in this cohort.

Conclusion: The acetabular index remodels after closed reduction toward the typical normal reference values. About 90% of patients improve to within normal values for age and gender after an average of four years after closed reduction.

Significance: Using Z-score to monitor post-operative acetabular index is a clinically meaningful approach that accounts for the natural remodeling of AI that is seen in a normal population. This approach allows a real evaluation of remodeling and assures its change over time is not just an effect of age, but rather a true remodeling of the acetabulum after closed reduction.

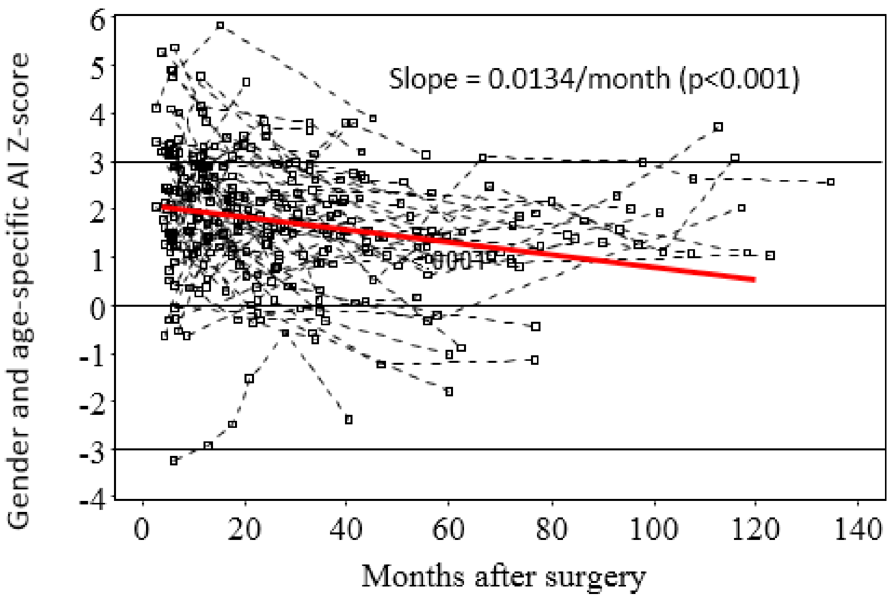
See pages 21- 66 for financial disclosure information.

Table 1: AI values at three time points

X-ray time point	N	Months to/from reduction Median (range)	Age at x-rays (years)	AI raw score (mean (SD))*	AI Z score (mean (SD))*
Pre-op	45	-0.9 (-8.6 to 0)	0.5 (0.05 to 1.89)	40.02 (6.32)	4.29 (1.7)
1st post-op**	53	5.5 (2.7 to 7)	1.06 (0.52 to 2.38)	31.96 (5.55)	2.07 (1.61)
Last post-op	61	50.5 (19.1 to 134.6)	5.04 (2.36 to 11.86)	24.75 (7.24)	1.42 (1.4)

*p ≤ 0.0001 for all pair-wise comparison between three time points in repeated measures ANOVA analysis by mixed effects model with unstructured covariance. **x-ray taken within 6 mo after CR

Figure 1: Post-operative AI Z-score and regression line



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The Prognostic Value of Power Doppler and Perfusion Magnetic Resonance Imaging for Predicting Avascular Necrosis and Redislocation after a Closed Reduction of the Hip

Pablo Castañeda, MD; *Carlos Vidal Ruiz, MD; Diego Perez-Salazar, MD*
Shriners Hospital for Children, Mexico City, Mexico

Purpose: To determine the predictive ability of power doppler and contrast-enhanced magnetic resonance imaging (MRI) after a closed reduction of a developmentally dislocated hip for AVN and redislocation.

Methods: Fifty-eight hips in 55 infants (aged 8-11 months) with developmentally dislocated hips underwent closed reduction. Immediate post reduction Power Doppler was performed to determine head perfusion and location and Perfusion MRI of the hips after intravenous gadolinium contrast injection for evaluation of epiphyseal perfusion was obtained within the first 48 hours after reduction. Serial radiographs were obtained and all patients had a minimum follow-up of 2 years. AVN was defined as having any one of the Salter criteria. Redislocation was determined by a break in Shenton's line greater than 8mm on an AP view of the pelvis. Power Doppler imaging and Perfusion MRI were graded by two observers, one an orthopaedic surgeon and one a radiologist and were graded as normal or hypoperfused and the distance from the femoral head to the triradiate cartilage was measured.

Results: 9 (16%) of 58 hips showed evidence of clinically significant AVN on follow-up radiographs. Of the 9 hips with AVN, 4 (44%) had hypoperfusion on Power Doppler, whereas only 5 of the 49 hips (10%) without AVN had hypoperfusion ($P < 0.05$, Fisher exact test). Multivariate logistic regression indicated that hypoperfusion on Power Doppler was associated with a significantly higher risk of developing AVN ($P < 0.01$), independently of age at reduction ($P = 0.02$). Only 2 of the 9 hips with AVN had decreased enhancement on MRI (22%), whereas 8 of the 49 hips (16%) without AVN also had decreased enhancement on MRI ($P > 0.05$, Fisher exact test). We only had one redislocation and the distance from the head to the triradiate cartilage was 2.3mm compared to a mean of 2.4mm to the other 57 hips which did not redislocate ($P > 0.05$, Fisher exact test), this measurement was similar on Power Doppler and MRI.

Conclusion: In addition to accurate anatomical assessment of a closed reduction in DDH, power Doppler provides information about femoral head perfusion that may be predictive for future AVN.

Significance: Power Doppler is an effective method for evaluating closed reduction of the hip with a significantly lower cost than perfusion MRI and should be considered a part of clinical practice.

See pages 21- 66 for financial disclosure information.

Unilateral Thoracic Nerve Resection Causes Rotated Lordotic Idiopathic-Like Right Thoracic Scoliosis

*Xiaobin Wang; **Hong Zhang, MD**; Daniel J. Sucato, MD, MS*
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Purpose: The initiating factor of idiopathic scoliosis is unknown. The purpose of this study was to test whether unilateral thoracic nerve resection can cause thorax imbalance to initially produce scoliosis in an immature pig model.

Method: Seventeen 1-month-old pigs were assigned to 3 groups: group-1 (n=6) in which the right thoracic nerve root was cut from T7 to T14 with bilateral paraspinal muscle stripping; group-2 (n=5): treated in the same way except the left paraspinal muscle was intact; group-3 (n=6) in which the thoracic nerve root was bilaterally cut from T7 to T14. All animals were euthanized at 17 weeks. The radiographs and true axial CT images of the spine were obtained. The parameters of the rib cage deformity including the rib hump (RH), rib vertebral angle difference (RVAD), apical rib spread difference (ARSD), apical vertebral body-rib ratio (AVB-R), and the rib length difference (RLD) were measured. The spinal deformity including the Cobb, sagittal kyphosis, and apical vertebral rotation (AVR) were measured. A histological examination of the intercostal muscle was performed.

Results: An average 53.0 degrees right thoracic scoliosis with a mean -3.6 degrees apical lordosis was created in the right thoracic nerve resection groups at 17-weeks follow up. The AVR (mean 32.8 degrees) occurred toward the right side. The RH (mean 10.5 mm), RVAD (mean 27.5 degrees), ARSD (mean 13.8 mm), AVB-R (mean 3.0) and RLD (mean 15.8 mm) measurements demonstrated the rib cage torsion to the convex side. The histological examination of the right intercostal muscle showed denervation. In the bilateral thoracic nerve neurotomy group, no scoliosis or thoracic torsion was seen, but an average thoracic lordosis of -32.3 degree was created.

Conclusion: Unilateral thoracic nerve root resection induced rib cage torsion toward the operative side resulting in rotated lordotic idiopathic-like right thoracic scoliosis in an immature pig model. The rotated lordosis at apex in idiopathic scoliosis may initially come from the rib cage torsion. Neurogenic thorax imbalance may be the initiating cause of idiopathic scoliosis.

Significance: The etiology of idiopathic scoliosis should focus on the neuraxis. The correction of rib cage torsion is the important treatment strategy for the idiopathic scoliosis.

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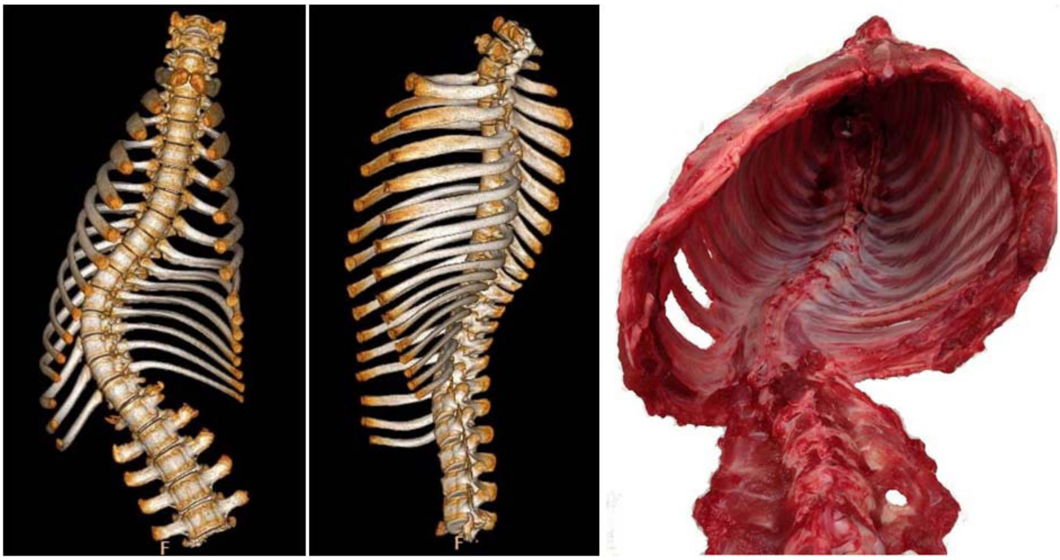

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Preoperative MRSA Screening in Pediatric Spine Surgery: A Helpful Tool or a Waste of Time and Money?

June C. O'Donnell, MPH; ***Scott J. Luhmann, MD***
Washington University, St. Louis, MO

Purpose: To review the use of pre-operative screening for *Staphylococcus aureus* for all spine procedures which was instituted at our facility 4 years ago in a multimodal approach to decreasing the frequency of postoperative wound infections after pediatric spine surgery.

Methods: A single-center, single-surgeon pediatric spine surgery database was queried to identify all patients who had preoperative methicillin-resistant *Staphylococcus aureus* nasal swab screening (MRSA). A retrospective analysis was completed of 349 MRSA screening (since its institution) from May 2009 to May 2014, in 310 patients undergoing spine surgery. Data collected included demographic data, diagnoses, MRSA swab findings, bacterial antibiotic sensitivities, and outcome of the spine surgery. Mean age of the cohort was 12.7 years (range 1.4 to 21.8 years).

Results: Of the 349 MRSA screenings performed, 20 (5.7%) were MRSA positive and 49 (14.0%) were MSSA-positive. In the MRSA-positive group, 14 of them were neuromuscular, 1 congenital, and 5 were AIS. Of the MRSA-positive screenings, 13 (65.0% of MRSA-positive screenings; 3.7% of entire cohort) of these patients were newly identified cases (3 AIS, 1 congenital, and 9 neuromuscular diagnoses. Antibiotic sensitivities were available for 16 of the MRSA-positive screenings:

	Abx resistant	Abx sensitive
Cefazolin	11	5
Clindamycin	11	5
Vancomycin	0	16

In the 49 MSSA-positive screenings, 5 of the antibiotic testings documented resistance to either cefazolin or clindamycin. Hence in 25 patients/screenings (7.2% of entire cohort; 20 MRSA-positive screenings and 5 MSSA-positive screenings with antibiotic resistance) the preoperative antibiotic regimen could be altered to appropriately cover the identified bacterial resistances. During the study period there were 6 patients who were diagnosed with a post-operative deep wound infection none of them being any of the MRSA-positive or MSSA-positive screening patients.

Conclusion: The use of pre-operative nasal swab MRSA screening permitted adjustment of the preoperative antibiotic regimen in 7.2% of patients undergoing pediatric spine surgery. This inexpensive, non-invasive tool can be used in preoperative surgical planning for all patients undergoing long procedures.

Significance: The use of pre-operative MRSA screening allowed adjustment of the preoperative antibiotic regimen in 7.2% of patients undergoing spine surgery.

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Is There a Role for a Child Life Specialist During Orthopaedic Cast Room Procedures? A Prospective Randomized Assessment

John A. Schlechter, DO*; Anna Lee Avik, DO; Stephanie Demello, MS, CCLS*
Children's Hospital of Orange County, Orange, CA

Purpose: Pediatric anxiety during cast room procedures is a common occurrence and various methods to help manage children's distress may be employed. Certified Child Life Specialists (CCLS) are formally trained professionals with proficiency in helping children and their families better manage taxing events, particularly those related to health care procedures and hospitalization. The utilization and role of a CCLS has not been well documented in a pediatric orthopaedic cast room. The objective of this study is to assess the impact of a CCLS in this setting through a prospective randomized trial.

Methods: 86 children, age range 2-10 years old, who underwent cast room procedures were randomized into two groups: Group I (42 children) had a CCLS present during their cast room procedure. Group II (44 children) did not have a CCLS present. Procedures included cast removal, cast placement, fracture manipulation and removal of previously inserted percutaneous smooth pins. We calculated change in heart rate recorded as beats per minute (bpm) during various stages of the visit along with a subjective behavior score evaluating three positive and three negative behaviors, score range -3 to 3.

Results: There was no significant difference in the demographics and age distribution between the two groups. The mean behavior score for Group I was 1.78 compared with Group II, which was 1.04 ($p<0.001$). The change in HR recorded during cast room procedures showed an increase by 7.5 bpm and 9.3 bpm in Groups I and II respectively ($p = 0.829$).

Conclusion: Certified Child Life Specialist Therapy significantly affects the observed behavior score of children while undergoing a procedure in a pediatric orthopedic cast room. A greater increase in heart rate was seen as a trend in those children treated in the absence of a CCLS.
Significance: The presence of a CCLS appears to positively affect the cast room experience for children and their caregivers.

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◆Epsilon-Aminocaproic Acid Does Not Reduce Blood Loss Associated with Periacetabular Osteotomy: A Retrospective Cohort Study

Alexander Stewart McLawhorn, MD, MBA; Ashley Levack, MD; Kara Fields, MS; Evan Sheha, MD; Kathryn Delpizzo, MD; ***Ernest L. Sink, MD***
Hospital for Special Surgery, New York, NY

Purpose: The goal of the periacetabular osteotomy (PAO) is to reorient the acetabular cartilage for acetabular dysplasia. It is a complex series of pelvic osteotomies that has the potential for significant blood loss, for which transfusion rates of up to 50% have been reported. Therefore it is important to identify effective strategies to manage blood loss and decrease morbidity. Epsilon-aminocaproic acid (EACA) is an anti-fibrinolytic agent known to reduce blood loss for other surgeries. Its efficacy for PAO surgery has not been reported. The purpose of this study was to determine the effects of EACA and other blood management strategies on blood loss after PAO.

Methods: 107 consecutive PAOs for acetabular dysplasia were reviewed and dichotomized based on EACA exposure. Demographics, autologous blood pre-donation, anesthetic type, intraoperative estimated blood loss (EBL), cell-saver utilization, and transfusions were recorded. 58 patients received EACA intraoperatively. Total perioperative EBL was calculated. Two-sample t-test, rank-sum test, and chi-square or Fisher's exact tests were used as appropriate. The association between EACA administration and calculated EBL, cell-saver utilization, intraoperative EBL, and maximum difference in postoperative hemoglobin (Hgb) were assessed via multiple regression, adjusting for confounders. *Post hoc* power analysis demonstrated sufficient power to detect a 250mL difference in calculated EBL between groups. Alpha level was 0.05 for all tests.

Results: Mean perioperative EBL was 1297±432mL in the control group (no EACA) and 1192±354mL in the EACA group (p=0.172). There was no association between EACA administration and perioperative EBL adjusted for other variables (p = 0.127). There were no differences in intraoperative EBL (p=0.522) and cell-saver utilization (p=0.665). There were no differences in preoperative Hgb (p=0.142), Hgb nadir (p=0.244), and maximum Hgb change (p=0.788). Neuraxial anesthesia was most associated with reduction in intraoperative EBL and cell-saver utilization, but had no association with overall perioperative EBL. 4.1% of controls and 1.72% of EACA patients received allogeneic blood postoperatively (p=0.239). 40.8% of controls were transfused autologous units versus 8.6% of EACA patients (p<0.001). There were no demographic differences between groups.

Conclusions: EACA administration was not associated with a reduction in any measure of perioperative blood loss in patients receiving PAO. Autologous blood donation resulted in a higher transfusion rate, but had no relationship with blood loss measures.

Significance: For PAO, EACA and autologous blood pre-donation may represent unnecessary patient exposures and costs. The efficacy of other anti-fibrinolytic agents (e.g., tranexamic acid) and blood management strategies for PAO requires further study.

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Persistence of the Gender Gap in Academic Pediatric Orthopaedics: An Analysis of POSNA Abstracts 2009-2013

Melinda S. Sharkey, MD*; Richard Feinn, PhD; Victoria V. Tate, BS; Cordelia W. Carter, MD; Todd Cassese, MD*
Yale University, New Haven, CT

Purpose: The purpose of this study was to investigate whether male and female pediatric orthopaedic surgeons participate equally in academic activities by looking at accepted abstract authorship at POSNA. The hypothesis was that, despite increasing numbers of female orthopaedic surgeons in the US, the proportion of females participating actively at POSNA meetings would be significantly lower than that of their male counterparts.

Methods: A retrospective review of the 2009-2013 POSNA Annual Meeting Final Programs was performed. The following information was recorded for all members: name, sex, membership level, and if the individual was an author on at least one abstract. To compare proportion of abstract authorship between sexes across years, while controlling for years of membership, general estimating equations with a binomial model and logit link were used. The study population was limited to candidate and active POSNA members only, as this group represents the most active practicing pediatric orthopaedic surgeons.

Results: Over the five year period studied, females comprised 16.6% (204/1227) of the total POSNA membership and 20.9% (184/880) of members at candidate and active status. The percentage of females with candidate or active member status in POSNA who had at least one abstract presentation (podium, e-poster, or poster) was 16.4%, 15.0%, 13.1%, 13.0%, & 17.9% for the years 2009-2013 respectively. The percentages for males during the same period were greater (23.1%, 19.4%, 20.5%, 22.4%, & 29.2%) and these differences were statistically significant (p=0.002, Figure 1). Subgroup analyses revealed that amongst both active members and candidate members, males were more likely to have authored an abstract than females (p=0.026 active, p=0.035 candidate) and there is no evidence the percentages are converging over time (p=0.65).

Conclusions: Female members of POSNA, in the most active parts of their careers, participated at significantly lower rates than males as POSNA accepted abstract authors for all POSNA meetings between 2009-2013.

Significance: In 1995 the Academic Orthopedic Society (now AOA) identified numerous challenges to the success of female orthopaedists in academic practice. Almost 20 years later, our data suggest that female pediatric orthopaedic surgeons are not participating as thought leaders at the same rate as their male peers. Given the trend of increasing numbers of women in orthopaedics, it is imperative to identify and address the specific barriers to effective academic participation that persist for female orthopaedists.

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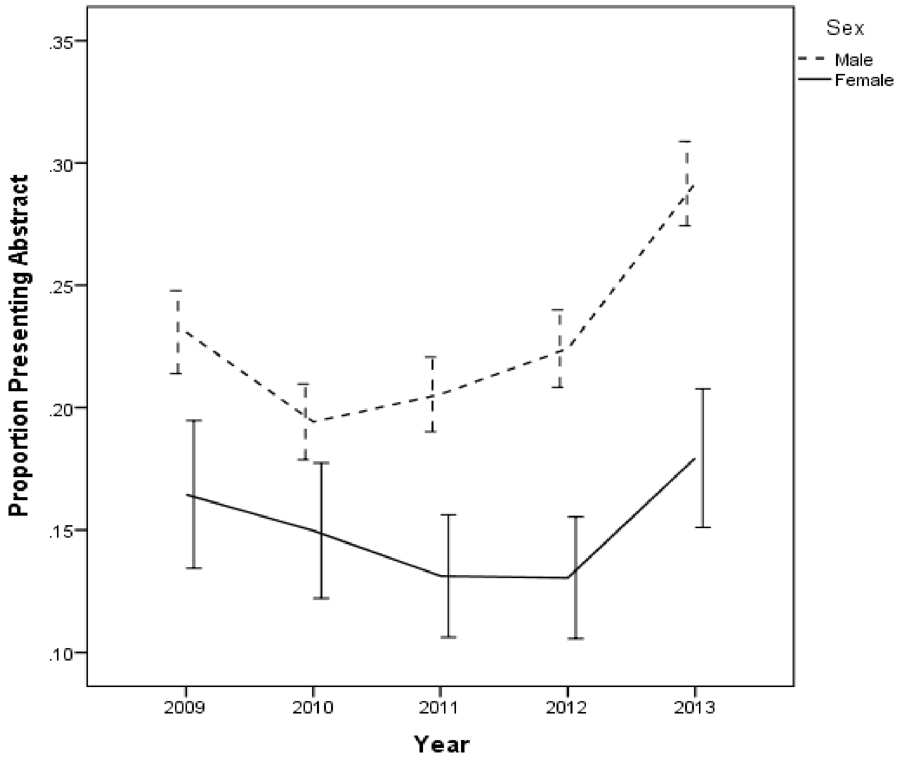
Figure 1. Proportion (±1 SE) of males and females that authored one or more abstracts.



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Peter M. Waters, MD; ***Donald S. Bae, MD***
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Purpose: Pollicization is a well-accepted treatment for thumb hypoplasia, yet little is known about the overall costs and complications of this procedure. The purpose of this investigation was to characterize the 30-day readmission rate, complications, and variation in cost associated with pollicization in the United States.

Methods: We analyzed 456 pollicization procedures performed in 405 patients in 38 U.S. pediatric hospitals from 2003 to 2014, utilizing the Pediatric Health Information System (PHIS) database. A step-wise search strategy identified all returns or readmissions within 30 days after pollicization, to quantify potential complications and/or additional procedures. Readmission and complications rates were compared across groups according to age, surgeon subspecialty, and associated diagnoses. Total cost was analyzed using univariate and multivariable general linear modeling based on a box cox transformation of 2014 adjusted cost data.

Results: Median patient age was 20 months (IQR 14-36); 54% were male. Surgery was predominantly performed by orthopaedic surgeons (60.7%). Mean length of stay was 1.14 days. Twenty-seven percent of patients had thumb deficiency alone; more than fifty percent had associated medical conditions. The median cost for the pollicization was $7122 (IQR=4993-9328), with significant differences according to age group and surgeon's subspecialty.

Sixty-seven patients (14.6%) returned within 30 days of their pollicization. Thirty-nine patients returned for suture removal, cast changes, or other aspects of post-operative care, with median additional cost of $1,076 (IQR= $354-1,612). The remaining 24 patients (6%) had a total of 28 complications. Twenty-one were treated for a single complication with median cost of $1079 (IQR= $259-3828), ranging from wound infection (median cost $351) to hemorrhage (median cost $28,606). Cost for readmissions for two to four complications ranged from $72,753 to $64,856. The number of procedures, the severity of the complication, and the length of stay were all significant factors of total cost.

Conclusion: Pollicization has a 30-day return rate of 14.6%, and a complication rate of 6%, which add considerable cost to pollicization. Surgeon subspecialty, severity, and number of complications are significant factors associated with higher costs.

Significance: This analysis of over 400 patients provides insights into post-operative return and complication rates following pollicization, along with important information regarding variations in cost. With this baseline data, future efforts may be made to establish benchmark rates for complications and identify opportunities for more cost-effective care.

See pages 21- 66 for financial disclosure information.

An Anatomical Study of the Greater Trochanter Starting Point for Intramedullary Nailing in the Skeletally Immature

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Purpose: Trochanteric entry femoral nails have been increasing in popularity in the pediatric population for stabilization in fractures and osteotomies. Characterization of greater trochanter entry position in the sagittal plane in the pediatric population has not yet been well studied.

Methods: Ninety cadaveric femora ages 8-20 years were studied in an apparent neck-shaft angle (ANSA) position, with distal condyles flat on the surface; and a true neck-shaft angle (TNSA) position, with internal rotation to neutralize femoral anteversion. A marker was placed at the apex of the greater trochanter. Anterior and lateral offset were measured in lateral and anteroposterior photographs, respectively, as the perpendicular distance from the marker to the center of the intramedullary canal. The effect of rotational position (ANSA versus TNSA) of the proximal femur was compared using intraclass correlation coefficient (ICC) for anterior and lateral offset. Correlation between age and anterior and lateral offset was evaluated with linear regression analysis.

Results*:* Mean age was 14.7±3.6 years. Mean anterior displacement of the trochanteric apex relative to the intramedullary canal was 4.9±3.0mm and 4.6±3.4mm in the ANSA and TNSA positions, respectively. Mean lateral displacement was 10.1±4.4 and 9.3±4.1 in the ANSA and TNSA positions, respectively. The intraclass coefficient (ICC) for anterior offset in the ANSA versus TNSA position was 0.704 (95% CI: 0.559-0.807), and for lateral offset was 0.900 (95% CI: 0.813-0.944). Change was minimal for anterior offset in the ANSA and TNSA positions versus age (r^2= 0.022; r^2= 0.001). There was a mild increase in lateral offset in the ANSA and TNSA positions with increasing age (r^2=0.333, p<0.001; r^2=0.203, p<0.001).

Conclusion: Neither anterior nor lateral offset are significantly affected by rotational positioning of the proximal femur. The apex of the greater trochanter is consistently anterior to the center of the intramedullary canal across all ages. Lateral offset increases with age.

Significance: This study demonstrates that the greater trochanteric apex is located approximately 5 mm anterior to the center of the intramedullary canal in juveniles and adolescents. This value remains relatively constant throughout the age range generally treated with trochanteric entry nails. Standard nail designs have accounted for the lateral position of the trochanteric apex in the coronal plane, but not for the anterior position of the apex in the sagittal plane. We recommend inserting the guidewire 5 mm posterior to the apex of the trochanter and confirming coronal and sagittal position with fluoroscopy.

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Ultrasound Exam At 6 Weeks of Age for Infants Born Breech with a Normal Hip Exam for Instability

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Purpose: Due to the risk of DDH in infants born breech--despite a normal physical exam-the AAP guidelines recommend ultrasound (US) hip imaging at 6 weeks of age for breech females and optional imaging for breech males. The purpose of this study is to report the US results and follow up of infants born breech at our institution.

Methods: The EMR and US for all children born at one hospital from 2008—2011 were reviewed. Data was analyzed for gender, birth weight, breech position, birth order, ethnicity, US results and follow up, and cost.

Results: 238 infants were breech. All were delivered by C Section. 130 (55%) were male, and 108 (45%) were female. The ave birth weight was 2850 grams. 119 (50%) were first born. 203 (85%) infants were White, 20 (8%) Latino or Hispanic, 10 (4%) Black, and 5 (2%) Asian. 151 breech infants (65%) with a normal Barlow and Ortolani exam had a precautionary hip US as recommended by the AAP performed at an average of 7 weeks of age (range 5-8). 75 were female (50 %) and 76 were male (50 %). 86 breech infants (35%) did not have an US and were followed clinically. 33 were female (38%) and 54 were male (63%). Of the 151 infants that had an US, 140 (93%) were normal, 6 (4%) had bilateral, 4 (2.5%) had left-sided, and 1 (.6%) had right-sided findings of minor hip dysplasia such as an alpha angle of < 60 degrees. None had a dislocated hip. 2 (0.8%) had normal physical exams but laxity via US. These 2 patients were the only infants treated in a Pavlik harness-- 1 month full- time and 1 month part-time. Follow up US and X-rays were normal. The infants with normal US exams were not referred to a pediatric orthopaedic surgeon. The infants with subtle US findings and no laxity were examined and followed by a pediatric orthopaedic surgeon with follow up imaging until normal. The cost of a hip US at our institution is Professional charge: $127, Technical charge $556. Total: $683.

Conclusions: The decision by the AAP to recommend US screening at 6 weeks of age for infants with a normal physical exam but a history of breech position was based on level 5 evidence. Not all pediatricians are following the AAP guidelines. We suggest that the guidelines be re-examined. The decision to perform an US should be done a case by case basis determined by the examining physician. A more practical and cost effective strategy would be to skip the US at 6 weeks if the exam is normal and simply obtain an AP pelvis X-ray at 4 months of age.

Significance: 4 million babies are born each year in the USA. 160,000 newborns (4%) are breech. The estimated cost to the nation to perform ultrasounds on all of these infants per AAP guidelines is $109,280,000 per year.

See pages 21- 66 for financial disclosure information.

L3 Translation Predicts When L3 is Not Distal Enough for An "Ideal" Result in Lenke 5 Curves

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Purpose: Determining whether to end a fusion distally at L3 or L4 for a Lenke 5 curve is an age old debate. The purpose of this study was to determine the preoperative variables that predict either an "ideal" or "less than ideal" outcome for Lenke 5 curves instrumented to L3 (i.e. Should they have been fused to L4?).

Methods: A prospective, multi-center registry was queried for surgically treated Lenke 5 curves with an LIV of L3 and minimum 2yr f/u. Five seasoned AIS surgeons qualitatively rated the 2yr post-op images as either "ideal" or "less than ideal" with respect to correction and alignment. Preop and postop radiographic variables were then compared and a multivariate regression analysis was performed to determine the variables most predictive of a "less than ideal" outcome

Results: 139 patients met criteria. 23 were considered "less than ideal" by 3 or more surgeons. 81 were considered unanimously "ideal". At 2yrs f/u, the "less than ideal" group had significantly larger lumbar curves (26° vs. 15°, $p < 0.001$), EIV angulation (11° vs 5°, $p < 0.001$), EIV translation (2.6 vs 1.4 cm, $p < 0.001$), and lower self-image SRS-22 scores (4.19 vs. 4.5, $p = 0.01$). Preop, the "less than ideal" group was significantly stiffer, had greater apical translation with an EIV that was more angulated and more translated (Table). Multivariate regression found that L3 translation ($p = 0.009$) was the single most important predictor of a "less than ideal" outcome. Specifically, a preop L3 translation <3.5cm consistently resulted in an "ideal" outcome, while a translation >3.5cm risked a "less than ideal" result.

Conclusion: The goal of surgery in Lenke 5 curves is to get an "ideal" clinical and radiographic outcome with the shortest fusion. Frequently, the decision is whether to instrument to L3 or L4 distally. While multiple variables are important in this choice, this study found the most important predictor of success was an L3 translation less than 3.5cm from the CSVL, suggesting this as a potential threshold for selecting L3 as the end instrumented vertebra.

Significance: In choosing between L3 and L4 for Lenke 5 curves, the pre-op translation of L3 is an important predictor of radiographic success. Pre-op L3 translation <3.5cm consistently resulted in an "ideal" radiographic outcome post-op.

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Table. Summary of univariate analysis for predicting "less than ideal" outcome in Lenke 5 curves fused to L3.

Pre-Operative Variable	**"Less than ideal"**	**"Ideal"**	**p value**
Thoracic curve magnitude	27 ± 9°	26 ± 10°	0.6
Lumbar curve magnitude	49 ± 9°	45 ± 7°	**<0.05**
Thoracic bend magnitude	11 ± 7°	12 ± 7°	0.7
Lumbar bend magnitude	26 ± 10°	18 ± 11°	**<0.01**
Lumbar flexibility percentage	48 ±16%	61 ± 21	**<0.01**
C7-CSVL magnitude	3.0 ± 1.2cm	2.9 ± 1.3cm	0.8
Thoracic apical translation	2 ± 1.3cm	1.7 ± 1.2cm	0.4
Lumbar apical translation	6.1 ± 1.7cm	5.3 ± 1.3cm	**<0.01**
EIV angulation (L3)	28 ± 8°	25 ± 6°	**<0.05**
EIV translation (L3)	3.9 ± 1cm	3.1 ± 0.8cm	**<0.001**
EIV disc angulation (L3-4)	4.1 ± 4.1°	3.7 ± 3.1°	0.6
T5-T12 kyphosis	27 ± 9°	28 ± 11°	0.7
T10-T12 kyphosis	6 ± 10°	4 ± 11°	0.4
Lumbar lordosis	55 ± 11°	59 ± 11°	0.2
Distal junctional lordosis	21 ± 9°	20 ± 8°	0.7

*bold values indicate statistical significance.

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The Patellar Insertion of the Medial Patellofemoral Ligament in Children: A Cadaveric Study

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Purpose: Previous research has reported the location of the medial patellofemoral ligament (MPFL) insertion on the patella, often through adult cadaver dissections and indirect imaging studies. The purpose of this study was to evaluate the MPFL patellar insertion in skeletally immature anatomic specimens and determine if this is similar to adult anatomic studies.

Methods: Nine pediatric cadaveric knee specimens were examined through gross dissection. Metallic markers were placed at the MPFL patellar insertion footprint. CT scans for each specimen were analyzed. The MPFL insertion footprint width, patellar height, and patellar width were measured. The distance from the MPFL insertion footprint center to the midline of the patella was assessed. The proportion of the patella that the MPFL footprint inserted upon was calculated.

Results: The mean width of the MPFL patellar insertion footprint was 12 mm (8-18mm). The mean patellar height was 31 mm (20-48 mm). The mean patellar width was 27 mm (21-39 mm). The center of the MPFL insertion footprint was found to be a mean 4.7 mm (-2 to 10.5 mm) above the midline of the patella, with insertion centers occurring both above and below the midline. The MPFL insertion footprint spanned a mean 41% (24-63%) of the longitudinal width of the patella.

Conclusions: Most adult studies report the MPFL insertion on the upper 1/2 to 2/3 of the patella. This series of skeletally immature subjects demonstrated that the center of the MPFL insertion was above and below the mid-point of the patella. The MPFL insertions of some of the younger specimens did extend into the distal 1/3 of the patella. The insertion of the older specimens was found in the proximal 2/3 of the patella, a similar location to most previous adult anatomic studies.

Significance: This research suggests that the MPFL insertion on the patella may be at slightly different locations in some skeletally immature subjects compared with adults. The specimens dissected in the present study showed more variability than previously published reports, with some insertions extending into the distal 1/3 of the patella in the youngest subjects. These dissections may be useful to surgeons performing MPFL reconstructions in skeletally immature patients.

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Demonstration of Characteristic Epiphyseal Vasculature in Predilection Sites of OCD in Children and Animals

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Purpose: Osteochondritis dissecans (OCD) is a developmental orthopaedic disease affecting both humans and animals at species-specific predilection sites. In veterinary medicine OCD is known to occur secondary to ischemic necrosis of epiphyseal cartilage. Utilizing susceptibility weighted imaging (SWI), an MRI sequence with ability to demonstrate vasculature contained in the epiphyseal cartilage, we compared the vascular architecture of the distal femoral epiphysis in humans, pigs, and goats. We hypothesized that vascular architecture differs among species which frequently develop OC in the femoral condyles (humans and pigs) compared to one which is free of the disease (goats).

Methods: Distal femoral specimens were harvested from three pigs aged 1, 7, and 21 days, three goats aged 1, 11, and 19 days, and from five human cadaveric donors aged 1, 3, 4, 24, and 36 months and imaged in a 9.4 T MR scanner. SWI datasets were acquired using a 3D gradient recalled echo sequence. To enhance visualization of the vascular architecture 2, 4, and 5 mm thick minimum intensity projections (MIP) were calculated in the sagittal, coronal, and axial planes, respectively.

Results: In humans and pigs, vascular architecture of the distal femoral epiphyseal cartilage appeared nearly identical, with vessels arising from the perichondrium on the axial and abaxial aspects of the condyles and coursing centrally. In both species, vessels terminated before reaching the midline of the condyles, creating an avascular zone in the sagittal plane. Conversely, in goats the vascular supply originated mainly from the ossification front, advancing radially towards the articular surface. Comparison of the MIPs of human samples of increasing age revealed that the abaxial vessels persist longer than the axial vessels.

Conclusion: Vessels arising from the perichondrium and coursing axially in pigs and humans are expected to be more prone to fail than the more dense vascular supply composed of numerous shorter vessels arising from the ossification front in goats, providing a potential explanation for the occurrence of OCD in pigs and humans vs. its absence in goats. More rapid regression of the vascular supply to the axial aspect of the femoral condyle in humans may explain predisposition of this area for OCD.

Significance The similarity of vascular supply and the shared predilection site for OC in the distal femur between pigs and humans suggest a common pathogenesis. Studies of naturally occurring OCD lesions in pigs will likely provide information relevant to the human disease.

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A New Method for Assessing Hip Congruence after Hip Reduction in Children with DDH

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Purpose: The purpose of this study was to describe a quantitative method of assessing hip congruence, which uses MATLAB software to calculate the spherical centers of the acetabulum and femoral head from MRI.

Methods: Coronal PD sequences from post-surgical MRI studies of 24 patients (21 female, 3 male) who were treated for DDH were retrospectively reviewed. Study inclusion criteria consisted of patients between 0-18 months of age who were diagnosed with unilateral DDH, who underwent closed or open reduction of the hip and who received same-day post-operative pelvic MRI in a Spica cast. Using a least squares regression algorithm, the software calculated best-fit spheres for the acetabulum and femoral head of both the affected and unaffected hips. The program calculated the distance between these spherical centers and normalized this value to the diameter of the acetabulum to determine a Congruence Index (CI). The CI integrated three indices evaluated in the coronal, sagittal and axial planes (Figure 1). A CI=1.0 indicated complete reduction and a CI=0 indicated a complete dislocation. The inter-rater reliability of two raters was assessed in a random sample of 15 subjects. Post-operative radiographs and patient medical records were reviewed to identify patients who required a revision within 6 weeks following the procedure.

Results: The mean chronological age at the time of the procedure was 7.2 months (range: 2-16 mo). Fourteen of the patients (58%) required revision surgery within six weeks following primary procedures. The mean CI for hips that required revision (mean=0.51; range: 0-0.8) was significantly smaller than the mean CI for hips that did not require revision (mean=0.79, range: 0.61-0.93; p=0.004). When evaluating the CI separately in all three planes, most of the subluxation was posterior. The average CI for unaffected hips was 0.94 (range: 0.83-0.99). Inter-rater reliability was excellent, with weighted Kappa =0.88 for dysplastic hips and weighted Kappa=0.95 for unaffected hips. The calculated 95% confidence interval included CI values ranging from 0.43-1.0.

Conclusions: We describe a novel, accurate and reliable method for calculating three-dimensional hip congruence, identifying residual subluxation, and indicating the direction of the subluxation. The calculated CI values reliably differentiated between hip reductions that required revision and those that did not require revision.

Significance: This novel, MRI-based method for assessing hip congruence may help predict the probability of success for both open and closed dysplastic hip reductions.

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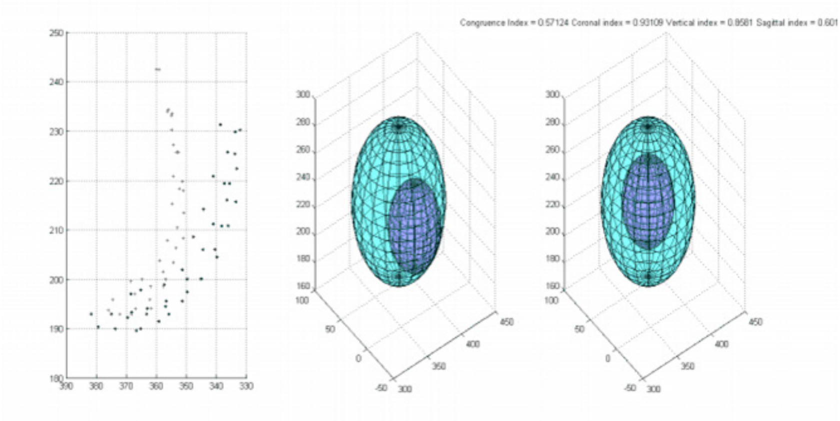
Figure1. Spherical centers are calculated from 3D coordinates and evaluated in each plane.



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Minimally Invasive Dega Acetabuloplasty for Neuromuscular Hip Dysplasia

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Purpose: Dega acetabuloplasty is used for the management of neuromuscular hip dysplasia. A minimally invasive technique may decrease perioperative morbidity while allowing for adequate reduction and ensuring stability. The purpose of this study was to compare the traditional Dega (TD) to a minimally invasive Dega (MID).

Methods: A retrospective review was performed from two centers of consecutive patients with cerebral palsy (GMFCS 4 & 5) and neuromuscular hip dysplasia who underwent bony reconstruction including a varus derotational osteotomy (VDRO) of the femur and a Dega acetabuloplasty. Patients in the TD group underwent acetabular procedures through a standard open approach compared to the MID group which had the osteotomy perfomed through a 2 cm incision with bony correction completed under fluoroscopic control. Clinical records were reviewed to evaluate preoperative comordibities and clinical complications. Radiographic review of pelvic radiographs preoperatively and at follow up evaluated correction of acetabular index, Reimer's migration index, and the presence of an intact Shenton's Arc.

Results: 39 patients (44 hips) underwent TD surgery while 42 (45 hips) patients underwent MID surgery. 91.4% of hips underwent additional soft tissue balancing. 8.6% only underwent bony surgery alone for hip subluxation following prior VDRO. Preoperative Reimer's migration index, acetabular index, and neck shaft angle were similar between groups and there was no difference in percentage of patients with a broken Shenton's arc. TD patients had a lower residual acetabular index (6.5±6.4° TD vs 16.0±8.7° MID, $p=0.001$) compared to MID patients, however hip stability was similar between groups with no difference in Reimer's index (12.1%±2.5 MID vs 13.9%±2.1 TD, $p=0.61$) or percentage of patients with an intact Shenton's arc (84.4% MID vs 92.3% TD, $p=0.24$) at final follow up. Patients with MID osteotomy had less blood loss (102±69.9 cc vs 352±194cc, $p=0.001$), shorter operative time (165±44 minutes vs 364±104 minutes, $p<0.0001$) and shorter hospital stay (3.2±1.3 days vs 9.1±8.5 days, $p=0.001$) than TD patients. Patients with TD sustained more medical complications requiring intervention (23.1% vs 4.1%, $p=0.02$). No patient in either group required revision acetabuloplasty.

Conclusion: Despite a smaller correction in acetabular index, the MID osteotomy had a similar rate of hip stability when compared the TD osteotomy. The MID procedure was associated with a significantly lower EBL, surgical time, length of stay, and post-operative medical complications.

Significance: A minimally invasive Dega acetabuloplasty allowed for a similar improvement in hip stability with less morbidity and shorter surgery than traditional Dega osteotomy.

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Abnormal Static and Dynamic Descend of Cerebellar Tonsil in Adolescent Idiopathic Scoliosis – A Case-Control Study with Upright Magnetic Resonance Imaging

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Purpose: Previous studies reported an association of AIS with abnormal somatosensory evoked potential (SSEP) and tonsillar ectopia. However, these studies were carried out with subjects in supine position. Since tonsillar levels can vary with positions, evaluation of craniovertebral junction at different postures is desirable in order to obtain an in-depth understanding of this important potential morphological and functional link. This study aimed to compare the effect of an upright posture on cerebellar tonsillar position between AIS patients and normal controls.

Methods: 25 female AIS patients (age: 14.9±2.3) and 18 female controls (age: 15.3±3.4) were recruited. The subjects were examined by 0.25T MRI in both supine and upright positions. The perpendicular distance (in millimeters) between the inferior cerebellar tonsil tip relative to a standard reference plane connecting the basion to the opisthion (i.e. the BO line) was measured, with position above the BO line assigned a positive value and vice versa. Measurements were performed independently by two experienced radiologists who were blinded to subject status and MRI position.

Results: None of the control subjects had cerebellar tonsillar descended below the BO line in the supine or upright position. In contrast, 7 (28%) of the 25 AIS patients had cerebellar tonsillar with a mean descent of 1.0 mm in the supine position ($p<0.001$); and 12 (48%) with a mean descent of 2.8 mm in the upright position ($p<0.001$). In the control group, no significant change in cerebellar tonsillar position between upright and supine position was observed. In contrast, in the AIS group, the tonsillar position had a mean of 1.9 mm lower in the upright than the supine position ($p<0.001$). In addition, positive correlations was also found between cerebellar tonsillar level and Cobb angle in the supine ($r=0.31$) and upright position ($r=0.45$) in the AIS patients.

Conclusion: AIS patients have more tonsillar descent in the upright position and a greater degree of dynamic cerebellar tonsil descend between supine and upright positions when compared with controls. Apart from supporting the hypothesis of relative anterior spinal overgrowth and posterior cord tethering, the results also enhanced the likelihood of chronic dynamic compression of brainstem and upper cervical spinal cord, which might be linked to subclinical neurophysiological disturbance such as dynamic postural balance and abnormal SSEP that might contribute to the etiopathogenesis of AIS.

Significance: This study further supports the hypothesis of relative anterior spinal vertebral overgrowth and posterior spinal cord tethering and the associated abnormal subclinical neuromorphological and neurophysiological observations in a subgroup of AIS.

See pages 21- 66 for financial disclosure information.

A Caremap on the Road to Recovery: Shorter Stays and Satisfied Patients in Posterior Spinal Fusion

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Purpose: Adolescent idiopathic scoliosis (AIS) patients undergoing posterior spinal fusion (PSF) experience variations in their hospital care which may lead to differences in objective and patient-reported outcomes. In 2009, a multidisciplinary team at our children's hospital developed an evidence-driven CareMap for the pre-operative education and post-operative care of patients undergoing PSF (earlier oral intake, setting mobilization expectations, multimodal pain-control regimen). Previous analysis of data obtained one-year post-implementation demonstrated improvement in daily pain scores, earlier intake of liquids, less time to sitting and walking, and increased patient satisfaction. However, time to discharge did not decrease significantly. Recent modifications to the CareMap included earlier removal of both the epidural and Foley catheters (on post-operative day 2 vs day 3). We hypothesized that using the CareMaps - educating families pre-operatively and standardizing some aspects of care - would decrease time to mobility and time to discharge while maintaining pain control and patient satisfaction.

Methods: Chart review was conducted in three groups: pre-CareMap (Group I; Dec 2008-Dec 2009, n=51), first CareMap (Group II; Dec 2nd 2009- July 24th 2013, n=100), latest CareMap (Group III; July 25th 2013- June 1st 2014, n=40) to track pain scores (0-10), time to regular diet, time to Foley catheter removal, time to epidural catheter removal, time to mobility, and time to discharge. Patient satisfaction surveys (0-10) were administered prior to discharge.

Results: Average and maximum pain scores were significantly lower in Group III (average=2.8±1.7, maximum=5.1±2.3) compared to Group I (average=3.7±1.8, maximum=6.4±2.2) on post-operative day 1(p=0.048, p=0.022). Time to sitting was significantly reduced in both Groups II (27.2±9.7 hours, p=1x10^{-8}) and III (28.4±13.59 hours, p=3x10^{-5}) compared to I (40.2±15.40 hours). Time to discharge was significantly lower in Group III (84.3±27.2 hours, p=0.036) compared to Group II (98.4±26.0 hours). Patient satisfaction was significantly higher in Groups II (9.1/10, p=2x10^{-12}) and III (9.3/10, p=3x10^{-7}) compared to Group I (6.5/10).

Conclusions: By educating families pre-operatively and standardizing portions of post-operative care in PSF for AIS, pain scores were significantly reduced while satisfaction remained high. Specifically, by removing the epidural and Foley catheters on postop-day 2, time to discharge was dramatically decreased by 15 hours of hospital stay.

Significance: The application of a multidisciplinary, evidence-driven CareMap for AIS patients undergoing PSF improves throughput and has beneficial effects on objective and patient-reported outcomes.

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Classification of Early Onset Scoliosis has Almost Perfect Inter and Intra Observer Reliability

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Purpose: To evaluate the inter-observer and intra-observer reliability of the Classification of Early Onset Scoliosis (C-EOS).

Methods: After institutional review board approval, a set of 50 patient cases was drawn from a prospectively collected database of patients with early onset scoliosis (EOS). Cases were selected using a stratified randomization scheme based on etiology. These cases were used to create an internet survey that was sent to faculty, research coordinators, and fellows involved in EOS care and research. Participants were asked to classify each case based on the C-EOS scheme and were provided with a written C-EOS scheme which could be referenced while they completed the survey. Surveys were sent to participants twice, 3 weeks apart, so both intra-observer and inter-observer reliability could be assessed. A 10 case pilot survey was used to power the project and determined 50 cases were needed for sufficient statistical significance. Fleiss Kappa and Cohen's Kappa were used to assess inter-observer and intra-observer reliability, respectively.

Results: There were 36 total participants, 29 who completed the survey twice (21 faculty members, 13 research coordinators, and 2 fellows). The overall Fleiss Kappa coefficient for inter-observer reliability was almost perfect across the major categories of etiology (0.84), Cobb angle (0.93), and kyphosis angle (0.96). Similarly overall intra-observer reliability was almost perfect with Cohen's kappa values for etiology (0.92), Cobb angle (0.96), and kyphosis angle (0.98). Faculty members showed almost perfect agreement across the 3 major categories of etiology (0.90), Cobb angle (0.91), and kyphosis angle (0.96). Research coordinators also showed almost perfect levels of agreement for Cobb angle (0.95) and kyphosis angle (0.96). The kappa value for etiology among research coordinators was 0.78 which constitutes substantial agreement. Intra-observer reliability was almost perfect across all major categories for all groups: faculty, research coordinators, and fellows.

Conclusion: The study shows high levels of inter-observer and intra-observer agreement of the C-EOS across all the major categories both overall, and when broken down by clinical role.

Significance: The C-EOS scheme can be used as a reliable tool for classifying EOS patients and can assist with group classification for communication between providers and clinical research.

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Anatomy of The Learning Curve in Adolescent Idiopathic Scoliosis

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Purpose: A recent study demonstrated better outcomes in AIS surgery for experienced surgeons compared to those with less experience. However, little data were presented on the pattern and timing of the learning curve. Were there a threshold number of years beyond which surgeons attained outcomes on par with other surgeons beyond that threshold? Or do surgeons continue to steadily improve with time?

Methods: A multicenter retrospective study using a prospectively collected database was performed. We analyzed only posterior fusion cases with a minimum of 2y follow-up. The analysis evaluated perioperative outcomes including estimated blood loss (EBL), surgical time, radiographic outcomes, and health-related quality of life (HRQOL) outcomes and analyzed these based on the number of years in practice of the operating surgeon. Thus for surgeon "A" who entered practice in the 2006-7 academic year, cases performed in 2009-2010 are analyzed as being performed by a surgeon with 4 years in practice.

Results: 862 cases performed by 17 surgeons were analyzed. The following outcomes were significantly correlated with the surgeon's number of years in practice: surgical time ($p<0.001$, correlation coef. = -0.493), EBL (<0.001, -0.156), cell saver usage (<0.001, -0.238). Not correlated were Cobb angle correction ($p=0.234$, correlation coef. =0.041) and SRS-24 scores ($p=0.394$, CC=0.030). For each outcome demonstrating a correlation, a linear and non-linear quadratic graph was constructed demonstrating gradually improving outcomes with increasing years-in-practice (see Figure).

Conclusion: Years in practice of the surgeon has a linear or near linear effect on various surgical outcomes in AIS surgery without demonstrating a plateau or threshold beyond which improvement ceases.

Significance: There does not seem to be distinct plateau beyond which surgeons reach their maximum outcomes. Surgery is a lifelong learning process for AIS practitioners.

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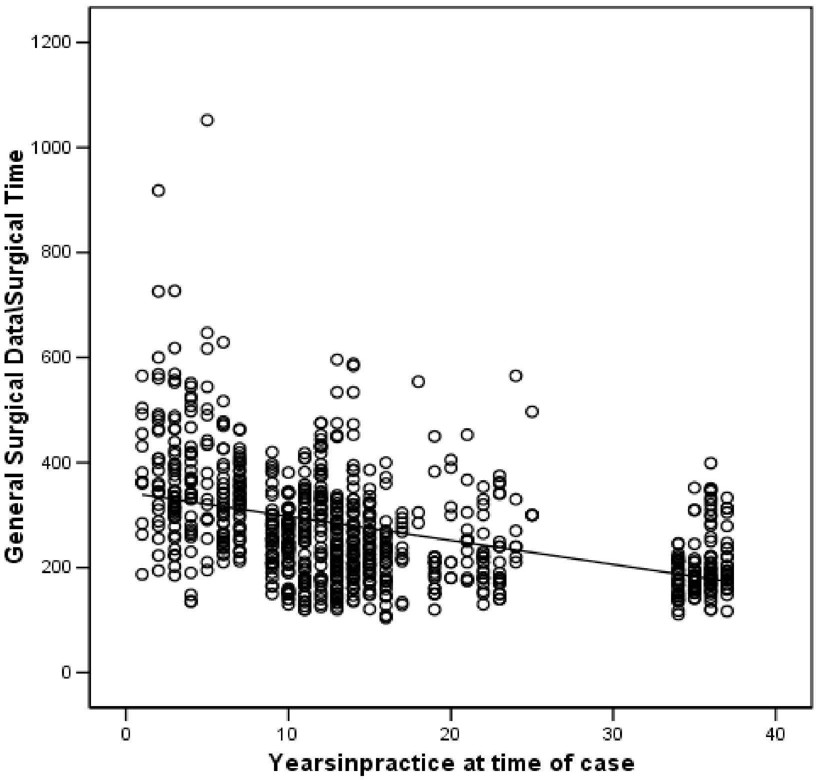

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Deficits Following Nonoperative Versus Operative Treatment of Shortened Midshaft Clavicular Fractures in Adolescents
Joshua A. Parry, MD; Meegan Van Straaten, MPH, PT; ***Annalise Noelle Larson, MD****; Anne-Laure Simon, MD; Tianyi David Luo, MD; Kenton R. Kaufman, PhD; William J. Shaughnessy, MD*

Mayo Clinic, Department of Orthopaedics, Rochester, MN

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Cam Deformity Is Associated with Posterior Hip Instability in Children and Adolescents – A Matched Study
Stephanie Watson Mayer, MD; Mary Katherine Hill, MS; Zhaoxing Pan, PhD; ***Eduardo N. Novais, MD***

Department of Orthopaedic Surgery, Children's Hospital Colorado – University of Colorado Anschutz Medical Campus, Aurora, CO

e-Poster #3 *(page 374)*
The Epidemiology and Demographics of Pediatric Supracondylar Humerus Fractures in New York State
Alexia Hernandez-Soria, MD; ***Emily Dodwell, MD, MPH****; Ting-Jung Pan, MPH; Stephen Lyman, PhD; Aaron Daluiski, MD*

Hospital for Special Surgery, New York, NY

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Abnormal Functional Responses of Osteoblasts to Leptin in Adolescent Idiopathic Scoliosis – Potential Implications on the Etiopathogenesis?
Elisa M.S. Tam, PhD; Shengping Tang; Kar-Hing Yeung; ***Tsz Ping Lam, MBBS, FRCS****; Bobby Kin Wah Ng, MD; Simon K.M. Lee; Yong Qiu; Jack C-Y Cheng, MD*

The Chinese University of Hong Kong

e-Poster #5 *(page 376)*
The Effect of Persistent Toe Walking on the Skeletal Development of the Foot and Ankle
Mark R. Sinclair, MD*; Allison Anne Lind, MN, MPH; Joshua Knowlton, MD, MPH; Michael H. Johnson, MD; Dorian Y. Reid, MD, MPH; Roshan T. Melvani, MD*

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Biotenodesis Screw Fixation of Tibialis Anterior Tendon Transfers in Pediatric Patients: Technique, Outcomes, and Complications

Jamie T. Frantz, MD; Joanna E. Foley, APN; Luciano Dias, MD; ***Vineeta T. Swaroop, MD***

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e-Poster #7 *(page 378)*

Assessment of Differences Regarding the Management of Pediatric Supracondylar Fractures Between Hand and Pediatric Orthopaedic Surgeons

Thao Nguyen, MD; Xuyang Song; Xiaomao Zhu, BA; ***Joshua M. Abzug, MD***

University of Maryland School of Medicine

e-Poster #8 *(page 379)*

Does Initial Cast Correction Predict Treatment Success For Infantile Scoliosis?

Jaime A. Gomez, MD*; Alexandra Grzywna, BS; Patricia Miller, MS; Lawrence I. Karlin, MD; John B. Emans, MD; Michael P. Glotzbecker, MD*

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e-Poster #9 *(page 380)*

Pediatric Spinal Deformity in the United States: Surgical Approach, Complications, and Hospital Charges from 1997 to 2012

Alan H. Daniels, MD; Hari Vigneswaran, BS; ***Craig P. Eberson, MD****; Mark A. Palumbo, MD*

Brown University, Alpert Medical School, Providence, Rhode Island

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Is Obesity Associated with Larger Curves in Adolescent Idiopathic Scoliosis and Worse Surgical Outcomes?

G. Ying Li, MD*; Laura C. Binkowski; Alexandra Grzywna, BA; Christopher B. Robbins, MPA, PhD; Michelle S. Caird, MD; Frances A. Farley, MD; Daniel J. Hedequist, MD; Michael P Glotzbecker, MD*

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VEPTR Versus Traditional Growing Rods: Preliminary Results From a Collaboration Between Two National Databases

Michael G. Vitale, MD, MPH*; Mark P. Sullivan Jr., BA; Evan P. Trupia, BS; Hiroko Matsumoto, PhDc; Sumeet Garg, MD; John (Jack) M. Flynn, MD; Peter F. Sturm, MD; Francisco Sanchez Perez-Grueso, MD; Children's Spine Study Group; Growing Spine Study Group; David P. Roye Jr., MD; David L. Skaggs, MD, MMM*

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Revision Surgery Rates After Primary Fusion For Adolescent Idiopathic Scoliosis
Bryan J. Tompkins, MD; *Paul M. Caskey, MD; William E. Bronson, MD; Joseph H. Dannenbaum IV, MD*

Shriners Hospitals for Children, Spokane, WA

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Reliability of X-Ray Based Evaluation of Pedicle Screw Misplacement in Adolescent Spinal Deformity
Saankyritya Ayan, MD, MBBS, MS; Beverly Thornhill, MD; Terry D. Amaral, MD; ***Jacob F. Schulz, MD***; *Vishal Sarwahi, MD*

Montefiore Medical Center, Bronx, NY

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Posterior Vertebral Column Resection in Pediatric Deformity: The Advantages of Staging
Firoz Miyanji, MD, FRCSC; *Sameer Desai, BS; Siddesh Doddabasappa, MBBS, MS*

British Columbia Children's Hospital, Vancouver, British Columbia, Canada

e-Poster #15 *(page 387)*
Postoperative Pain Management After Surgical Hip Dislocation For The Treatment of Femoroacetabular Impingement in Adolescents
Eduardo N. Novais, MD; *Lauryn A. Kestel, BS; Patrick M. Carry, BA; Kim M. Strupp, MD*

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Predictive Factors of Osteonecrosis of the Femoral Head After Closed Reduction for Treatment of Developmental Dysplasia of The Hip
Eduardo N. Novais, MD; *Meredith Mayo, MD; Julie Ma, BA; Zhaoxing Pan, PhD; Gaia Georgopoulos, MD*

Children's Hospital Colorado, Aurora, CO

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Safety Profile of Three Guided Growth Implants: Body Weight Correlates with Implant Failure
Yong-Woon Shin, MD, PhD; Tyler J. Uppstrom, BA; Samir K. Trehan, MD; Roger F. Widmann, MD; ***Daniel W. Green, MD***

Hospital for Special Surgery, New York, NY

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Clinical Significance of The Effect of A Six-Months Schroth Exercise Intervention in Adolescents with Idiopathic Scoliosis
Sanja Schreiber PhD; Eric Parent, PT, PhD; ***Douglas M. Hedden, MD***; *Marc J. Moreau, MD, FRSC(C)*

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Percutaneous Subtrochanteric Valgus Osteotomy For Painful Dislocated Hips in Patients with Cerebral Palsy

Maximilian Martinez, MS; ***Sanjeev Sabharwal, MD, MPH***

Rutgers – New Jersey Medical School, Newark, NJ

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Conservative Treatment of Idiopathic Clubfoot: A Two-Institutional Retrospective Review

Nancy Hadley Miller, MD*; Patrick M. Carry, BA; Bryan Mark, BA; Glenn H. Engelman, BA; Susan Graham, PA-C; Matthew B. Dobbs, MD*

Children's Hospital Colorado, Aurora, CO

e-Poster #21 *(page 395)*

Are All Metals The Same? Developing An In Vivo Model of Post-Operative Spinal Implant Infection and Employing It to Assess Susceptibility of Different Metals

Anthony A. Scaduto, MD; ***Nicholas Bernthal, MD****; Alexandra Stavrakis, MD; Amanda Loftin; Trevor Scott, MD; Elizabeth Lord, MD*

Orthopaedic Institute for Children/UCLA, Los Angeles, California

e-Poster #22 *(page 397)*

Radiation Safety Training Results in Reduced Radiation Exposure For Orthopaedic Residents When Using The Mini C – Arm

David Gendelberg, MD; ***William L. Hennrikus Jr., MD****; Douglas G. Armstrong, MD; Jennifer Slough, BS*

Penn State College of Medicine, Hershey, PA

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Serial Casting For Infantile Idiopathic Scoliosis: When Can A Cure Be Achieved?

Daniel J. Sucato, MD, MS*; Dong-Phuong Tran, MS; Anna McClung, RN*

Texas Scottish Rite Hospital for Children, Dallas, Texas

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The Predictive Value of Drain Tube Tip Culture Results For Spine Infection Following Posterior Spinal Fusion Surgery

Viral V. Jain, MD*; Sunil Agarwal; Johan Forslund, MS, BS; Jennifer M. Anadio, MA; Peter F. Sturm, MD; Alvin Howell Crawford, MD*

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Vertebral Fractures in Duchene's Muscular Dystrophy Patients Managed with Deflazacort
Amardeep Singh, MBBS, MS(Ortho); ***Christopher W. Reilly, MD, FRCSC***
BC Children's Institute, Vancouver, BC, CANADA

e-Poster #26 *(page 402)*
The Optimal Surgical Approach for Lenke 5 Curves: Is the Anterior Approach Ready for a Comeback?
Firoz Miyanji, MD*; Tracey P. Bastrom, MA; Amer Samdani, MD; Burt Yaszay, MD; Jahangir Asghar, MD; Suken A. Shah, MD; Randal R. Betz, MD; Harry L. Shufflebarger, MD; Peter O. Newton, MD*
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Pediatric Cervical Fractures with Associated Spinal Cord Injury: Epidemiology, Costs, and in-Hospital Mortality in 4418 Children
Amit Jain, MD; Jaysson T. Brooks, MD; Sandesh Rao, MD; ***Paul D. Sponseller, MD***
Johns Hopkins Orthopaedic Surgery, Baltimore, MD

e-Poster #28 *(page 405)*
Flexible Growing Rods: Polymer Rod Constructs May Provide Stability to Skeletally Immature Spines
Donita Bylski-Austrow, PhD; David Glos, BS; Anne C. Bonifas; Max F. De Carvalho Sr, PhD, MD; Matthew T. Coombs, MS; ***Peter F. Sturm, MD***
Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio

e-Poster #29 *(page 406)*
Choosing Distal Instrumentation Level in Growing Rod Surgery – Where to Stop?
Senol Bekmez, MD; Gokhan Halil Demirkiran, MD; ***Ozgur Dede, MD****; Peter F. Sturm, MD; Muharrem Yazici, MD*
Hacettepe University Hospitals, Ankara, Turkey
Cincinnati Children's Hospital Medical Center, Cincinnati OH

e-Poster #30 *(page 407)*
Abnormal Vascular Examination Predicts Poorer Outcomes in Supracondylar Humerus Fractures: A Prospective Study
Justin J. Ernat, MD; ***Anthony Riccio, MD****; Robert Lane Wimberly, MD; David A. Podeszwa, MD; William Taylor Gheen, BA; Christine Ann Ho, MD*
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The Implication of Fracture Location on Bone Health in Children
Daniel M. Dean, BS; Rachel E. Mednick, MD; ***Joseph A Janicki, MD***
Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

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Under Pressure: The Utility of Splitting Fiberglass Casts
Kevin Kleis, DO; ***John Schlechter, DO****; Joshua Doan, MEng;*
Christine L Farnsworth, MS; Eric William Edmonds, MD
Division of Orthopedics, Rady Children's Hospital-San Diego, San Diego, California

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Pediatric Motocross Injuries At An Annual Elite Competition: Rates and Severity
James P. McFadden, MD; Brendan A. Williams, MD; Tyler L. Teurlings;
Laurel C. Blakemore, MD
University of Florida, Department of Orthopaedics and Rehabilitation, Gainesville, FL

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Operative Versus Conservative Management of Displaced Tibial Shaft Fractures in Adolescents
Matthew C. Kinney, MD; David Nagle, BA; Tracey P. Bastrom, MA; Michael S. Linn, MD;
Alexandra K. Schwartz, MD; ***Andrew Pennock, MD***
Rady Children's Hospital, San Diego, CA

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Surgical Hip Dislocation for the Treatment of Traumatic Posterior Hip Dislocation in Children
Eduardo N. Novais, MD*; Travis C. Heare, MD; Mary K. Hill, BA; Stephanie W. Mayer, MD*
Children's Hospital Colorado, Aurora, CO

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Incidence of Humeral Lateral Condyle Fractures Nonunion in Children
Lior Shabtai, MD*; Alexandre Arkader, MD; Alexander M. Broom; Ted Sousa, MD;*
James Lee Pace, MD
Children's Hospital Los Angeles, Los Angeles, CA

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Change in the Epidemiology of Slipped Capital Femoral Epiphysis From 1985 to 2010
Eduardo N. Novais, MD*; Adam Nasreddine, BS, MA; Michael B. Millis, MD;*
Yi-Meng Yen, MD, PhD
Children's Hospital Boston, Boston, MA

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Knee Arthroscopy Rates in Children, Adolescents, and Adults: A Comparison of Insurance Records Between Two States

John C. Jacobs Jr., BS; Noah Archibald-Seiffer; Itai Gans, MD; Jacob R. Butts, BA; ***Theodore J. Ganley, MD****; Aaron Smith-McLallen; Somesh Nigam; Kevin G. Shea, MD*

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Children's Hospital of Philadelphia, Philadelphia, PA

e-Poster #39 *(page 416)*

Presentation of Adolescent Idiopathic Scoliosis: The Bigger The Kid, The Bigger The Curve

Christine M. Goodbody, BA; Wudbhav N. Sankar, MD; ***John (Jack) M. Flynn, MD***

Children's Hospital of Philadelphia, Philadelphia, PA

e-Poster #40 *(page 417)*

Does The "Law of Diminishing Returns" Apply For Growing Rod Surgery After Seven Lengthenings?

Howard Y. Park, MD; Alexander M. Broom, BA; Lindsay M. Andras, MD; ***David L. Skaggs, MD, MMM****; Growing Spine Study Group*

Children's Hospital Los Angeles, Los Angeles, CA

e-Poster #41 *(page 418)*

A Novel Method for Improved Biologic Environment in ACL Reconstruction in Young Athletes

Paul R. Fleissner, MD

Crystal Clinic Orthopedic Center, Akron, Ohio

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Internal Rotation Stress Testing Improves Radiographic Outcomes of Type 3 Supracondylar Humerus Fractures

Jennifer Marie Bauer, MD; Jonathan G. Schoenecker, MD, PhD; Christopher M. Stutz, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD***

Vanderbilt Children's Hospital, Nashville, TN

e-Poster #43 *(page 420)*

Is Acetabular Rim Trimming Safe and Effective For Idiopathic Femoroacetabular Impingement in The Adolescent Patient?

Kevin Smit, MD*; Adriana De La Rocha, MS; David A Podeszwa, MD; Daniel J. Sucato, MD, MS*

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Pelvic Shielding is Ineffective in Pediatric Pelvic Radiographs
Mark Tsu Chong Lee, MD; *Matthew J. Solomito, MS; Jessica R. Lloyd, BSBE; Erin J. Garibay, MS*

Connecticut Childrens Medical Center, Hartford, CT

e-Poster #45 *(page 422)*
Predicting Mrsa Osteomyelitis Based on Clinical Parameters – The Atlanta Experience
Jill C. Flanagan, MD; *Kalyn M. Conner BS; Kristen-Kaye Goulbourne MD; Mackenzie M. Herzog, MPH*

Children's Healthcare of Atlanta/Children's Orthopaedics of Atlanta, Atlanta, GA

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Donald B. Franklin, MD; *Byron F. Stephens, II, MD; Richard A. Smith, PhD; James H. Beaty, MD; David D. Spence, MD; Derek M. Kelly, MD; Jeffrey R. Sawyer, MD; William C. Warner Jr., MD*

University of Tennessee-Campbell Clinic Department of Orthopaedic Surgery, Memphis, TN

e-Poster #47 *(page 424)*
The Effect of Foot Alignment on Ankle Power in Children with Cerebral Palsy
David M. Scher, MD; *Paz Kedem, MD; Lisa Drefus, PT, DPT; Jayme Carolynn Burket, PhD*

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Functional and Radiographic Outcomes of Adductor Myotomy in Patients with Spastic Cerebral Palsy
Alejandro Marquez-Lara, MD; ***Vineeta Swaroop, MD***; *Luciano S. Dias, MD*

Rehabilitation Institute of Chicago, Chicago, IL

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O2 Cost and Walking Speed in Youth with Cerebral Palsy
Nancy Lennon, MS, PT; ***Julieanne P. Sees, DO***; *Maria Fragala-Pinkham, DPT; Chris Church, PT; Margaret E. O'Neil, PhD, PT, MPH; Freeman Miller, MD*

Nemours A. I. duPont Hospital for Children, Wilmington, DE

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Does Patellar Position Change with Growth After Patellar Tendon Advancement in Children with Cerebral Palsy?
Claire Beimesch, MD; *Ranjit A. Varghese, MD; Jean L. Stout, PT; Michael H. Schwartz, PhD; Tom F. Novacheck, MD*

Gillette Children's Specialty Healthcare, Saint Paul, MN

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Parental Perception of Quality of Gait in Children with Spastic Diplegia
Ashley Erdman, BS, MBA; Kelly Jeans, MSc; ***Lori A. Karol, MD***

Texas Scottish Rite Hospital for Children, Dallas, TX

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

Lexington Shriners Hospital for Children, Lexington, KY

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The Coagulation Profile During Scoliosis Surgery in Adolescent Idiopathic Patients
Patrick Bosch, MD*; Antonio Cassara, MD; James D. Cooper, MD, MSc;*
Tanya Kenkre, PhD, MPH; Joanne A. Londino, RN

Children's Hospital of Pittsburgh of University of Pittsburgh Medical Center, Pittsburgh, PA

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Michael J. Heffernan, MD*; Rachel Y. Goldstein, MD, MPH; Michael G. Vitale, MD, MPH;*
Lawrence G. Lenke, MD; Lindsay M. Andras, MD; David L. Skaggs, MD, MMM

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Rib Penetration in Children with Neurofibromatosis and Scoliosis
Scott P. Kaiser, MD*; Sunitha V. Kaiser, MD, MSc; Patricia C. Parkin, MD, FRCPC;*
Reinhard D. Zeller, MD, DSc, FRCSC

Hospital for Sick Children, Toronto, Ontario, Canada

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Posterolateral Diskectomies As Alternative to Anterior Posterior Spinal Fusion in Children with Severe Spinal Deformities
Hamid Hassanzadeh, MD; Amit Jain, MD; Emmanuel Nganku Menga, MD;
Paul D. Sponseller, MD

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◆ Is There A Relationship Between Lengthening Intervals and Rod Fracture in Traditional Growing Rod Surgery For The Treatment of Early Onset Scoliosis?
Pooria Hosseini, MD, MSc; Jeff Pawelek; Stacie Nguyen, MPH; George H. Thompson, MD; Suken A. Shah, MD; John (Jack) M. Flynn, MD; John P. Dormans, MD; ***Behrooz A. Akbarnia, MD****; Growing Spine Study Group*
San Diego Center for Spinal Disorders, San Diego, CA

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Scoliosis School Screening: Analysis of The Cincinnati Metropolitan Statistical Area
Charles T. Mehlman, DO*; Kaitlyn A. Brennan MPH; Alexandria J. Greenler BS; Progga Das BS, MPH*
Cincinnati Children's Hospital Medical Center, Cincinnati, OH

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The Effects of Proximal Hooks Versus Screws on Shoulder Balance in PSIF
John A. Heflin, MD; ***Michelle C. Welborn, MD****; Jessica V. Morgan; John T. Smith, MD*
University of Utah, Salt Lake City, UT

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Does the "Law of Diminishing Returns" Apply to Guided Growth Shilla Constructs?
Lindsay M. Andras, MD*; Haleh Badkoobehi, MD; Alexander M. Broom; Frances L. McCullough, RNP, MNSc; Richard E. McCarthy, MD; David L. Skaggs, MD, MMM; Growing Spine Study Group*
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Smaller Patients Lose A Greater Proportion of Their Blood Volume During Posterior Spinal Arthrodesis
Amit Jain, MD; ***Paul D. Sponseller, MD****; Peter O. Newton, MD; Suken A. Shah, MD; Patrick John Cahill, MD; Randal R. Betz, MD; Amer Samdani, MD; Tracey Bastrom, MA; Michelle Marks, NMD; Harms Study Group*
Johns Hopkins Orthopaedic Surgery, Baltimore, MD

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There is Variability of Patient Standing Position in Operative Adolescent Idiopathic Scoliosis (Ais) Patients: A Motion Capture Analysis
David M. Robertson, BS; James Carollo, PhD; Cameron R. Niswander, BA; ***Sumeet Garg, MD***
Children's Hospital Colorado, Aurora, CO

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e-Poster #63 *(page 443)*

Temporary Intraoperative Instrumentation of Lowest Instrumented Vertebra + 1: A Novel Technique to Help Minimize Extent of Arthrodesis in Scoliosis

Firoz Miyanji, MD*; Burt Yaszay, MD; Christopher W. Reilly, MD; Jahangir Asghar, MD; Patrick John Cahill, MD; Amer F. Samdani, MD*

British Columbia Children's Hospital, British Columbia, Vancouver, Canada

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◆ Safety and Efficacy of Apical Resection Following Growth Friendly Instrumentation in Myelomeningocele Patients with Gibbus: Growing Rod Vs. Luque-Trolley

Can Emre Bas, MD; Gokhan Halil Demirkiran, MD; Jonathan Preminger, BA; ***Paul D. Sponseller, MD****; Muharrem Yazici, MD; Growing Spine Study Group*

Hacettepe University Faculty of Medicine, Orthopedics and Traumatology Department, Ankara Turkey

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Factors Associated with Non-Accidental Trauma Evaluation Among Patients <36 Months Old Presenting with Femur Fractures

Matthew E. Oetgen, MD*; Arielle Katcher, BS; Allison M. Blatz, BA; Catherine W. Gillespie, MPH, PhD; Allison Matthews, MSCR; Megan Young, MD*

Children's National Medical Center, Washington, DC

e-Poster #66 *(page 448)*

Nerve Injury Predicts Worse Functional Outcomes in Supracondylar Humerus Fractures: A Prospective Study

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

Texas Scottish Rite Hospital for Children, Dallas, TX

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Efficacy and Safety of Percutaneous Reduction and Sacroiliac Screw Placement with a Pelvic Reduction Frame: A Review at a Single Institution

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Treatment Outcomes After Pathologic Femoral Diaphyseal Fractures in Non-Ambulant Children

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Boston Children's Hospital, Boston, MA

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David A. Muzykewicz, MD; Katie Fields MSN; CPNP; John F. Munch MPA; Jerry R. Dwek, MD; ***Scott J. Mubarak, MD***

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Bryce A. Basques, BS; Nicholas Golinvaux, BA; Daniel D. Bohl, MPH; ***Brian G. Smith, MD****; Jonathan N. Grauer, MD*

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Andrew Z. Mo, BS; Anthony O. Asemota, MBBS, MPH; Arun Venkatesan, MD, PhD; Eva K. Ritzl, MD; Dolores B. Njoku; ***Paul D. Sponseller, MD, MBA***

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Anny Hsu, MD; Hiroko Matsumoto, PhDc; Mark P. Sullivan Jr., BA; Evan P. Trupia, BS; Benjamin D. Roye, MD, MPH; David P. Roye, MD; ***Michael G. Vitale, MD, MPH***

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Jaysson T. Brooks, MD; Amit Jain, MD; Francisco Sanchez Perez-Grueso MD; David L. Skaggs, MD, MMM; George H. Thompson, MD; Behrooz A. Akbarnia, MD; ***Paul D. Sponseller, MD****; Growing Spine Study Group*

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Shawn S. Funk, MD; Steven A. Lovejoy, MD; Gregory A. Mencio, MD; ***Jeffrey E. Martus, MD***

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Matthew Oetgen, MD*; Shannon McClure Kelly, MD; Jeffrey L. Hanway, MD; Benjamin Donahue Martin, MD; John Fletcher Lovejoy, MD; Allison Matthews, MS; Laurel C. Blakemore, MD*

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Christopher N. Carender BS; William Z. Morris, MD; Connie Poe-Kochert, RN, CNP; George H. Thompson, MD; Jochen P. Son-Hing, MD; ***Raymond W. Liu, MD***

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

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Dane Todd, MD; Alexander D. Ghasem MD; ***Nicholas D. Fletcher, MD****; John W. Xerogeanes, MD*
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Martin J. Herman, MD*; Alexa J. Karkenny, MD; Conor Russell, BS; Justin K. Williams, BS*

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Deficits Following Nonoperative Versus Operative Treatment of Shortened Midshaft Clavicular Fractures in Adolescents

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Purpose: We sought to determine whether functional deficits are found in adolescents following operative versus nonoperative treatment of clavicle fractures.

Methods: Patients with displaced and shortened midshaft clavicle fractures between the age of ten and sixteen years at the time of injury were recruited. Exclusion criteria included concomitant upper extremity injuries or other deficits that would affect biomechanical strength testing. Consenting subjects completed a QuickDASH Score, Constant Shoulder Score, and questions regarding their satisfaction with treatment. Quantitative isometric strength testing, range of motion, and abduction endurance was performed on the involved and uninvolved side for bilateral comparison.

Results: Sixteen patients (eleven boys, five girls) met inclusion criteria and consented to testing. Eight received non-operative treatment and eight underwent open reduction and internal plate fixation. Mean time from injury was 21±9 months. Mean fracture shortening was 25±6 mm. The treatment groups did not differ in terms of time from injury (p=0.5) or fracture shortening (p=0.8). The operative group tended to be older (15 versus 13 years, p=0.09). QuickDASH and Constant Shoulder Scores were zero in all but one patient in the operative group who was actively complaining of symptomatic hardware. Two patients treated with plate fixation required hardware removal. There were no symptomatic malunions in the nonoperative group. All subjects reported being satisfied with their received treatment. Four patients (three in operative group and one in the nonoperative group) were dissatisfied with the appearance of the clavicle. All patients had full symmetric range of motion. The involved side's isometric strength and abduction endurance did not differ from the uninvolved side in either treatment group (Table 1) or between treatment groups (Table 2).

Conclusions: We found no differences in patient-based outcome scores, isometric shoulder strength, abduction endurance, and range of motion between treatment groups.

Significance: Adolescents with shortened midshaft clavicular fractures have uniformly good outcomes with either operative or nonoperative treatment.

See pages 21- 66 for financial disclosure information.

Table 1: Mean (±SD) of strength and endurance testing data expressed as a percent of uninvolved side.

Nonoperative Group (n=8)	**Involved Side**	**Uninvolved Side**	**P-value**
Abduction peak force	106% ± 12	100%	0.43
Internal rotation peak force	111% ± 18	100%	0.31
External rotation peak force	104% ± 9	100%	0.62
Post-fatigue abduction MVC *(% of pre-fatigue value)*	91% ± 41	100%	0.84
Operative Group (n=8)			
Abduction peak force	96% ± 18	100%	0.68
Internal rotation peak force	107% ± 21	100%	0.81
External rotation peak force	94% ± 16	100%	0.37
Post-fatigue abduction MVC *(% of pre-fatigue value)*	116% ± 32	100%	0.31

Table 2: Mean (±SD) of strength and endurance data expressed as a percent of uninvolved side compared between treatment groups.

	Nonoperative (n=8)	**Operative (n=8)**	**P-value**
Abduction peak force	106% ± 12	96% ± 18	0.32
Internal rotation peak force	111% ± 18	107% ± 21	0.74
External rotation peak force	104% ± 9	94% ± 16	0.25
Post-fatigue abduction MVC *(% of pre-fatigue MVC)*	91% ± 41	116% ± 32	0.32

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Cam Deformity Is Associated with Posterior Hip Instability in Children and Adolescents – A Matched Study

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Purpose: Cam-type femoroacetabular impingement (FAI) has been associated with posterior hip instability in adults. Our hypothesis was that children and adolescents with posterior hip dislocation related to sports injury would have a Cam deformity of the proximal femur similar to skeletally mature patients.

Methods: Following IRB approval we identified 14 patients (13 males, 1 female; mean age 12.6; range 7.7-16.2) who sustained a sports related posterior hip dislocation and underwent a computed tomography (CT) scan after closed reduction. For each patient, three age and gender matched healthy controls were identified from a pool of patients undergoing a pelvic CT scan for evaluation of abdominal pain. CT scans were reformatted into radially planes rotated around the femoral neck axis. Femoral head-neck morphology was assessed by measurement of the alpha angle using a clock-face system on the radial cuts at the 12-o'clock (superior); 1-o'clock (superior-anterior); 2-o'clock (anterior-superior) and 3-o'clock (anterior) positions. Alpha angle at each position on the involved hip in the dislocation group was compared with the matched controls using a mixed effects model. A logistic regression analysis using generalized estimating equation was used to compare the percentage of subjects with Cam-FAI defined as alpha angle greater than 50^{o} in each group.

Results: The mean alpha angles were statistically significantly higher in the dislocation cohort at each position along the femoral head-neck junction (Table 1). The average differences between the dislocation group and controls were 3.0°, 3.8°, 5.2°, and 3.9° at the 12-o'clock through the 3-o'clock positions respectively. Cam-deformity at the 1-o'clock (superior-anterior) position was present in 21.4% of the dislocation group and 2.4% of the controls (P=0.055). At the 2-o'clock (anterior-superior) position, a Cam-deformity was found in 65% of the dislocation group compared to 36% of the control group (P=0.0003)

Conclusion: This retrospective matched study found a higher mean value of alpha angle from the superior to the anterior regions of the femoral head and neck junction in children and adolescents who sustained posterior hip dislocation secondary to sports injuries. Further studies are necessary to evaluate whether recognizing and treating the underlying Cam impingement should be recommended at the time of surgical treatment of posterior hip instability in children and adolescents.

Significance: Abnormal hip morphology associated with Cam FAI may contribute to the mechanism of posterior hip instability in low-energy injury secondary to sports activity in children and adolescents. This should be taken into consideration when surgical treatment is recommended.

See pages 21- 66 for financial disclosure information.

Level of evidence: Level 3 retrospective comparative study

Table 1 – Alpha angle measurements between a cohort of skeletally immature patients and a matched control group

Alpha Angle	Traumatic Dislocation	Controls	P-value
Superior	43.4° (35° to 48°)	40.4° (32° to 51°)	0.004
Superior-anterior	47.0° (39° to 53°)	43.2° (34° to 54°)	0.001
Anterior-superior	52.7° (42° to 70°)	47.6° (38° to 57°)	0.001
Anterior	48.8° (34° to 65°)	44.9° (32° to 55°)	0.009

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The Epidemiology and Demographics of Pediatric Supracondylar Humerus Fractures in New York State

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Purpose: Supracondylar humerus fractures (SCHF) are the most common elbow fractures in children, although the true incidence is not known. The purpose of this study was to define the incidence of complications and reoperation following the surgical treatment of SCHF in children. We hypothesized that surgeons who treat a higher volume of pediatric SCHF may have lower reoperation and complication rates.

Methods: The SPARCS database (a census of New York State hospital admissions and ambulatory surgical procedures) was used to identify all SCHF in patients less than 16 years old treated in New York State between 1997 and 2009. The first admission for each patient with a SCHF was considered the index procedure. The surgeon's license number for the primary attending surgeon is also recorded allowing calculation of surgeon volume. Patient complication and reoperation records were identified. These included Volkmann's contracture, compartment syndrome, peripheral nerve injury, claw hand, wrist drop, cellulitis, osteomyelitis, median nerve palsy, radial nerve palsy and ulnar nerve palsy. Multivariate logistic regression analysis was used to evaluate the association of surgeon volume with the likelihood of complications and reoperation.

Results: 25,872 patients were admitted for SCHF between 1997 and 2010. The mean age was 6.6 ±4.1y. 57.4% were male and 43% were female. Within one year of initial diagnosis 71(0.3%) were admitted for a Volkmann's ischemic contracture, 43 (0.2%) for cellulitis or osteomyelitis, 10 (0.1%) for a nerve palsy and 923 (3.6%) underwent a reoperation. Of the 923 patients who underwent reoperation within 1 year, 773 (83.8%) were treated by a low volume surgeons (<6 cases/year) and 150 (16.3%) by a high volume surgeons (>6 cases/year). Patients treated by high volume surgeons had a lower risk of reoperation than patients treated by low volume surgeons (OR 0.61; 95%CI [0.51, 0.73]; p<0.001).

Conclusion: Patients treated by high volume surgeons have a lower risk of reoperation compared to those treated by a lower volume surgeon. Despite limitations inherent in the database model, the overall rate of complications and reoperations is comparable to the current literature.

Significance: Further study is required to identify the specific factors that contribute to the higher reoperation rates such as patient co-morbidities, fracture complexity and surgeon characteristics (e.g. fellowship training, years in practice, practice setting, etc.).

See pages 21- 66 for financial disclosure information.

Abnormal Functional Responses of Osteoblasts to Leptin in Adolescent Idiopathic Scoliosis – Potential Implications on the Etiopathogenesis?

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Bobby Kin Wah Ng, MD; Simon K.M. Lee; Yong Qiu; Jack C-Y Cheng, MD
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Purpose: Leptin have important regulatory and modulatory functions in neuro-osseous development affecting skeletal growth, onset of puberty, energy expenditure and body composition. Recent studies have shown the association of abnormal leptin bioavailability with abnormal bone mass, bone microarchitecture and bone strength in AIS, suggesting possible abnormalities in leptin regulated bone metabolic pathways which could play a significant role in the etiopathogenesis and progression of AIS. This study aimed to investigate the effect of leptin on the functional responses of osteoblasts cultured from bone biopsies obtained intra-operatively from AIS girls Vs that from normal controls.

Methods: Standard *in vitro* assays were performed with osteoblasts isolated from fresh bone biopsies obtained intra-operatively from 12 severe Chinese AIS girls undergoing posterior instrumentation and fusion, and 6 controls undergoing other elective orthopaedic procedures. The osteoblasts were exposed to four leptin concentrations (0, 10, 100, 1000 ng/ml). Effects of leptin on osteoblast cell proliferation were evaluated with MTT assay after 3 days of leptin treatment; differentiation with ALP activity assay after 6 and 14 days, and with osteocalcin secretion during culture; and mineralization with von Kossa staining after 21 and 35 days.

Results: Baseline comparison showed lower differentiation and mineralization potentials in the osteoblasts from AIS group. For functional responses to leptin, control group showed increasing proliferative response to leptin in a dose dependent manner ($p=0.008$), while AIS group showed no response to leptin ($p=0.962$). For differentiation, control group showed increase in ALP activity (Day 6: $p=0.012$; Day 14: $p=0.017$) and osteocalcin secretion (Day 35: $p=0.007$) to increasing leptin concentrations, in contrast to be absence of response in AIS group ($p>0.05$). For mineralization, control group showed an increasing trend to increasing leptin concentrations ($p=0.002$), and again no trend was observed in AIS group ($p=0.305$).

Conclusion: Results in this pilot study suggested that the osteoblasts isolated from AIS girls had significantly lower differentiation and mineralization potentials, as well as abnormally low functional responses to leptin at both physiological and pharmacological dosage when compared with controls. These decrease in functional responses might due to dysfunction of leptin signaling pathway, resulting from abnormalities in the leptin receptor or downstream intermediate signaling factors and molecules.

Significance: This is the first direct study showing abnormal functional osteoblast from AIS patients. The important findings could provide new directions for studies that might help to explain the low bone mass and deranged bone quality observed in a significant percentage of AIS patients.

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The Effect of Persistent Toe Walking on the Skeletal Development of the Foot and Ankle

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Purpose: The purpose of this study is to determine if persistent habitual toe walking leads to compensatory skeletal changes in the pediatric foot and ankle.

Methods: An IRB-approved retrospective review of twenty-two idiopathic toe walkers and twenty-two sex and age matched controls was performed. Individuals were excluded if they did not have bilateral weight bearing foot films, were older than 18 years of age or had an associated medical condition. Four blinded orthopedic providers and a pediatric radiologist independently assessed the anonymized foot radiographs for the presence or absence of four radiographic changes: loss of roundness to the talar dome, loss of anterior recess to the talus, widening of the talar neck and widening of the anterior distal tibial physis. Each again reviewed the films greater than three weeks later. If 4 out of the 5 providers saw a radiographic change on both reads, the group considered it present. If fewer than 4 providers saw a radiographic change, it was classified as absent. Chi-square and Fisher's exact tests were used to determine statistical significance. Mann-Whitney tests were used to compare foot angles between toe walkers and non-toe walkers.

Results: Thirty males (68%) and fourteen females (32%) with a mean age of 8.7 years (range 6-14 years) were included. Intra-reader agreement was high for all talar changes (kappa 0.63-0.96). The likelihood of seeing radiographic changes varied across measurements. In 30% of toe walkers a loss of roundness to the talar dome was seen in comparison to 0% of non-toe walkers ($p < 0.001$). 66% of toe walkers had a loss of anterior recess of the talus, compared to only 2% in non-toe walkers ($p<0.001$). 75% of toe walkers had a widened talar neck while only 5% of non-toe walkers had this finding ($p<0.001$). There was no difference in the presence of a widened anterior tibial physis or of continuous foot angles between toe walkers and non-toe walkers.

Conclusion: In this study, providers were able to see skeletal changes of the talus in idiopathic toe walkers compared to sex and age matched controls, suggesting that persistent toe walking impacts the skeletal development of the talus.

Significance: This is the first study to look at the skeletal impact of persistent toe walking. Skeletal changes of the talus need to be considered in clinical decision making for idiopathic toe walkers.

See pages 21- 66 for financial disclosure information.

Biotenodesis Screw Fixation of Tibialis Anterior Tendon Transfers in Pediatric Patients: Technique, Outcomes, and Complications

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Purpose: Abnormal function of the anterior tibialis tendon can cause foot pain, callous, skin breakdown, difficulty with shoe wear, and gait disturbances. When surgical treatment is indicated, tibialis anterior tendon transfer (TATT) is commonly performed. Traditional fixation methods have employed suture fixation of the transferred tendon to periosteum, through bone tunnels, or over a button on the plantar aspect of the foot. Complications of suture fixation include neurovascular injury, pressure ulcers, infection, and early loss of fixation. Biotenodesis screw fixation has gained popularity in both upper and lower extremities in the adult population. Our goal was to describe biotenodesis screw fixation in TATT in a pediatric population, assess the outcomes, and evaluate for complications.

Methods: Retrospective chart review identified all patients who underwent TATT with biotenodesis screw fixation at a single institution from 2008-2011. Demographic and clinical data included diagnosis, preoperative foot deformity, previous interventions, concomitant procedures, postoperative protocol, tibialis anterior tendon function, and postoperative foot deformity. Complications were noted including wound healing, infection, screw extrusion, loss of fixation, and recurrence of deformity.

Results: 21 children (32 feet) were identified, including 11 males (7 bilateral) and 10 females (4 bilateral). Preoperative diagnoses included cerebral palsy, chromosomal abnormality, collagen deficiency, clubfoot, spinal cord injury, tethered cord, and spinal muscular atrophy. Average age at surgery was 11.5 years (4-24 years), with average follow-up of 3.7 years (0.4 to 5 years). 91% had >2 years follow up. Using the Kling scale to assess the clinical outcome of patients with underlying neuromuscular etiology, there were 16 excellent, 8 good, and 3 poor. 92% of the 13 patients with pre- and post-operative muscle testing lost at most one half grade in the transferred tendon. 2 (6.3%) complications were identified related to the TATT: one partial screw extrusion at 3.5 months without loss of fixation, one local swelling at 2.5 months. There were no cases of loss of fixation, deep infection, delayed wound healing, or recurrence of the preoperative deformity.

Conclusion: In children undergoing TATT, biotenodesis screw fixation provides a safe method of fixation with 89% good/excellent clinical outcomes. Complications were mild and did not require return to surgery.

Significance: Use of biotenodesis screw fixation for TATT is a safe option with reliable clinical outcomes in a pediatric population. This method avoids the complications associated with more traditional suture fixation as well as need for hardware removal with a metallic screw.

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Assessment of Differences Regarding the Management of Pediatric Supracondylar Fractures Between Hand and Pediatric Orthopaedic Surgeons

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Purpose: Supracondylar humerus (SCH) fractures are the most common elbow fracture among the pediatric population. The purpose of this study is to investigate the technique and outcomes differences of pediatric supracondylar fractures treated by hand and pediatric orthopaedic fellowship trained surgeons.

Methods: A blinded retrospective review was performed to assess the management and outcomes of pediatric SCH fractures treated by hand and pediatric orthopaedic fellowship trained surgeons over a 4-year period. Data reviewed included patient demographics, Gartland classification, time from injury until operative intervention, operative technique, post-operative treatment, and complications. Simple statistical analysis and Student's t-test were performed.

Results: 65 cases were reviewed including 23 patients in the hand fellowship trained surgeon group and 42 patients in the pediatric orthopaedic fellowship trained group. 22% (5/23) of patients had a medial pin placed in the hand group while only 2% (1/42) had one placed in the pediatric group. 65% (15/23) of cases in the hand group were performed within 12 hours of the injury, while only 48% (20/42) were performed within 12 hours in the pediatric group. 31% (4/13) of Gartland type III fractures underwent an open reduction in the hand surgeon group, with none performed (0/26) in the pediatric group. The average operative time was 47 minutes in the hand group versus 26 minutes in the pediatric group ($p<0.005$). Removal of hardware (ROH) occurred at 4.3 weeks in the hand group, including 26% (6/23) of cases performed in the operating room (OR). The average time of ROH in the pediatric group was 3.3 weeks, with none performed in the OR. 39% (9/23) of patients in the hand group were referred to PT while only 7% (3/42) were referred in the pediatric group. No complications occurred in either group.

Conclusion: Adult hand and pediatric orthopedic surgeons treating pediatric supracondylar humerus fractures have similar patient outcomes and low complication rates. However, hand surgeons perform more open reductions, have longer operative times, more commonly refer patients to physical therapy, and often return to the operating room for pin removal.

Significance: The different management of these patients has potential for substantially higher health care costs when SCH fractures are treated by hand surgeons. More standardized approaches and guidelines may improve efficiency and value when treating these cases.

See pages 21- 66 for financial disclosure information.

Does Initial Cast Correction Predict Treatment Success For Infantile Scoliosis?

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Purpose: Casting for early onset scoliosis (EOS) results in varying amounts of curve correction. Because the reasons for patients' differential outcomes are not fully elucidated, the aim was to examine casting outcomes and identify which factors correlate with appropriate curve control.

Methods: Patients who underwent casting for idiopathic EOS were identified. Demographic and clinical data was collected, including Cobb angles and rib-vertebra angle difference (RVAD) at presentation, after first casting, and at last follow-up. Uni and multivariable regression analysis was used to identify prognostic factors associated with good outcomes.

Results: 29 patients (13 F, 16 M), mean ages at initial casting of 2.2 (0.6 - 5.8) years were identified. Mean follow-up after initial casting was 2 (±.9) years. Cobb angles were improved from a mean of 45°(±9.9) to 17.3°(±6.4) with initial cast application demonstrating a 62.1% correction. RVAD showed improvement from 26° to 13° (48%) after placement of initial cast. Overall patients remained a mean of 15 months in a body casts and required an average of 6 casts (range 2 -13) during follow up.

Multivariable regression determined that age and change in Cobb with initial cast were significant predictors of most recent Cobb angle ($p=0.004$; $R^2 = 29.9\%$). Subjects who are casted at a younger age yield a smaller Cobb angle at follow-up compared to subjects who start casting at an older age. For each additional year of age at casting, the most-recent Cobb angle increased by 4° ($p=0.01$). It was also found that patients with greater change in Cobb angle with initial casting result yielded a smaller Cobb angle at follow-up. For each additional percent change in Cobb angle at casting, the final Cobb angle decreased by 0.41° ($p=0.005$).

Conclusions: Age and change in Cobb angle with initial casting were significant predictors of curve outcome at 2 year follow up. Patients casted at an earlier age and those with greater Cobb correction in first cast had smaller Cobb angles at last follow up. For each 10% decrease in Cobb angle at initial casting, we found a 4-degree decrease in Cobb angle at last follow-up.

Significance: Curve control is more likely attained the younger a child is casted, reaffirming the importance of early treatment. Initial cast correction, which may represent curve flexibility and/or cast quality, can predict the overall success of casting treatment and therefore should be taken into account when considering casting in EOS.

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Pediatric Spinal Deformity in the United States: Surgical Approach, Complications, and Hospital Charges from 1997 to 2012

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Purpose: Spinal deformity surgery in pediatric and adolescent patients can provide significant clinical benefit. These complex surgeries, however, are associated with numerous complications and substantial financial cost. In this study, we aimed to evaluate trends in pediatric spinal deformity surgery in the United States from 1997-2009.

Methods: The Kid's Inpatient Database (1997 to 2009) was utilized for this study. Patients were identified using 737.xx ICD-9-CM diagnosis codes. Patients who underwent spinal fusion with 81.xx ICD-9-CM procedure codes comprised the study cohort. Parameters examined included patient co-morbidities, operative approach (posterior, anterior or combined anterior-posterior), in-hospital complications, hospital length of stay, and hospital charges.

Results: A total of 22,823 patients who underwent spinal deformity surgery were identified. The proportion of patients undergoing anterior fusions decreased from 31.3% of procedures in 1997 to 7.6% of procedures in 2009 ($r=-0.94$, $p=0.02$). The rate of patients undergoing posterior fusions increased from 78.4% of procedures in 1997 to 89.3% of procedures in 2009 ($r=0.95$, $p=0.01$). Patients who underwent anterior fusions had a significantly greater number of discharge diagnoses, longer hospital length of stay, more complications, and higher hospital charges compared to posterior approach patients for each year examined ($p<0.0001$). In 1997 16.3% of patients that underwent anterior fusions had at least one complication, compared to 11.5% of patients undergoing posterior fusions ($p=<0.0001$). In 2009, 10.4% of the patients that underwent anterior fusions had at least one complication compared to 6.3% of patients with posterior fusions ($p=<0.0001$). The mean hospital charges for inpatient stays increased 2.8-fold from $55,361 in 1997 to $153,764 in 2009 ($r=0.99$, $p<0.01$). Estimated total aggregate inpatient National charges in 1997 were $353,000,000 for inpatient pediatric spine deformity surgery, which increased 4.4-fold to $1,508,000,000 in 2009.

Conclusions: Over the course of this 13-year study period, there was an increasing trend toward posterior based surgical techniques compared to anterior or combination procedures. Mean hospital charges for treatment of spinal deformities have increased 2.8-fold per patient, with a National bill of over $1.5 billion per year in 2009.

Significance: The number of comorbid diagnoses per spinal deformity patient has increased over time, yet the complication rate for both anterior and posterior based procedures has steadily decreased, therefore the increasing charges associated with surgical treatment may be well justified.

See pages 21- 66 for financial disclosure information.

Is Obesity Associated with Larger Curves in Adolescent Idiopathic Scoliosis and Worse Surgical Outcomes?

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Purpose: Current estimates suggest that one in three children in the United States is overweight or obese. Clinical exam findings for scoliosis may be less apparent in overweight adolescents. The primary purpose of this study was to compare preoperative curve magnitude between healthy-weight (HW; body mass index percentile for age [BMI %] ≤ 84), and overweight (OW; BMI % ≥ 85) and obese (OB; BMI % ≥ 95) adolescents. Since previous studies comparing surgical outcomes of healthy-weight and overweight adolescents after posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) have shown conflicting results, the secondary purpose of this study was to compare surgical outcomes between these groups.

Methods: This was a multicenter, retrospective comparative study. We identified patients 11 to 17 years old who had undergone primary PSF for AIS between 2007 and 2013. Demographic data, radiographic measures, perioperative data, and complications were recorded. Descriptive and inferential analyses, including chi-square and student's t-test, were conducted to compare patient characteristics and surgical outcomes scores.

Results: We analyzed 457 patients (375 females, 82 males). The mean follow-up was 2.2 ± 1.6 years. The average BMI was 21.6 ± 5.2 kg/m^2 and average BMI % was 56.5 ± 30.6. The groups had a similar distribution of males and females, and number of levels fused. In comparison to the HW group (n = 349), the OW group (n = 108) had PSF at a younger age (13.3 vs 14.1 years) ($P < 0.0001$), larger preoperative Cobb angle (58.2^o vs 54.9^o) ($P = 0.011$), increased operative time (293 vs 263 minutes) ($P = 0.009$), and increased length of stay (5.6 vs 5.3 days) ($P = 0.039$). Comparison of the HW and OB (n = 63) groups demonstrated similar results, including further increase in operative time in the OB adolescents (322 vs 263 minutes) ($P < 0.0001$). Although there was a trend towards a higher postoperative complication rate in the OB group (25.4% vs 15.8%) ($P = 0.062$), postoperative complication rates in patients with a minimum 2-year follow-up (n = 230) were similar.

Conclusion: Overweight status may lead to a delay in diagnosis of scoliosis, resulting in a larger preoperative curve magnitude and PSF at a younger age. Overweight adolescents who undergo PSF for AIS have increased operative times and lengths of stay.

Significance: Overweight adolescents must be carefully screened for scoliosis and should be appropriately counseled prior to undergoing PSF for AIS.

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VEPTR Versus Traditional Growing Rods: Preliminary Results From a Collaboration Between Two National Databases

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Purpose: Currently, there is significant equipoise regarding the selection and placement of instrumentation when treating patients with early onset scoliosis (EOS). The purpose of this study is to compare complications, curve correction and health related quality of life (HRQoL) of patients receiving vertical expandable prosthetic titanium rib (VEPTR) with proximal rib anchors versus Traditional Growing Rods (TGR) with proximal spine anchors as part of posterior growing instrumentation in the management of EOS.

Methods: This prospective, multi-center study was organized and supported by the Children's Spine Study Group (CSSG) and Growing Spine Study Group (GSSG) and funded by the SRS. 70 patients age 3-9 years with EOS and a Cobb angle > 40° were enrolled. Average follow up of 0.75 years, and each patient will have one-year follow up by the POSNA Annual Meeting 2015. 77% (54/70) of enrolled patients received VEPTR with rib proximal anchors and 23% (16/70) received TGR with spine proximal anchors.

Results: There were no differences between VEPTR and TGR in Cobb angle correction (24% versus 29%) or EOSQ-24 scores (disease specific health related quality of life). However, 18 of 54 (33%) VEPTR patients experienced a total of 30 complications, whereas, none of the TGR patients had any reported complications.

Among the 18 VEPTR patients with reported complications, 14 patients experienced a total of 21 device-related complications. Based on the Complication Classification System for Growing Spine Surgery (Smith 2012): the device-related complications included five Grade I complications (no unplanned surgery), twelve Grade IIA (4 device migration, 4 hardware failure, 3 spine infection, 1 wound dehiscence; all requiring unplanned surgery), three Grade IIB (spine infections requiring multiple debridement operations), and one Grade III (infection requiring removal of hardware). Within VEPTR patients, those with < 4 proximal anchors were 2 times more likely and 3 times more likely to experience one complication and one severe complication, respectively, compared to patients with ≥ 4 proximal anchors (p = 0.10, 0.05).

Conclusions: There was no difference in Cobb angle correction or HRQoL between VEPTR patients and TGR patients. Patients with < 4 proximal rib anchors were significantly more likely to experience complications. Careful attention to proximal implant selection and density is critical in the treatment of children with EOS and posterior growing instrumentation.

Significance: This study will improve surgical management of EOS by providing prospective data on the potential benefits and risk profiles of differing growing instrumentation.

See pages 21- 66 for financial disclosure information.

Revision Surgery Rates After Primary Fusion For Adolescent Idiopathic Scoliosis

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Purpose: The purpose of this study is to define the revision rates in Adolescent Idiopathic Scoliosis (AIS) at a single referral based pediatric center and compare various instrumentation constructs utilized during the initial spinal fusion.

Methods: A retrospective chart review was performed of all patients with AIS who underwent instrumented fusion from January 1990 through December 2011 with minimum of 2 year follow up. Demographic information, types of implants, surgical approach and other information concerning the primary surgery and all subsequent revision operations was obtained from medical chart and operative logs. Exclusion criteria included age younger than 10 or 19 and older, diagnosis of congenital, infantile, or neuromuscular scoliosis, isolated kyphosis and primary surgical fusion performed at an outside facility.

Results: Four hundred and eleven patients who underwent instrumented fusion for AIS during the study period met our inclusion criteria. There were 333 posterior spinal fusions, 30 anterior only fusions, and 48 combined anterior and posterior fusions performed. The posterior spinal fusion constructs included 103 pedicle screw constructs, 27 hybrid hook and pedicle screw constructs, 200 all hook constructs and 3 wire only constructs. A total of 66 revision operations were performed in 50 patients (12.2%). Prominent hardware, pseudarthrosis, and infection were the most common indications for revision. Posterior pedicle screw constructs had a lower revision rate (5.8%) compared to the rest of the study population (p=0.02). The all hook, hybrid, anterior only and combined fusions had revision rates of 13.0%, 18.5%, 10.0% and 20.8% respectively which were not statistically different. When comparing pedicle screw and all hook constructs, there was a statistical difference in pseudarthrosis rates, favoring pedicle screw instrumentation with no difference in the rates of infection or prominent hardware (p=0.03).

Conclusions: Patients undergoing instrumented fusion for AIS are at some risk for requiring subsequent surgery after their initial procedure. To lessen that risk, pedicle screws constructs should be considered as they show an overall lower revision rate compared to other constructs specifically regarding the rate of pseudarthrosis compared with posterior hook only constructs.

Significance: Revision rates for AIS instrumented fusion vary throughout the literature. This study compares revision rates overtime time as types of instrumentation and technique have advanced.

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Reliability of X-Ray Based Evaluation of Pedicle Screw Misplacement in Adolescent Spinal Deformity

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Purpose: The purpose of this study is to evaluate pedicle screw misplacement on x-ray utilizing criteria previously described by Kim et al. and comparing it to post-op CT scan.

Methods: Post-op XR and low dose CT scans of 104 spinal deformity patients who underwent PSF were reviewed. Blinded review of screw placement on x-ray was done by 6 observers using Kim et al.'s criteria: 1)violation of the harmonious change; 2)no crossing of medial pedicle wall by screw tip; 3)violation of imaginary midline of vertebral body. Anterior violation was recorded when anterior breach screw length was ≥80% of the width of the vertebral body. Overall and independent assessment of sensitivity, specificity, accuracy and concordance was done.

Results: 2034 screws were evaluated on x-ray and CT. CT classified 1772 screws as acceptable, 142 lateral, 30 medial, and 90 anterior. Overall sensitivity, specificity and accuracy for diagnosis of correct screw placement with x-ray was 0.52(0.36-0.72),0.69(0.45-0.84) and 0.67(0.48-0.78), respectively. XR overestimated the number of misplaced screws and had poor reliability for detecting properly placed screws. Overall agreement among six observers (kappa value) was 0.23 (95% CI: 0.23 - 0.24), indicating poor correlation. Overall concordance of plain radiograph as compared to CT scan for diagnosis of correct anterior, lateral, medial and normal screw position was 0.53(0.13-0.84), 0.25(0.19-0.51),0.13(0.13-0.20) and 0.70 (0.45-0.84), respectively.

Conclusion: X-ray evaluation of screw placement showed poor correlation with CT data and very poor inter-observer correlation. X-rays were found to be inadequate to evaluate screw misplacement. Low dose CT scan or intra-operative 3D image and/or navigation should be used for reliable evaluation of screw placement.

Significance: X-ray-based evaluation of pedicle screw misplacement is severely limited in spine deformity and better evaluation methods are needed.

Posterior Vertebral Column Resection in Pediatric Deformity: The Advantages of Staging

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Purpose: Vertebral column resection (VCR) through a single all posterior approach has been described for the treatment of severe rigid spinal deformity. Due to the length and complexity, some authors favor a planned staged approach for posterior VCR procedures. The aim of our study was to evaluate radiographic and perioperative outcomes of patients who underwent a planned two-stage VCR (PS-VCR) compared to those who had a single-stage procedure (SS-VCR).

Methods: After institutional IRB approval, a retrospective consecutive case review of 35 patients who underwent an all-posterior VCR procedure was performed. All surgeries were between 2007-2014. The charts were reviewed for patient demographic data, operative time (ORT), estimated blood loss (EBL), length of hospital stay (LOS) and surgeon-reported intra-operative, immediate post-operative and most recent follow-up complications. Radiographic measurements were made pre-operatively and at most recent follow up.

Results: Eleven patients were in the PS-VCR group and 24 patients were in the SS-VCR group. Demographic data are summarized in Table 1. The PS-VCR and SS-VCR groups were comparable pre-operatively. Post-operatively, the PS-VCR group had significantly better mean percent curve correction (57.8%) compared to the SS-VCR group (46.1%). No statistical significant differences were found in EBL and LOS between both groups (p=0.790, p=0.643, respectively). ORT was significantly longer in the PS-VCR group (p=0.001), however, the PS-VCR group had on average a significantly lower complication rate (36.4%) than the SS-VCR group (58.4%). Four patients in the SS-VCR group had their procedures aborted due to intra-operative complications.

Conclusions: Although staging posterior VCR surgeries resulted in significantly longer ORT, there was no difference in EBL and LOS compared to SS-VCR procedures. Staging has the advantage of a significantly lower complication rate with better deformity correction compared to SS-VCR procedures.

Significance: Posterior VCR procedures are inherently high-risk and it is imperative that strategies to help minimize perioperative complications are explored. We found complications associated with posterior VCR procedures to be significantly reduced if these procedures are staged.

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Table 1: Patient Demographics and Outcome Variables

Patient Demographics	Non-staged (n=24)	Staged (n=11)	
Gender (% female)	41.7	45.5	
Mean Age at Surgery (yrs)	14.1 (5.4-19.7)	16.3 (12.1-20.6)	
Mean Follow-up (yrs)	2.9 (0.1-6.3)	1.5 (0.3-3.3)	
Mean Preop Major Cobb (°)	84.1 ±7.3	88.2 ±6.6	
Mean Preop Kyphosis (T2-T12)	42.9 ± 7.6	40.5 ±13.9	
Mean Preop Lordosis (T12-S1)	-42.0 ± -12.0	-33.1 ± -14.0	
Etiology (n)			
Neuromuscular	7 (29.2%)	6 (54.5%)	
Congenital	8 (33.3%)	3 (27.3%)	
Kyphosis	3 (12.5%)	0	
Kyphoscoliosis	2 (8.3%)	1 (9.1%)	
Syndromic	2 (8.3%)	0	
Other	2 (8.3 %)	1 (9.1%)	
Outcome Variables			**p-value (α=0.05)**
Mean % Correction Major Cobb	46.1	57.8	0.138
Mean MRF Postop Kyphosis (°)	43.0 ±4.5	36.6 ±5.1	0.358
Mean MRF Postop Lordosis (°)	-49.7 ± -6.1	-47.7 ± -5.4	0.286
Mean OR time (min)	656.0 ±36.3	877.7 ±43.4	0.001*
Mean EBL (ml)	2454 ±400.0	2195.9 ±392.6	0.790
Mean LOS (days)	20.1 ±5.1	18.0 ±5.4	0.643
Complications (%)	58.4%	36.4%	0.227

* - indicates point at which a significant difference (p<0.05) found

Postoperative Pain Management After Surgical Hip Dislocation For The Treatment of Femoroacetabular Impingement in Adolescents

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Purpose: The purpose of this study was to compare three pain management protocols after surgical hip dislocation (SHD) for the treatment of femoroacetabular impingement (FAI) in adolescents.

Methods: After IRB approval, data was retrospectively collected from 121 subjects (12 to ≤ 21 years old) who underwent a SHD for treatment of FAI from January/2003 to June/2014. Subjects received epidural analgesia (n=72), patient-controlled-analgesia (PCA; n=29), or a periarticular infiltration catheter (n=20). Total opioid consumption and VAS pain scores during the first 24 hours post-surgery, hospital length of stay (LOS), and incidence of nausea and pruritis were recorded. All opioids were converted into an IV morphine equivalent dose and normalized according to subject weight [mg/kg]. Pain scores were defined as moderate/severe (VAS>3.4mm) or mild/no pain (VAS≤3.4 mm). Differences between groups in pain, opioid consumption and LOS were evaluated using multi-variable logistic regression, linear regression and Cox-proportional hazards regression models, respectively.

Results: There was no difference [p>0.05] in intra-operative opioid consumption, age, or BMI across the three groups. The incidence of postoperative nausea was significantly [p=0.0277] lower in the periarticular (40%) compared to the epidural (72.2%) and PCA groups (65.5%). The incidence of pruritis was also significantly [p=0.0008] lower in the periarticular group (0%) versus the epidural (45.83%) and PCA groups (41.38%). Total opioid consumption in the PCA group was 118% [95%CI: 4.3-355.7%, p=0.0385] higher than the opioid consumption in the periarticular group. There was no difference in opioid consumption between the periarticular and epidural groups [p = 0.1901]. There was no difference in pain across the three groups 12 hrs [p =0.0557] or 24 hrs after surgery [p=0.6406]. Median LOS was 44 hrs [95%CI: 23-47 hrs] in the periarticular group, 63 hrs [95%CI: 46-71 hrs] in the PCA group and 71 hrs [95% CI: 56-73 hrs] in the epidural group. The likelihood of a shorter LOS was significantly increased in the periarticular group relative to the epidural [Hazard Ratio (HR):6.9, 95%CI: 3.6-13.4, p<0.0001] and PCA [HR:4.3, 95%CI: 2.1-8.8, p<0.0001] groups.

Conclusion: Periarticular infiltration was equally effective at controlling pain as the epidural protocol with advantages of shorter hospital stay and lower incidence of nausea and pruritis. The PCA group was associated with a significantly higher opioid consumption and pain scores relative to the epidural and periarticular groups.

Significance: Periarticular infiltration controls pain without unwanted side effects and should be considered for pain management after SHD for the treatment of FAI in adolescents.

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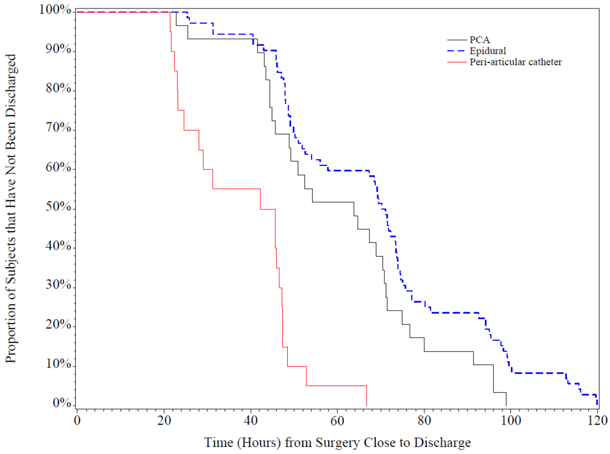

Figure 1. Probability of Remaining in the Hospital After Surgery (y-axis) vs Time (x-axis)

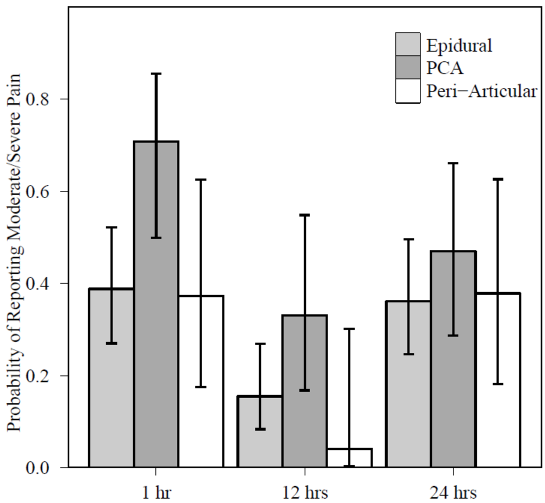

Figure 2. Probability of Reporting Moderate/Severe Pain (y-axis) vs Time (x-axis)

See pages 21- 66 for financial disclosure information.

Predictive Factors of Osteonecrosis of the Femoral Head After Closed Reduction for Treatment of Developmental Dysplasia of The Hip

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Purpose: The purpose of this study was to investigate predictive factors of ON after closed reduction for treatment of hip dislocation secondary to DDH.

Methods: Following IRB approval, 133 patients who underwent treatment for non-teratologic DDH between January-2001 and June-2010 were identified. Forty-five patients with less than 2-year follow-up and eleven patients who required open reduction were excluded. Fifty-seven patients (49 females, 8 males; mean age 8 months (range:1-24 months) were followed for an average of 5.1 years (range:2.1-11.2 years). Preoperative radiographs were evaluated for acetabular index (AI), lateral and superior position, ossific nucleus and dislocation severity assessed by Tönnis classification. The Tönnis arthrogram classification was used to assess the quality of reduction. Sequential postoperative were blindly reviewed in a randomized order by two pediatric orthopedic surgeons for the presence of osteonecrosis. Cox regression was used to find predictive factors of osteonecrosis according to Salter's criteria, the Bucholz-Odgen and Kalamchi-MacEwen classification systems. The raw agreement between the two reviewers was greater than 70% for three AVN classifications used.

Results: The overall ON incidence was 29.5% (18 hips). Gender, bilateralism, previous conservative treatment, concurrent adductor tenotomy, the presence of ossific nucleus before reduction, degree of abduction in spica cast, and pre-operative AI were not significant predictors of ON. For every year increase in age at time of reduction, the risk for ON increased by 40%. Older age at surgery, pre-operative Tönnis classification of severity of dislocation, multiple closed reduction attempts, and Tönnis grade II classification of the arthrogram after closed reduction were found to be significant factors associated with ON by univariate analysis ($P<0.05$). After multivariate analysis, the single most independent factor was the degree of superior dislocation of the femoral head before reduction (hazard ratio per 0.1 unit: 0.18, $P<0.001$)

Conclusion: In this retrospective study, we determined that older age at the time of reduction, severity of initial dislocation, and quality of reduction significantly affected the risk for ON of the femoral head after treatment for DDH.

Significance: Our results suggest that delaying CR for hips that do not respond to conservative treatment may increase the risk of AVN after reduction. Furthermore, hips with a more severe initial dislocation and where a partial reduction (Tönnis grade II) is achieved may have a higher risk of AVN. Surgeons should only accept a full reduction in older patients with highly dislocated hips.

Level of Evidence–Level IV, Retrospective Case Series

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Safety Profile of Three Guided Growth Implants: Body Weight Correlates with Implant Failure

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Purpose: The purpose of this study was to retrospectively evaluate the safety profile of three different implants used to correct lower extremity malalignment in pediatric patients.

Methods: This retrospective study reviewed a consecutive series of children who underwent implant-mediated guided growth performed by two surgeons between 2004 and 2014. Implants were selected based on surgeon preference. Each patient received post-operative radiographs and patient medical records were analyzed. Deformity correction and implant integrity were assessed on post-operative radiographs. Screw pull-out, defined as greater than 5 mm, was also recorded. Rate of correction was determined for all cases that completed guided growth treatment.

Results: During the study period, 115 plates were implanted in 52 patients (24 males, 28 females). Average age at implantation was 12.3 (range: 4.3-16.5) in boys and 11.1(range: 6.4-15.0) in girls. Average length of follow-up was 18.4 months. Of the 115 plates in this series, 63 were peanut plates, 30 eight-plates and 22 hinge plates. There was no statistically significant difference in rate of correction between implant types (p=0.081).

Three (2.6%) screw breakages were observed which all involved cannulated screws in peanut plates. A total of four peanut plates (6.3%) demonstrated an implant-related complication: three cannulated screw breakages and one screw pull-out. Two of the 30 eight-plates (6.7%) showed partial screw pull-out and one eight-plate (3.3%) showed partial screw pull-out with bending of a cannulated screw. There were no reported complications within the hinge plate group. Multivariate analysis demonstrated that increased body weight was significantly associated with implant complication (p=0.046). There were no deep infections, premature growth arrests or plate breakages in this cohort.

Conclusion: Implant-mediated guided growth is a safe technique for pediatric lower extremity deformity correction with a low rate of complications. Obese patients were at a significantly increased rate of implant complications in our cohort. Screw breakages were only observed in cases with cannulated screws and the less flexible peanut plates.

Significance: This retrospective review evaluating three guided growth implants demonstrated an increased implant complication rate in obese patients. In addition, we recommend using solid, non-cannulated screws in obese children who are at higher risk of hardware failure.

Post-operative x-ray
showing two broken screws

See pages 21- 66 for financial disclosure information.

Clinical Significance of The Effect of A Six-Months Schroth Exercise Intervention in Adolescents with Idiopathic Scoliosis

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University of Alberta, Edmonton, Alberta

Purpose: Appraising the clinical significance of outcomes is important, but it has not been standard in research on adolescents with idiopathic scoliosis (AIS) treated conservatively. The purpose of this study was to determine the clinical significance of the effects of Schroth exercises added to the standard of care compared to standard of care alone in children with AIS.

Methods: Data from a randomized controlled trial (RCT) was used to estimate anchor- and distribution-based thresholds to determine the clinical significance of the outcomes. Fifty children with AIS, aged 10-18, with curves ranging from 10°-45°, with or without brace, and all maturity levels were randomly assigned to a supervised six-months Schroth exercise intervention added to standard of care (bracing or observation) or to standard of care alone. Anchor-based minimally clinically important difference (MCID) and distribution-based minimal detectable difference (MDD_{95}), standard error of measurement (SEM) and Cohen's d effect sizes (ES) were determined for the Largest Cobb angle (LC), Sum of all Cobb angles (SOC), the Biering-Sorensen test, SRS-22r and Spinal Appearance Questionnaire (SAQ) domains. Number needed to treat (NNT) and the significance of differences in the proportion of improved, stable and deteriorated patients tested using Chi-square tests are also reported.

Results: MCIDs for the radiographic outcome and Biering-Sorensen test were larger than their SEMs, but smaller than the MDD_{95}. All but one of the questionnaires' anchor-based cut-offs were below their SEM, while most of their MDD_{95} produced values higher than changes commonly seen in this population. ES for the radiographic measures were large, while others ranged from small to medium, mainly favoring the Schroth group. NNT for radiographic outcomes and the SRS-22r function were small (<4). Using MDD95 of 3.4 degrees for the largest Cobb, 8.7 degrees for the sum of Cobb angles and a SEM of 0.11 for the SRS-22 function scores, the sum of the proportions of improved and stable patients were significantly larger in the Schroth group.

Conclusion: Schroth exercises had clinically significant effects on radiographic outcomes and the SRS-22r function. Clinical significance thresholds were estimated with four methods for all outcomes in this exercise study.

Significance: This first Schroth exercises RCT study demonstrated a clinically significant effect. The lower anchor-based cut-offs for questionnaire scores compared to their distribution–based cut-offs suggest that these surgical outcome questionnaires may not have statistical properties allowing to capture change in response to exercises that are meaningful to the patients.

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Percutaneous Subtrochanteric Valgus Osteotomy For Painful Dislocated Hips in Patients with Cerebral Palsy

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Purpose: Treatment of a painful, chronically dislocated hip in children with cerebral palsy (CP) is challenging. The purpose of our study was to evaluate the effect of a percutaneous subtrochanteric valgus osteotomy (SVO) using external fixation (EF) on hip abduction, radiographic parameters, and quality of life measures in non-ambulatory CP patients with painful hip dislocations.

Methods: 15 patients (8 male, 7 female) with CP (GMFCS 5) with 18 chronically dislocated hips underwent SVO using EF and adductor tenotomy at an average age of 14.3 (range 10.7-26.8) years. Changes in hip abduction and radiographic parameters following surgery were assessed. Caregivers were contacted and asked to complete a survey detailing differences in the patient's quality of life measures, including severity and duration of pain and ease of nursing care as reported by Hogan et al., and the modified Child Health Index of Life with Disabilities (CPCHILD).

Results: At a mean follow-up of 38 (range 6-100) months, the hip abduction improved from -6.8° (range -32 - 5°) preoperatively to 21° (range -20-50°) ($p<0.0001$). Intraoperative blood loss averaged 49 (range 10-250) cc. The mean valgus angulation at the osteotomy site was 48° (range 2-93) intraoperatively and 35° (range 12-71) at latest follow-up. All osteotomies healed without further intervention and the time in external fixator averaged 18 (range 11-30) weeks. Caregivers of 11 patients completed both surveys. Using the questionnaire developed by Hogan et al., there was improvement in pain, sitting tolerance, ease of transfers, and perineal care in the majority (9/11) of patients. The modified CPCHILD score (range 10-50) improved from 27.2 to 16.13 ($p=0.028$). One patient had persistent pain that resolved with subsequent femoral head resection. The only adult in this series (age 26.8 years) sustained a post fixator removal fracture. While pin tract infections were common, none required premature removal or surgical debridement.

Conclusion: Based on preliminary results, percutaneous subtrochanteric valgus osteotomy stabilized with external fixation improves quality of life in the majority of non-ambulatory cerebral palsy patients. Despite some untoward events, this technique is a viable alternative to open osteotomy with internal fixation in such adolescents with chronically dislocated hips.

See pages 21- 66 for financial disclosure information.

Conservative Treatment of Idiopathic Clubfoot:
A Two-Institutional Retrospective Review

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Purpose: The Ponseti casting method for idiopathic clubfoot (IC) has been established as the gold

standard treatment. However, its application has mixed results. We performed a retrospective chart review to identify common predictors of success/failure in treatment of IC at an institution utilizing a non-Ponseti conservative treatment approach (Institution 1) and an institution fully committed to the Ponseti method (Institution 2).

Methods: Following IRB approval, IC patients treated between 1/03 and 12/07 were identified through an ICD-9 query. A total of 222 feet, 131 from Institution 1 and 91 from Institution 2, were included in the cohort. At Institution 1, fourteen providers (4 orthopedic surgeons and 10 midlevel providers) managed care using a non-Ponseti conservative approach to IC. At Institution 2, a single orthopaedic surgeon dedicated to the Ponseti method managed care.

Results: There was a significant difference in treatment outcomes between the institutions. The proportion of feet requiring major soft-tissue release surgery ($p=0.0001$) as well as the proportion of feet requiring minor and/or major soft tissue surgery ($p<0.0001$) was significantly higher at Institution 1 compared to Institution 2. Four years post-initial casting, the major soft-tissue release surgical survival rate was 50.14% (95% CI: 39.64 to 59.74%) at Institution 1 compared to 97.28% (95% CI: 89.29 to 99.33%) at Institution 2 (see Figure 1). At Institution 1, 34% of feet received major surgery within 2 years of the initial visit and 39% within 3 years. The median and maximum time to surgery was 4.1 years and 5.16 years, respectively. Variables significantly related to the need for major surgery in the Cox-Regression model included: number of different providers that performed castings (3 or 4 vs 1 and 3 or 4 vs. 2); increase in number of casts, and increase in proportion of cast visits with a documented complication. For every 10% increase in proportion of casts performed by a primary provider (clinician applying majority of the casts) the subject is 13% less likely to need surgery.

Conclusion: A treatment approach committed to the Ponseti method yields superior results over alternative conservative approaches for IC. Commitment to the Ponseti method will likely reduce costs and improve patient outcomes. Our data additionally suggest that unlike treatments utilizing multi-disciplinary physician collaboration, the treatment of IC is best achieved through a single provider.

Significance: The Ponseti methodology for IC treatment remains superior to alternative conservative methods.

Level of Evidence Level : III, Therapeutic study.

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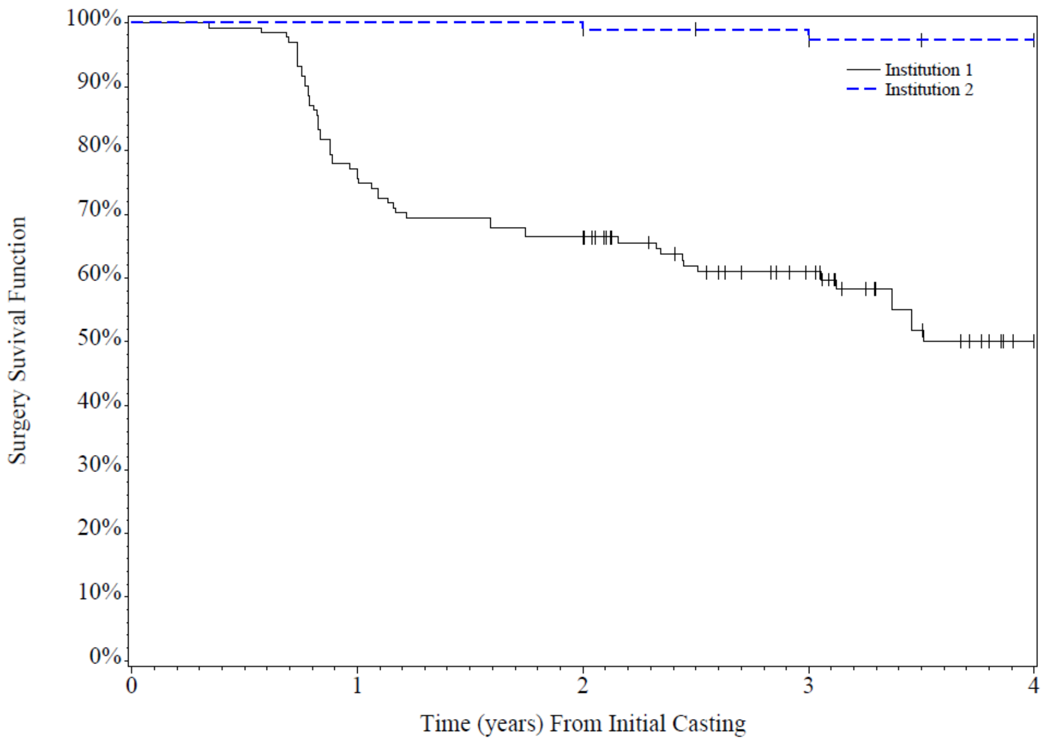
Figure 1. Surgery Free Survival at Institution 1 vs 2



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Are All Metals The Same? Developing An In Vivo Model of Post-Operative Spinal Implant Infection and Employing It to Assess Susceptibility of Different Metals

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Purpose: Infection occurs in 3-10% of implant-related spine surgeries, causing significant morbidity, mortality, and additional health care spending. Existing animal models of spinal implant infection are histology based, requiring euthanasia for each data point. This study aims to 1) establish a novel, *in vivo* mouse model of spine implant-related infection, utilizing optical imaging to longitudinally quantitate postoperative bacterial burden and immune response humanely, efficiently, and accurately; 2) utilize the model to determine if titanium implants are less susceptible to infection than stainless steel.

Methods: Survival surgery was performed in which a stainless steel (Ss) implant was press fit into the L6 spinous process of LysEGFP mice. The mice were inoculated with $1x10^2$, $1x10^3$, or $1x10^4$ colony forming units (CFU) of bioluminescent *S. aureus*, or sterile saline (control). Bacterial burden and immune response were tracked longitudinally with quantitative bioluminescence and fluorescence imaging up to postoperative day (POD) 26. Implants and surrounding tissue were then extracted and cultured. Variable-pressure scanning electron microscopy (VP-SEM) was performed. Experiments were repeated comparing Ss and titanium (Ti) implants. Statistics were performed using ANOVA to identify significant differences ($p<0.05$).

Results: Mean bacterial bioluminescence signal was higher for the $1x10^4$ inoculum group than the two lower inocula groups throughout the postoperative period ($p<0.05$). Bacterial burden peaked on POD5 for all groups. All animals in the $1x10^4$ group developed skin breakdown, whereas no evidence of skin breakdown was seen in the other groups. VP-SEM confirmed biofilm formation in all non-control groups. The metal comparison experiment was performed using $1x10^3$ CFU. There were no statistically significant differences in bacterial signal or immune response from pins made of titanium or stainless steel at any time point over the 26 day experiment. This was confirmed with cultures on POD26, with a mean of $9.3x10^2$ CFU from the Ss group and $9.4x10^2$ CFU from the Ti group.

Conclusions: This novel mouse model allows noninvasive, longitudinal assessment of bacterial burden and immune response after spine surgery. There appears to be no difference in susceptibility to infection or induced immune response among two commonly used metals in spinal surgery.

Significance: This mouse model of postoperative implant-related spine infection represents a novel approach to study post-operative infection, metal susceptibility, novel antimicrobial coatings, and local antibiotic delivery. The model calls into question the practice of choosing a metal based on bacterial susceptibility.

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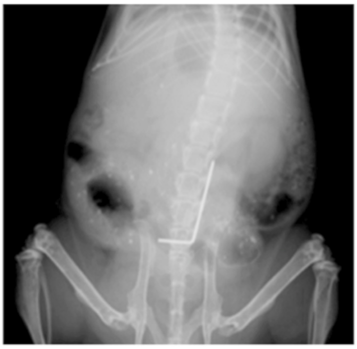
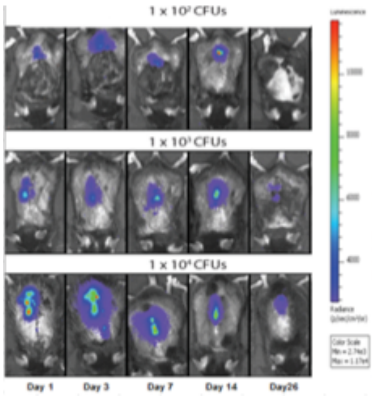
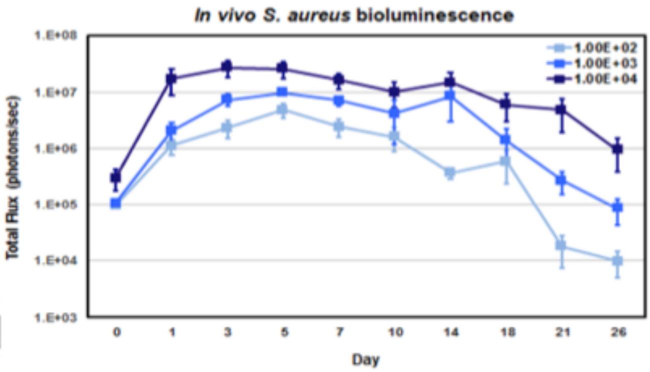
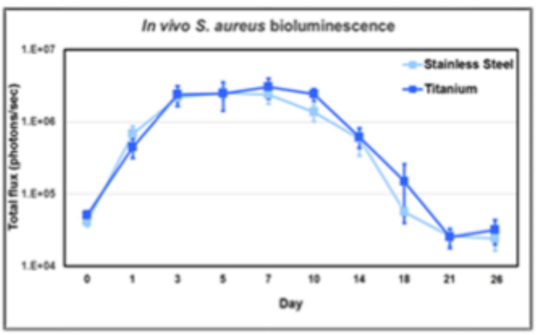
Figure 1: Radiograph showing implant placement through the L6 spinous process

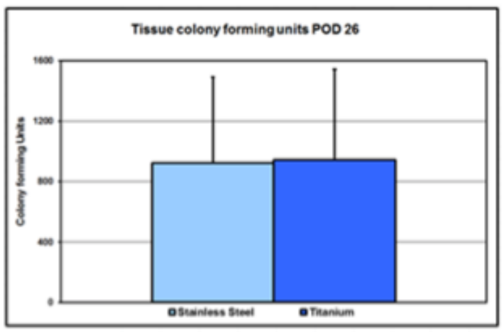


*Funding: This study was funded by the generous support of the Pediatric Society of North America Biome Spine Research Grand (20131078)









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Radiation Safety Training Results in Reduced Radiation Exposure For Orthopaedic Residents When Using The Mini C – Arm

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Purpose: The importance of proper fluoroscopy is essential and has taken on a central role in the ABOS surgical skills curriculum for residents. According to the National Council on Radiation and Standards the recommended maximum annual dose of radiation to the whole body is 5,000 mR and 50,000 mR to the extremities. Sumko et al demonstrated that the amount of radiation exposure to residents was underestimated and significantly different between PGY2s and PGY3s. If a PGY2 were to perform 50 forearm reductions per year under direct beam exposure they would exceed the recommended maximum annual dose of radiation to their body. The purpose of this study is to report radiation exposure among the residents after receiving a radiation safely education program.

Methods: Residents underwent a new annual 3 hour educational program about radiation safety including hands on mini C-arm use. The program was taught by the hospital's health physics department. 45 consecutive pediatric patients undergoing forearm fracture reduction in the ED by a resident after the radiation safety education program were compared to 53 consecutive pediatric fracture reductions prior to the education. Radiation exposure times and amount of whole body radiation incurred by the resident were compared. Fracture reductions were performed using the mini C-arm. The mini C-arm recorded the amount of kilovolts, milliamps and the number of seconds the foot pedal was used. Whole body radiation exposure was calculated by a radiation physicist using this data. Statistical analysis was performed with data expressed as a mean +- 95% confidence interval. A student t-test was used and results were reported to be significant with p<0.05.

Results: The average age of the patients before the training session was 9.6 years compared to 9.5 years after. Of the 53 patients treated before the radiation safety program, 31 were male and 22 were female, 20 were both bone fractures and 33 were distal radius fractures. Of the 45 after the education program, 32 were male and 13 were female, 19 were both bone fractures and 26 were distal radius fractures.

20 patients who underwent a reduction of a both bone fracture before the radiation safety education utilized an average of 41.2 seconds of radiation (STDev 24.7) with 90.9 mR of radiation exposure (STDev-60.9) compared to 28.9 (STDev 14.4) seconds and 30.4 mR (STDev-18.5) for the 19 patients treated after the radiation safety education.(p-0.07 and p<0.01 respectively). 33 patients undergoing reduction of a distal radius fracture before the education session utilized an average of 38.1 seconds of radiation (STDev 26.1) and 83.1 mR of radiation exposure (STDev-58.9) compared to 26.7 (STDev 15.8) seconds and 32.6 mR (STDev-26.4) for 26 patients (p-0.04 and p<0.01 respectively) treated after the educational session.

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Conclusions: We evaluated the change in radiation exposure to both the resident and the patient when using the mini c-arm after undergoing radiation safety training by a radiation physicist including mini c-arm use. We report a statistically significant decrease in radiation exposure for distal radius and both bone fracture reductions when comparing residents before and after radiation safety training. There was also a statistically significant decrease in reduction time for distal radius fractures.

Significance: A radiation safety educational program including mini c-arm use significantly decreased the duration and amount of radiation exposure among residents performing fracture reductions in children.

See pages 21- 66 for financial disclosure information.

Serial Casting For Infantile Idiopathic Scoliosis: When Can A Cure Be Achieved?

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Summary: Mehta serial casting for infantile idiopathic scoliosis patients can grow the spine straight for a cure in nearly 40% of patients without subsequent need for treatment. This required on average 5 casts over a 10-11 month period. Predictors of success are younger age (<18 months) and smaller curve magnitude (<45 degrees).

Introduction: The goal of Mehta casting for infantile idiopathic scoliosis (IIS) is to grow the spine straight to avoid surgical treatment. There are no large consecutive studies demonstrating the likelihood of achieving a straight spine following Mehta casting and no predictors for success.

Methods: A single pediatric orthopedic institution's experience with casting in IIS patients who were less than 3 years old prior to their first cast was performed. A minimum of 2 year evaluation following the removal of their last cast was required. Patients were categorized in 3 groups at final follow-up: radiographically cured if the major Cobb angle was <10 degrees, clinically-cured if the major Cobb angle was 10-15 degrees and no clinical deformity was present, or not cured. Comparisons were made between groups to determine predictors for success.

Results: There were 31 consecutive patients at an average age of 20 months at first casting, treated with 5.1 casts over 11.4 months with an average starting curve of 48.2°. At a minimum of 2 years from the last cast, 19 had residual scoliosis, 8 were radiographically cured and 4 were clinically cured so that12 of 31 (38.7%) patients were considered cured requiring no subsequent treatment. When compared to the non-cured group, the cured group were younger at casting (15.3 vs. 24.0 months, p=0.0046) and had smaller pre-cast major curves (41.3 vs. 56.0°, p=0.0138). There were no differences between the cure and no-cure groups for having a phase 1 rib (36.4 vs 26.3%), RVAD (20.8 vs 21.8°), the number of casts (4.7 vs. 5.2 casts,) or total duration in cast (10.0 vs. 11.9 months,). In the group with residual scoliosis 15/19 (78.9%) were treated with brace only, and 4/19 (21.1%) required surgical intervention.

Conclusion: Mehta casting can straighten a spine so that it does not have radiographic or clinical scoliosis requiring further treatment in nearly 40% of patients. Younger patients with smaller major Cobb deformity are more likely to have a cure. Overall, casting has prevented surgery in 87.1% in this series with 3 years of after cast follow-up. Longer follow-up is needed to strengthen these conclusions.

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The Predictive Value of Drain Tube Tip Culture Results For Spine Infection Following Posterior Spinal Fusion Surgery

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Purpose: Spinal surgeries have the highest rate of infection compared to other orthopedic surgeries, ranging from 0.4% to 11.9%. Postoperative infection often necessitates prolonged medical and surgical management, increased medical costs, and results in adverse outcomes. Recent studies have investigated the use of drain tip culture as a predictor of infection in total joint arthroplasty and fracture reconstruction surgery, but yielded varying results. Drain tip culture was added to the standard regimen for posterior spinal fusions at Cincinnati Children's Hospital Medical Center (CCHMC) between 2008 and 2012 in an attempt to address rising infection rates. In this study, we retrospectively analyze the results of the drain tip cultures in their predictive value for postoperative surgical site infection (SSI).

Methods: Over a 58 month period, drain tips were cultured in all patients with a scoliosis or kyphosis diagnosis and a posterior spinal fusion of 5 or more vertebral levels with the use of a standard negative suction reservoir system. Two hundred twenty-seven patients (152 female, 75 male) had drain tip cultures performed. Analysis was performed with respect to demographic data, preoperative diagnosis, postoperative drain tip culture lab results, vertebral levels fused, and postoperative infection according to World Health Organization standards.

Results: Fourteen patients (6.2%) had positive drain tip cultures. Thirteen patients with positive drain tip cultures did not have an SSI. One patient had positive culture for *Pseudomonas aeruginosa*, which was different from the deep wound infection of Oxacillin Resistant *Staphylococcus aureus* (ORSA). Three patients with negative drain tip cultures had postoperative infection. The sensitivity of drain tip culture for diagnosing SSI in our patients was 0% and the specificity was 93.75%. The total financial cost in performing 227 drain tube tip cultures was $22,264.63, with each drain tube tip culture ranging from $75.83 to $137.77.

Conclusions: Based on our results, we found no correlation between a positive drain tip culture and a postoperative SSI in patients undergoing posterior spinal fusion.

Significance: This retrospective data review does not support the practice of routine drain tip culture after posterior spinal fusion for the diagnosis of postoperative infection. The associated financial cost would decrease.

See pages 21- 66 for financial disclosure information.

Vertebral Fractures in Duchene's Muscular Dystrophy Patients Managed with Deflazacort

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Purpose: We sought to establish the relationship between deflazacort use and vertebral fractures in patients with Duchene's Muscular Dystrophy (DMD).

Method: We retrospectively reviewed 49 boys with DMD on long term deflazacort therapy for incidence of vertebral fractures (VF) and its association with age at start of deflazacort treatment, duration of deflazacort treatment, Bone Mineral Density Z-score (BMD Z) and whether the patient was ambulatory at the time of fracture.

Results: Twenty-six out of 49 boys on long-term deflazacort treatment had VF. Out of 26 patients who had VF, 15% showed evidence of VF in their third year of therapy, 50% within five years of starting therapy, 73% within seven years of starting therapy, and within 9 years 100% had VF. The first evidence of VF was observed at a mean BMD Z score of, lumbar (L) = -2.2 and whole body (B) = -3.1. 85% of these had more than three collapsed vertebrae. Mean BMD Z- score at the time of or prior to when multiple fractures were noted was -2.4 (L) and -3.4 (B). The patients who started deflazacort at age 3-5 years developed a VF after a mean of 59.6 months, those who started at age 5-7 years after a mean of 67.8 months, and at age >7 years after a mean of 62.8 months. 62% of patients had VF by 12 years of age and 91% of patients by 15 years of age. Sixteen out of 26 patients were ambulatory at the time of VF.

Conclusion: Our findings suggest that there is a high risk of VF associated with deflazacort use in DMD patients.

Significance: Additional therapy, such as pamidronate, should be considered in patients on long term Deflazacort.

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The Optimal Surgical Approach for Lenke 5 Curves: Is the Anterior Approach Ready for a Comeback?

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British Columbia Children's Hospital, Vancouver, BC, CANADA

Purpose: Historically the anterior approach was the treatment of choice for Lenke 5 curves; recently the posterior approach has gained popularity for its ease, versatility and correction with screw fixation. The objective of this study was to prospectively compare both radiographic and clinical outcomes between anterior and posterior instrumented fusions in Lenke 5C curves.

Methods: A prospective, longitudinal multicenter surgical Adolescent Idiopathic Scoliosis (AIS) database identified consecutive patients with Lenke 5C curves treated either by open anterior instrumentation and fusion (ASIF) with a dual rod system, or posterior instrumentation and fusion (PSIF) with a pedicle screw-rod construct and wide posterior release. Pre and 2 year postoperative radiographic data, SRS outcome scores, and peri-operative comparisons were made between the 2 approaches.

Results: 69 patients were treated with ASIF (2002-2008) and 92 with PSIF (2002-2011). The stable and end vertebrae were similar in the 2 groups (p=0.91;p=0.62). The only differences pre-operatively were a greater curve flexibility and coronal trunk shift in the anterior group (p=0.008;p=0.05). Post-operatively the lowest instrumented vertebrae (LIV) distribution in the ASIF group was L1: 2.9%, L2: 23.2%, L3: 69.6% and L4: 4.3%, compared to L2: 5.4%, L3: 67.4% and L4: 27.4% for the posterior cases (p<0.001). There were no differences in the % correction (ASIF:59.2%, PSIF:59.6%; p=0.82), length of hospital stay(ASIF:5.6, PSIF:5.7; p=0.75), post-op day conversion to oral pain medication(ASIF:3.2, PSIF:3.2; p=0.66), and SRS outcome scores(p=0.1). Although number of levels fused was significantly lower in the anterior group (4.7 versus 6.3; p<0.001), PSIF resulted in significantly less disc angulation below LIV (ASIF:3.4, PSIF:1.8; p=0.008), greater lordosis (p<0.001), and greater % correction of lumbar prominence (p=0.01)[Table 1].

Conclusions: This prospective, multicenter study found that although ASIF resulted in shorter fusions, this was at the expense of increased disc angulation below the LIV, less lumbar lordosis, and a lower % correction of the lumbar prominence than PSIF.

Significance: The debate between anterior versus posterior surgery for Lenke 5C curves has re-surfaced with modern posterior techniques. Although significant differences in radiographic parameters were noted in this prospective, multi-center study, two-year clinical outcome scores were similar in both groups. Longer-term follow up may provide better insight into which trade-off is most ideal.

See pages 21- 66 for financial disclosure information.

Table 1

	PRE-OPERATIVE			POST-OPERATIVE		
Mean Values	Anterior	Posterior	p-value	Anterior	Posterior	p-value
Stable Vertebra Distribution (%)	L3: 2.9 L4: 43.5 L5: 53.6	L3: 2.2 L4: 41.5 L5: 56.5	0.91			
End Vertebra Distribution (%)	L2: 4.3 L3: 69.6 L4: 20.3 L5: 5.8	L2: 6.5 L3: 71.7 L4: 19.6 L5: 2.7	0.62			
LIV Distribution (%) L1 L2 L3 L4				2.9 23.2 69.6 4.3	0 5.4 67.4 27.2	***<0.001***
Lumbar Cobb (°)	45.3+/-7.2	46.3+/-7.1	0.37	18.5+/-7.2	18.7+/-7.7	0.82
Thoracic Cobb (°)	26.2+/-8.3	24.6+/-9.0	0.26	17.2+/-8.2	17.3+/-8.7	0.94
Apical Translation (mm)	-3.1+/-4.4	-2.5+/-5.4	0.43	-0.80+/-1.7	-0.67+/-2.3	0.70
Lumbar Curve Flexibility (%)	63+/-20	54+/-19	***0.008***			
Coronal C7 to CSVL (mm)	-2.1+/-2.7	-1.3+/-2.8	***0.05***	-0.6+/-1.2	-0.3+/-1.4	0.14
Lateral T5-T12 (°)	27.5+/-11.3	26.7+/-10.4	0.67	28.2+/-10.4	31.2+/-10.7	0.084
Lateral T10-T12 (°)	4.7+/-10.7	5.3+/-11.6	0.76	6.1+/-7.5	-6.2+/-7.7	***<0.001***
Lateral T12-S1 (°)	-58.9+/-11.9	-56.8+/-12.0	0.28	-56.6+/-10.9	-64.3+/-12.1	***<0.001***
Disc Angulation Below End Vertebra (°)	0.3+/-5.2	-1.4+/-5.9	0.064			
Disc Angulation Below LIV (°)				3.4+/-4.4	1.8+/-3.3	***0.008***
% Correction Lumbar Prominence				61+/-37	75+/-25	***0.01***
Length of Hospital Stay (days)				5.6+/-1.3	5.7+/-1.4	0.75
Post-op Day Conversion to PO meds				3.2+/-0.9	3.2+/-0.9	0.66
# Levels Fused				4.7+/-0.9	6.3+/-1.1	***<0.001***

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Pediatric Cervical Fractures with Associated Spinal Cord Injury: Epidemiology, Costs, and in-Hospital Mortality in 4418 Children

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Purpose: Spinal cord injuries in children in the setting of cervical spine fractures can have devastating consequences. The aim of our study is to describe the epidemiology of children with cervical spinal fractures and associated spinal cord injury and to analyze length of stay, total charges, and in-hospital mortality.

Methods: The Nationwide Inpatient Sample database was used to identify children (≤18 years of age) who had cervical spinal fractures with associated spinal cord injury and who were admitted to a hospital in the United States from 2000 through 2010 (n = 4418). Outcomes of interest were: patient characteristics (age, gender, and race), injury characteristics (fracture location and cord injury pattern), economic variables (length of stay and total charges), and mortality.

Results: Upper cervical fractures occurred half as often as lower cervical fractures (31.4% and 68.8%, respectively). Of children <8 years of age, 73.6% had an upper cervical fracture; of children ≥8 years of age, 72.3% had a lower cervical fracture. Of all children, 22.4% had complete spinal cord injury, 68.7% had incomplete spinal cord injury, 2.3% had anterior cord syndrome, and 6.6% had central cord syndrome. Patients with complete cord injury had the longest stay and highest hospital charges. Overall in-hospital mortality was 7.3%; there was a 6-fold higher mortality in in children <8 and vs ≥8 years of age (30.6% vs 5.1%, respectively; P<0.001). There was a 3-fold higher mortality in children with an upper vs a lower cervical fracture (13.5% vs 4.3%, respectively; P<0.001). Children with complete cord injury had 1.85-fold higher mortality compared to the children with overall mortality of other 3 cord syndromes (P<0.001).

Conclusion: Most cervical fractures with associated spinal cord injuries occurred in teenagers. Children <8 years were more likely to sustain upper cervical fractures than were older children. Children with upper cervical fractures had a 3-fold higher significantly higher mortality rate than those with lower cervical fractures. There was a difference in patient outcomes by cord syndrome; patients with complete cord injury had the highest length of stay, total charges, and in-hospital mortality.

Significance: The aim of our study is to describe the epidemiology of children with cervical spinal fractures and associated spinal cord injury and to analyze length of stay, total charges, and in-hospital mortality.

See pages 21- 66 for financial disclosure information.

Flexible Growing Rods: Polymer Rod Constructs May Provide Stability to Skeletally Immature Spines

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Purpose: Surgical treatments for early onset scoliosis (EOS) typically require multiple operations and many complications. A more flexible growing rod construct might result in a more flexible spine with fewer complications. Polymer rods (polyetheretherketone, PEEK) are relatively flexible in bending, and so might allow for greater range of motion (ROM) during treatment. The purpose of this study was to determine changes in spine ROM after implantation of simulated growing rod constructs with a range of clinically relevant structural properties.

Methods: Biomechanical tests were conducted on 6 skeletally immature porcine thoracic spines (domestic pigs, age 2-4 months, 35-40 kg, T1-T13). Paired pedicle screws were inserted into T3 and T4 proximally, and T10, and T11 distally. Specimens were tested under the following conditions: 1) control, then dual rods of 2) PEEK (6.25 mm, n=6), 3) titanium (4 mm, n=6), and 4) CoCr alloy (5 mm, n=4). Lateral bending (LB) and flexion-extension (FE) moments of ±5 Nm were applied. Vertebral rotations were measured using video analysis. ROM for the treated region was determined by averaging all maximum side-to-side rotations at each instrumented level. Differences were determined by t-tests and Bonferroni procedure.

Results: In LB, ROM of specimens with PEEK rods was lower than control at each instrumented level. ROM was greater for PEEK rods than both Ti and CoCr at every instrumented level. Mean ROM at proximal and distal uninstrumented levels was lower for PEEK than for Ti and CoCr. In FE, mean ROM at proximal and distal uninstrumented levels was lower for PEEK than for Ti and CoCr. Combining treated levels, in LB ROM for PEEK rods was 35% of control ($p<0.0001$) and 270% of CoCr rods ($p<0.05$). In FE ROM for PEEK rods was 27% of control ($p<0.005$) and 180% of CoCr rods ($p<0.05$).

Conclusion: PEEK rods provided increased flexibility versus metal rods, but also significantly greater stiffness than controls. Smaller increases in ROM at proximal and distal adjacent motion segments occurred most often with PEEK compared to the metal rods, which may decrease probability of junctional kyphosis.

Significance: Polymer rods constructs or composites may eventually provide a viable compromise between the stability needed for deformity correction and the flexibility needed to prevent or reduce complications at the ends of the instrumentation.

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Choosing Distal Instrumentation Level in Growing Rod Surgery – Where to Stop?

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Purpose: There is no consensus on the selection of distal instrumentation levels in growing rod surgery. Many surgeons use the stable zone of Harrington, but there is not overwhelming evidence to support this. The aim of this study was to determine the value of bending/traction radiographs in selection of distal instrumentation levels of a growing rod construct in children with idiopathic or idiopathic-like early onset scoliosis (EOS).

Methods: Twenty-three consecutive patients with idiopathic or idiopathic-like EOS who underwent growing rod surgery at two separate institutions between 2006 and 2011 were included. Lengthening procedures were performed periodically at six-month intervals. Analyses were done retrospectively for age at index surgery, follow-up period and radiographic measurements. Lower instrumented levels, neutral vertebra, stable vertebrae (SV) and stable-to-be vertebrae (StbV) were identified in the pre-operative radiographs. StbV was defined as the vertebra that was most closely bisected by the central sacral vertical line on traction and/or bending films. Tilt of lower instrumented vertebra (LIV) and LIV+1 and disc wedging under the LIV and LIV+1 were measured on the early post-operative (within 1 month post-surgery) and latest follow-up radiographs.

Results: Average age at index surgery was 83.6 ±24.4 (45-145) months. Mean follow-up period was 68.1 ±25.3 (25-107) months. LIV was the SV in 5 patients, above SV in 17 patients and below SV in one patient. On bending/traction radiographs, LIV was the StbV in 9 patients, proximal to the StbV in 8 patients and distal to the StbV in 6 patients. At the latest follow-up, tilt of LIV+1 exceeded 10° in 7 of the 8 patients which LIV was proximal to the StbV, whereas only in one of 9 patients which LIV was StbV and in none of the 5 patients which LIV was distal to the StbV. The analysis showed that selection of StbV as LIV could save an average of 1.4 vertebral segments compared to selection of SV as LIV.

Conclusion: StbV maybe the appropriate distal instrumentation level in growing rod surgery for idiopathic and idiopathic-like curves in EOS. Choosing StbV as the LIV instead of SV saves motion segments while providing good deformity control.

Significance: This study provides a simple method for distal instrumentation level selection in children with idiopathic early onset scoliosis.

See pages 21- 66 for financial disclosure information.

Abnormal Vascular Examination Predicts Poorer Outcomes in Supracondylar Humerus Fractures: A Prospective Study

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Purpose: To prospectively evaluate the relationship between vascular abnormality at presentation and functional outcome in children with supracondylar humerus fractures (SCHFX) using validated outcome measures.

Methods: An IRB approved prospective enrollment of consecutive patients with operative SCHFX was performed over a 3-year period. Among other injury parameters, the presence and symmetry of the radial pulse in comparison to the uninjured extremity was documented by the treating surgeon at presentation. Doppler examination of all non-palpable pulses was documented as was the perfusion status of the hand. Functional outcome was assessed at final follow-up using the Pediatric Outcomes Data Collection Instruments (PODCI) and the quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) Outcome Measure. Multiple regression analysis was used to determine the relationship between the presence of a vascular abnormality and functional outcome while controlling for other injury parameters including patient age, fracture classification, fracture pattern, neurologic deficit and presence of an open fracture.

Results: 752 patients were enrolled during the study period of which 199 (average age 6.7 years) completed functional outcome measures at final follow-up. Of these, 24 (12%) patients had an abnormal vascular exam at initial presentation: 11 (5.5%) with a palpable asymmetric pulse and 13 (6.5%) with a non-palpable pulse. Of those with a non-palpable pulse, 10 (5%) were dopplerable and 3 (1.5%) had no identifiable Doppler signal. Patients with a symmetric, palpable pulse demonstrated better outcomes in PODCI pain and comfort scale scores (95.2 vs. 85.2) ($p<0.002$), PODCI upper extremity scores (93.4 vs. 87.2) ($p<0.05$), and QuickDASH scores (10.9 vs. 21.6) ($p<0.003$) compared to those with any abnormal vascular examination. Patients with a palpable pulse, regardless of symmetry, demonstrated significantly higher PODCI pain and comfort scale scores (94.6 vs. 84.7) ($p<0.02$) compared to those with nonpalpable pulses. No other statistically significant differences in outcome scores were found between patients with different types of abnormal examinations (palpable asymmetric vs. nonpalpable dopplerable vs. nonpalpable nondopplerable).

Conclusions: In children with operative supracondylar humerus fractures, the presence of an abnormal vascular examination at presentation is predictive of poorer outcomes with regards to pain and upper extremity function at final follow-up.

Significance: This is the first study to prospectively determine an association between vascular examination at presentation and functional outcome using validated outcome measures following the operative treatment of children with SCHFX

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The Implication of Fracture Location on Bone Health in Children

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Purpose: Previous research has shown an association between hypovitaminosis D and increased fracture incidence in children. However, no previous study has demonstrated an explicit association between fracture location – metaphyseal (MET) vs. non-metaphyseal (NON-MET) – and vitamin D or calcium levels. The purpose of this study was to evaluate the relationship between serum vitamin D (25(OH)-D) and calcium levels with fracture location within the bone.

Methods: A retrospective review of prospectively collected data was completed. A previously identified cohort of sixty children aged 2-14 years with long bone fractures from low-energy mechanisms were included for analysis. Patients were classified by fracture location and segregated into MET and NON-MET cohorts. Mean serum 25(OH)-D and calcium levels between groups were compared using two-tailed student's t-tests. The cohorts were further compared for disparities in race, sex, BMI, medical history, family history of fracture or osteoporosis, dietary calcium intake, vitamin D supplementation, sun exposure and sunscreen usage.

Results: Forty children were in the MET and 20 were in the NON-MET cohort. The mean ages of the MET and NON-MET cohorts were 5.9 (SD=2.6) and 5.6 (SD=3.2), respectively ($p=0.724$). Similarly, there was no statistically significant difference in any other demographic, social, or medical factors. Mean serum calcium level in the MET group was 9.285 ± 0.16, which was significantly lower than that of the NON-MET cohort (9.605 ± 0.16) ($p=0.020$). Mean serum 25(OH)-D was 27.292 ± 1.92 in the MET and 30.825 ± 3.29 in the NON-MET group ($p=0.062$).

Conclusion: Children who fractured at the metaphysis had statistically significantly lower serum calcium levels and a trend toward lower 25(OH)-D levels than children with fractures outside of the metaphyseal region following similar mechanisms of injury.

Significance: Metaphyseal fractures are more likely to be associated with, and perhaps reflective of, serum calcium and vitamin D insufficiencies/deficiencies than non-metaphyseal fractures. Fracture in the diaphysis or epiphysis is not necessarily reflective of current measures of bone metabolic status (vitamin D and calcium levels), as non-metaphyseal bone is more mature compared to metaphyseal bone. In analyzing the relationship between pediatric fracture and metabolic bone health, grouping metaphyseal and non-metaphyseal fractures together may fail to identify a subset of children with acute metabolic derangement who may be at risk for low bone density. Special consideration should be given for routine testing of serum calcium and vitamin D levels in children with metaphyseal fractures, specifically.

Level of Evidence: Prognostic Level III

See pages 21- 66 for financial disclosure information.

Under Pressure: The Utility of Splitting Fiberglass Casts

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Purpose: Univalving fiberglass casts after fracture manipulation or extremity surgery is commonly performed to reduce the risk of developing compartment syndrome. Previous experiments have demonstrated that univalving decreases intra-compartmental pressures, but also alters cast mechanical properties, increasing risk for loss of fracture reduction. The purpose of this study was to correlate cast spacer width within a univalved cast as it relates to decreasing intra-compartmental pressure.

Methods: One-liter saline bags with 200-250ml removed were covered with 2" stockinette, Webril (50% overlap), and one roll of 3" fiberglass tape extending to the bag ends. Bags were connected to the arterial pressure line monitor. Resting pressure within each bag was recorded, then a water column was added to simulate two groups (n=5 each) of clinical compartment syndrome (CS): *Low Pressure CS (LPCS* range 28-31mmHg) and *High Pressure CS* (*HPCS*, range 64-68mmHg). After the designated pressure was reached, the fiberglass was cut with an oscillating cast saw, leaving the stockinette and Webril intact. Cast spacers were inserted into the univalve and taped into place at position #1 (3mm wide), #2 (6mm), #3 (9mm), and #4 (12mm). Pressure was recorded after the fiberglass was cut and following each spacer placement.

Results: In LPCS and HPCS groups, after univalve and placement of spacer position #1, pressure dropped by mean 52% and 57%, respectively. Spacer #2, however, decreased the pressure by mean 78% and 80%, respectively. Both spacer sizes significantly decreased the underlying pressure in both groups. Spacer #3 and #4 progressively reduced pressure to the pre-CS state within the cast, but not statistically significantly more than the previous spacer widths.

Conclusion: Our experimental model best replicates the iatrogenic elevation in the interstitial compartment pressure due to a rigid cast diameter, and not necessarily a self-sustained true compartment syndrome. Increasing the spread of a univalved cast to ≥9mm of the initial cast diameter will reduce pressure to a pre-CS pressure; however, a spread of only 6mm can effectively reduce the pressure to less than 30mmHg depending on the initial elevated intra-compartmental pressure being observed.

Significance: Although the utility of splitting a fiberglass cast has been previously demonstrated, we present evidence that highlights the benefit of spacing the split by at least 6 to 9mm.

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Pediatric Motocross Injuries At An Annual Elite Competition: Rates and Severity

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Purpose: Pediatric motocross injuries have been demonstrated to occur frequently and with significant associated morbidity; however, data is limited regarding injury occurring during competition. North Central Florida hosts an annual motocross competition with numerous pediatric competitors. We sought to evaluate the rates and severity of injuries sustained at this event over a multi-year period. Our primary hypothesis was that motocross injury rates and severity in competition exceed that of other competitive sports.

Methods: A retrospective review was performed identifying pediatric (17yo and younger) patients presenting to a single Level 1 Trauma Center as a result of injury sustained at an elite motocross competition from 2009-2012. Demographic, diagnostic and treatment data were recorded including injuries sustained, mechanism of injury, required procedures, and length of hospital stay. Rates and types of injury were evaluated and compared to established norms in other competitive sports at the high school level.

Results: Over a four-year period, 51 pediatric motocross competitors sustained 75 injuries. Injured riders were 14.2 ± 2.51 (8-17) years old and 92% (47/51) male. Forty (78%) patients sustained at least one orthopaedic injury and 17 (33.3%) patients suffered polytrauma. Riders were most frequently injured landing jumps (37%). Twenty-four (47%) patients required a procedure, 15 (21%) of which were operative. Thirty-nine (76%) patients necessitated pediatric subspecialty care. Twenty patients (39%) required hospital admission for an average length of stay of 2.45 ± 1.7 days. Higher level of care was required in four of these patients and one death occurred secondary to C2-C3 fracture dislocation with cord transection. Average Injury Severity Score (ISS) was 6.5 (1-75). Twenty-seven (36%) of the 75 injuries were upper extremity trauma, the most common being forearm fracture. There were 19.9 injuries sustained in pediatric motocross riders per 1000 total competitors, which far exceeds the 12.5 injuries per 1000 athletic exposures in high school football (the highest rate of injury seen in high school sports).

Conclusions: High rates and severity of injury occur among pediatric patients in competitive motocross, far exceeding that seen in other sports in this age group. The majority of patients suffer at least one orthopaedic injury and nearly all patients require pediatric sub-specialist care. Polytrauma is common.

Significance: There is significant morbidity associated with motocross injuries and mortality has been demonstrated. Pediatric subspecialty care is frequently necessary. Motocross participants should be aware of these risks of competition and event organizers should seek to arrange events near facilities with an adequate offering of pediatric sub-specialty services.

See pages 21- 66 for financial disclosure information.

Operative Versus Conservative Management of Displaced Tibial Shaft Fractures in Adolescents

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Purpose: Despite the commonplace nature of displaced tibial shaft fractures in adolescents, there is wide variability in management strategies. The purpose of this study was to assess treatment outcomes and determine predictors of failure in patients treated for displaced tibial shaft fractures.

Methods: We retrospectively reviewed all patients aged 12-18 who presented to one of two Level 1 trauma centers with a displaced tibial shaft fracture that required reduction. Exclusion criteria included open fractures and lack of follow-up to either radiographic union or to 6 months from the index procedure. Fractures were treated based on surgeon preference with one of two approaches: (1) closed reduction and casting (CRC) under conscious sedation or general anesthesia, (2) immediate operative fixation with a rigid intramedullary nail or flexible nails. Radiographic healing was defined as bridging of 3 of 4 cortices on radiographs and adequacy of final fracture alignment was defined as less than 5 degrees of angular deformity and less than 1.0 cm of shortening. Outcomes were analyzed both on intent-to-treat principles and by definitive treatment method.

Results: 74 patients were included, of which 17 were initially managed with operative fixation and 57 with CRC. While all fractures in both cohorts achieved bony healing, 23 of the 57 patients who underwent initial CRC failed closed treatment and ultimately required operative intervention (40.3%). Multivariate analysis of patient and fracture characteristics revealed initial fracture displacement of >20% of the tibial width (Odds Ratio = 7.8, $p<0.05$) and the presence of a fibula fracture (Odds Ratio = 5.06, $p=0.05$) as independent predictors of closed treatment failure. Patients managed operatively had longer hospital stays (5.4 vs 1.9 days, $p<0.001$), fewer clinic visits (4.8 vs 5.9, $p<0.01$), a higher incidence of anterior knee pain at healing (20% vs 0%, $p<0.01$) and trended towards better final alignment (92.5% adequate vs 72.4% $p=0.10$). There were no differences between cohorts with respect to time to radiographic healing, final ROM, and return to activity.

Conclusions: Treatment outcomes between initial operative fixation and attempted closed reduction of displaced tibia fractures in adolescents are similar, but treatment failure is higher in CRC. Predictors of CRC failure include initial fracture displacement >20% and presence of a fibula fracture.

Significance: Patients must be counselled about the high failure rates with CRC and the need for active follow-up during treatment; whereas, those undergoing surgical management should understand the risk of anterior knee pain and prolonged hospitalization.

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Surgical Hip Dislocation for the Treatment of Traumatic Posterior Hip Dislocation in Children

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Purpose: Traumatic posterior hip dislocation in children is a rare injury that typically is treated with closed reduction. Non-concentric reduction and joint space asymmetry have been reported as indications for surgical treatment. The surgical hip dislocation (SHD) allows for full assessment of the acetabulum and femoral head and has been our preferred surgical strategy. The purpose of this study is to report clinical outcomes after SHD for treatment of posterior hip instability in children.

Methods: Following IRB approval, 40 patients who sustained a traumatic posterior hip dislocation between 2003-2013 were identified. Two patients with acetabular fractures and one with neurofibromatosis were excluded. In 8/37 (22%) of the eligible patients there was evidence of non-concentric reduction after closed treatment and surgical treatment was performed using the SHD approach. Demographic data, mechanism of dislocation, indication for surgery, and intraoperative findings were recorded. The modified Harris Hip Score (MHHS) and the UCLA activity score assessed clinical hip outcome and activity leve at minimum of one year after surgery

Results: Seven male and one female (mean age 11.2 years; range 6-14.6) were followed for an average of 28 months (range 13-67). Six patients were treated after an acute trauma, while 2 were treated after recurrent dislocations. Five patients were involved in motor-vehicle accidents and 3 in sports. Intra-operative findings include posterior labral avulsion in all patients, fracture of the cartilaginous posterior wall (N=4) and femoral head chondral injuries (N=5) and fracture (N=1). The labral root was repaired using suture anchor technique in 7/8 patients and resected in one. In two patients labral repair was complemented by screw fixation of the posterior wall. All but one patient (MHHS=94) reported maximum MHHS. The UCLA activity score was 10 for 5/8 patients and 7 in 3 patients. No case of femoral head osteonecrosis was noted. One patient had asymptomatic heterotopic ossification.

Conclusion: Surgical dislocation of the hip allows complete assessment of hip joint pathology after posterior traumatic dislocation of the hip in children. In this case series all patients were active with minimal or no pain at an average of 28 months after surgery.

Significance: When open reduction is recommended for the treatment of posterior dislocation of the hip, the SHD is an excellent approach that allows surgical correction of the damaged bony and soft tissue structures including repair of the capsule-labral complex, reduction and internal fixation of the cartilaginous posterior wall and femoral head internal fixation.

Level of evidence: Level IV – therapeutic study, case series

See pages 21- 66 for financial disclosure information.

Incidence of Humeral Lateral Condyle Fractures Nonunion in Children

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Purpose: Nonunion following lateral condyle fracture is a known complication; however the specific incidence is yet to be documented. The purpose of this study is to analyze the incidence of, as well potential significant contributing factors leading to nonunion following lateral condyle fractures.

Methods: Retrospective chart review of children under the age of 15 that were diagnosed with a lateral condyle fracture between 2001-2014 at one level-1 tertiary pediatric center. Information collected included demographic data, past medical history, lateral condyle classification, time from injury to surgery, operative versus non operative management, open versus closed reduction and type of fixation. Nonunion was defined as no fracture callus or bony consolidation seen on X-ray after 8-12 weeks following definitive management. Patients with less than 4 weeks of follow up and potentially complicating medical history were excluded from this study.

Results: 500 children were available for review. There were 315 (63%) boys and 185 (37%) girls. The average age at injury was 5 years (range – 0.6 to 14.7). The average follow up was 10 weeks (range 4- 110 weeks). 182 (36.4%) were Type 1 fractures, 140 (28%), Type 2 and 178 (35.6%) Type 3. 168 (33.6%) were treated in a cast without reduction, 121 (24%) by closed reduction and percutaneous fixation (CRPP), and 211 (42%) by open reduction and fixation (ORPP). In the ORPP group, 10/211 (4.7%) were fixed with a screw instead of K-wires. The incidence of non-union was 2% (10/500), of which 2/140 (1.4%) were type 1 fractures, treated in a cast; 1/178 (0.55%) type 2 fracture, treated by ORPP: and 7/168 (4.2%) type 3 fractures, of which two were treated by CRPP and 5 by ORPP. Type 3 fractures were associated with nonunion (p=0.05). There was no significant correlation between type of fixation and nonunion (p=0.5), gender and nonunion (p=0.57), age and nonunion (p = 0.37) and time from injury to surgery and nonunion (p=0.69).

Conclusion: Nonunion following lateral condyle fracture is a known complication but fortunately appears to be rare with a rate of only 2%. Type 3 fractures are significantly associated with nonunion.

Significance: This is the first description of the incidence and risk factors of non-union after lateral condyle fracture in the literature.

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Change in the Epidemiology of Slipped Capital Femoral Epiphysis From 1985 to 2010

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Purpose: The changes in the epidemiology of patients diagnosed with SCFE (1985-2010) were evaluated as well as the effect of demographic changes on the dynamic of SCFE slips.

Methods: SCFE cases (n=762) were reviewed to collect epidemiological data and to identify patients with stable SCFE slip at presentation and compare them to patients with unstable slips. Data collected included gender, age at time of the first SCFE, slip stability, race, time between slips for patients with bilateral SCFE, BMI, and BMI centile. The changes in SCFE epidemiology over the last two decades were descriptively analyzed. Inclusion criteria encompassed available SCFE slip data and surgical records over the study period.

Results: Six hundred ninety patients treated for SCFE between 1985 through 2010 met our inclusion criteria, of which 27% had BL-SCFE and 7% were prophylactically pinned; mean time between slips was 10.2 months. The average age at index SCFE was 12.25 years old (range, 2.2-18.2) and 59% were males. BMI data was available for 322 patients, median BMI centile was 97.5 (25-75% IQR:93.0-99.0). Data on slip stability was available for 387 patients, of which 24% were unstable. Patients with an unstable slip had a mean BMI centile significantly less than patients with stable slips (p=0.003, 95%CI:2.4-11.3). Females were significantly younger than males (p=0.000, 95%CI:-1.6;-1.1). Overall, gender distribution, age, and ratio of stable slips to unstable slips did not change with time. Time to second slip amongst patients with bilateral SCFE and incidence of bilateral SCFE both decreased with time; in contrast, median BMI centile increased with time. Comparing changes in patients with a stable slip versus those with an unstable slip for the last 25 years, the percentages of males presenting with an unstable slip increased with time while that of females decreased with time. The slope of BMI centile increase in patients with an unstable slip was two times the slope of patients presenting with a stable slip; females presenting with an unstable slip are getting younger and males with an unstable slip are getting older.

Conclusion: The results of this study may suggest a cause-and-effect relationship between some SCFE patients' demographics and dynamics of slips. The paradigms that govern the description of SCFE high risk patients over the last two decades may need to be reassessed.

Significance: The adolescent population have changed significantly over the last 25 years and with that change so did the epidemiology of SCFE.

See pages 21- 66 for financial disclosure information.

Knee Arthroscopy Rates in Children, Adolescents, and Adults: A Comparison of Insurance Records Between Two States

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Purpose: Surgical rate variation is of interest to health care policy experts, as this information is used to evaluate and establish national standards and coverage decisions. Analysis of orthopedic pediatric surgery rate variation is limited, partially due to the lack of availability of adequate national databases. The purpose of this project was to assess the surgical rate variability of knee arthroscopic procedures in pediatric, adolescent, and adult patients from two separate, but comparable, insurance companies in two states.

Methods: This project was received IRB approval for performance improvement review. Blue Cross Insurance data (2003-12) from a western US state was compared to data (2008-12) from an eastern state, using CPT codes, age and sex.

Results: The eastern state's knee arthroscopy frequency in children, adolescents, and adults were 0.33, 6.58, and 74.57 per 10,000 people respectively, compared to the western state's frequency of 0.17, 4.29, and 35.73 per 10,000 people. Medial or lateral menisectomy had frequencies of 0.12 per 10,000 for children and 32.26 per 10,000 for adults in the eastern state, and frequencies of 0.03 per 10,000 for children and 20.31 per 10,000 for adults in the western state, making this procedure most common for these ages in both states. It was second most common in adolescents for both states (1.65 and 1.56 per 10,000 for eastern and western, respectively). Arthroscopically assisted anterior cruciate ligament repair was the most common procedure for adolescents in both states (1.83 and 1.79 per 10,000 respectively). Medial or lateral meniscus repair was second most common for children in both states (0.03 per 10,000 for both).

Conclusion: The rate of overall knee arthroscopic surgery was higher in the eastern region with approximately double the frequency of knee arthroscopy in children and adults, and 1.5 times the frequency in adolescents. Both patient populations shared the same two most common procedures for children, adolescents, and adults (menisectomies).

Significance:. Some regions in the U.S. have 5 fold or great variation in adult surgical rates for specific procedures based upon national CMS databases. Moderate variation in surgical rates is expected when comparing different regions, but significant variation in surgical rates may indicate inconsistent surgical indications and lack of evidence for procedure efficacy. Future investigations on variation in pediatric surgery rates may clarify standards for training and best practices. A national database for pediatric populations could support this type of investigations.

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Presentation of Adolescent Idiopathic Scoliosis: The Bigger The Kid, The Bigger The Curve

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Introduction: It is our clinical suspicion that children with a higher body mass index (BMI) who are diagnosed with scoliosis tend to have larger curves on presentation. The purpose of this study was to determine the effect of BMI on severity of curve at initial presentation of adolescent idiopathic scoliosis (AIS).

Methods: This is a retrospective cohort study of consecutive patients age 10 or older referred to a single large tertiary care center with concern for spinal deformity. Data collected included demographics, BMI, curve magnitude, curve location, Risser stage and where or by whom the spinal deformity was first noted. Patients were separated into three BMI categories as measured on the presenting visit: 5^{th}-85^{th} percentile—normal weight, 85^{th}-95^{th} percentile—overweight, > 95^{th} percentile—obese.

Results: 150 patients, 50 in each the normal weight, overweight and obese categories, were included in this study. Average curve at presentation for normal weight patients was 18.1^o, for overweight patients 23.9^o ($p = 0.02$) and for obese patients 24.5^o ($p = 0.02$). As compared to the normal weight group, odds ratio of presenting with a curve of 40^o or above was 10.8 for the overweight group ($p = 0.03$) and 12.2 for the obese group ($p = 0.02$). Assuming a threshold of 45^o as within surgical range, no normal weight patients presented in surgical range (0%), but 7/50 (14%, $p = 0.01$) overweight and 8/50 (16%, $p < 0.01$) obese patients did. Moreover, higher-BMI patients were significantly more likely to present at a higher degree of skeletally maturity, with an average Risser of 1.8 for normal weight patients, 2.7 ($p = 0.01$) for overweight patients, and 2.9 ($p = 0.01$) for obese patients.

Conclusion: Overweight and obese patients with AIS present with significantly larger curve magnitudes and significantly higher degrees of skeletal maturity. Moreover, these patients were significantly more likely to present with very large curves and, in our study, all patients initially presenting with a surgical curve were either overweight or obese.

Significance: To our knowledge, this is the first study to demonstrate an association between BMI and curve magnitude at presentation. As they present later in their course, overweight and obese patients with scoliosis have a narrower window for non-operative treatment. Given these findings, it is important that front-line clinicians maintain particular vigilance for AIS in their overweight and obese patients.

See pages 21- 66 for financial disclosure information.

Does The "Law of Diminishing Returns" Apply for Growing Rod Surgery After Seven Lengthenings?

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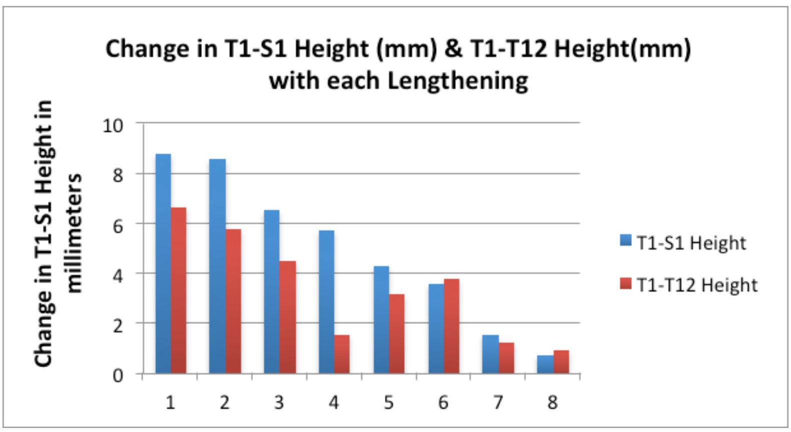
Purpose: Skaggs et al. previously demonstrated "diminishing returns" with less increase in spine height from each successive lengthening possibly due to auto-fusion of the spine. However, that study had limited follow up and only investigated the effect on T1-S1 length. The purpose of this study was to investigate the interval changes in T1-S1 and T1-T12 spine height in patients who have undergone greater than 7 lengthenings.

Methods: A multicenter early-onset scoliosis database was queried for growing rod surgery patients that had undergone at least 7 lengthenings. Subjects with more than 20% of data missing were omitted from the study. Statistical analysis utilized paired t-tests and analysis of variance.

Results: 32 patients met the inclusion criteria. The average age of study subjects was 4.8 years (1.6-9.07 years), mean follow-up was 6.7 years (4.1-17.3), and mean number of lengthenings was 9.1 (7-15). The average interval between lengthenings was 7.1 months. Cobb angle decreased significantly following pre-implantation surgery 77.1° to 46.6° ($p<.001$) and did not change significantly after repeated lengthenings ($p=0.95$). After initial implantation, the average annual T1-S1 growth was 6.9mm/year ± 5.1mm/year and T1-T12 growth was 5.4mm/year ± 3.9mm/year. Interval increases in spine height decreased with successive lengthenings as shown in Table 1.



Conclusion: Interval increase in spinal (T1-S1) and thoracic (T1-T12) height continued to decrease with successive lengthenings. It appears that the "law of diminishing returns" is observed beyond 7 lengthenings.

Significance: These findings suggest that the change in T1-T12 and T1-S1 length continue to decrease with subsequent lengthenings. Surgeons' decision towards timing of index instrumentation and timing of definitive fusion should account for this effect.

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A Novel Method for Improved Biologic Environment in ACL Reconstruction in Young Athletes

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Purpose: Previous researchers have demonstrated that collagen and autologous growth factors (AGFs) stimulate ACL healing at early time points in large animal models. This study evaluates the effectiveness of a collagen matrix – autologous growth factor combination in human ACL reconstruction.

Methods: Twenty - two patients, age 14 – 19, underwent autologous hamstring ACL reconstruction utilizing a collagen matrix augmented with AGFs. Ten patients had associated meniscal tears, all on the lateral side. Five patients underwent repair and five had partial menisectomy. The tendons were wrapped in a collagen matrix augmented with AGFs. All patients were followed to completion of physical therapy (PT) and documentation of time to complete PT was recorded. At the completion of PT, all patients had an MRI and were assessed with IKDC and Lysholm knee scores. MRIs were scrutinized for tunnel enlargement, bony edema, bony ingrowth, graft integrity and homogeneity of the graft signal.

Results: The average time to complete PT and return to sports was 19 weeks (range 14 – 24). The average follow up was 29.5 months (range 24 – 37). All patients have returned to competitive sports with no retear of their ACL reconstruction. The average IKDC score was 95 (range 85 – 100) and average Lysholm score was 97 (range 91 – 100). All patients had symmetric Lachman testing at all time intervals. There was no patient with a positive pivot shift phenomenon. All reconstructed ACLs demonstrated a dark, homogeneous signal on MRI consistent with revascularization and ligamentization. MRIs demonstrated no cases of tunnel enlargement on the femoral or tibial sides. Bony ingrowth evaluation showed excellent ingrowth on the femoral and tibial side. Second look arthroscopy with biopsy in two patients revealed three fourths revascularization at six months in one patient and total revascularization at eight months in the other.

Conslusion: In this human study, a collagen matrix augmented with autologous growth factors in ACL reconstruction significantly affects the post-operative rehabilitation time and MRI findings of ingrowth, revascularization and ligamentization of the graft.

Significance: These early findings may alter future approaches to surgery, rehabilitation and return to sports in patients undergoing an ACL reconstruction. This technique may provide some direction for primary ACL repair in the future.

See pages 21- 66 for financial disclosure information.

Internal Rotation Stress Testing Improves Radiographic Outcomes of Type 3 Supracondylar Humerus Fractures

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Introduction: The purpose of this study was to determine if routine use of an intraoperative internal rotation stress test (IRST) will reduce the incidence of loss of reduction. Our hypothesis was that fractures treated with routine IRST will have greater intrinsic stability resulting in lower rates of radiographic malunion and reoperation.

Methods: An intraoperative protocol for type 3 supracondylar humerus fractures was adopted at our institution, consisting of fracture reduction, placement of two laterally based divergent pins, and then an internal rotation stress test (IRST). If rotational instability was observed, then additional fixation was utilized to achieve stability, either a medial pin or a 3rd lateral pin. Medial pins were placed via a small open approach. Fractures treated with the prospective IRST protocol were compared with a retrospective cohort prior to adoption of the protocol (pre-IRST). Bauman's angle, the humerocapitellar angle, and the rotation index were measured on final intraoperative fluoroscopic images and compared with healed radiographs at final follow-up. Complications were recorded.

Results: There were 78 fractures in the retrospective cohort (pre-IRST) and 49 in the prospective cohort (IRST). Rotational loss of reduction (>10 degrees) was less common in the IRST cohort (1/49 vs. 13/78, p=0.009). Major loss of reduction was less frequent in the IRST cohort for both Bauman's angle (>12 degrees) (0/49 vs. 3/78, p=0.28) and the humerocapitellar angle (>10 degrees) (6/78 vs 2/49, p=0.48), although the differences were not statistically significant. There were no significant differences between the cohorts with minor changes in Bauman's angle (6-12 degrees) or humerocapitellar angle (5-10 degrees). Loss of proximal pin fixation was also noted in the pre-IRST cohort (2/78) but not in the IRST cohort (0/49), p=0.52. There were no postoperative nerve injuries or reoperations in either cohort.

Conclusion: Intraoperative IRST after placement of 2 lateral pins assists with the decision for additional fixation to achieve rotational stability (medial pin or 3rd lateral pin). In the prospective cohort, routine use of the IRST significantly reduced the incidence of rotational loss of reduction. Although the difference was not statistically different, there were 3 fractures with major postoperative changes in Baumann's angle in the retrospective cohort (no-IRST), and none in the prospective cohort (IRST).

Significance: Routine use of an intraoperative internal rotation stress test (IRST) to evaluate the need for additional pin fixation may reduce the incidence of loss of reduction.

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Is Acetabular Rim Trimming Safe and Effective For Idiopathic Femoroacetabular Impingement in The Adolescent Patient?

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Purpose: Femoraoacetabular impingement (FAI) has been most commonly treated with a femoral osteochondroplasty to address the cam-type impingement with overall good results. There is a paucity of published results in the pediatric population evaluating the effectiveness of acetabular rim trimming and labral reattachment to improving clinical and radiographic outcomes for pincer impingement

Methods: This is a prospective analysis of consecutive patients with symptomatic idiopathic FAI treated with SHD from 2004-2013 at a single institution. Pre-operative and post-operative radiographs and functional scores (modified Harris Hip Score (HHS) and the Hip disability and Osteoarthritis Outcome Score (HOOS)) were compared for SHD combined with acetabular rim trimming to those who underwent femoral head/neck osteoplasty alone.

Results: There were 50 hips in 45 patients with idiopathic FAI (13 male, 32 female) at an average age of 16.4 years (range 11.8-19.6 years) and BMI of 24.4 (17.1-40.2). All subjects presented with anterior groin and/or lateral hip pain and all had a positive impingement sign. There were 14 patients in the acetabular rim trimming group (ART) and 36 in the femoral osteochondroplasty group (FOC). All patients in the ART had labral reattachment. There were no differences in age or gender. Preoperatively, there were no differences between the ART and FOC groups in hip flexion (96.4 vs 99.3 ^{o}) or internal rotation (30.0 vs 30.7^{o}), however, the ART group had a larger LCEA (33.1 vs 28.5^{o}, $p=0.002$), without difference in acetabular index (5.1 vs 5.7^{o}) or alpha angle (64.2 vs 64.1^{o}). The ART group demonstrated a significant improvement in the LCEA (-3.0 vs 1.2^{o}, $p<0.05$) while the FOC group demonstrated greater improvement in the alpha angle (-10.8 vs -14.0 ^{o}, $p<0.05$). The HHS and HOOS scores improved at follow-up in the ART (71.6 to 90.9, $p=0.006$) (69.5 to 90.3, $p=0.002$) and FOC groups (64.3 to 82.9, $p<0.001$) (57.6 to 79.3, $p<0.001$), respectively. There weren't any reoperations in the ART group. In the FOC group, 3 patients required reoperation. These procedures included removal of screws for implant irritation (1), labral repair for an acute tear (1) and arthroscopic labral debridement for a degenerative tear.

Conclusions: Acetabular rim trimming improves the radiographic parameters of pincer impingement and, when added to a femoral osteochondroplasty leads to significant improvement in clinical scores without additional complications.

Significance: An acetabular rim trimming is safe and effective when it is deemed appropriate in the adolescent patient with symptomatic femoroacetabular impingement.

See pages 21- 66 for financial disclosure information.

Pelvic Shielding is Ineffective in Pediatric Pelvic Radiographs

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Purpose: Children and adolescents are thought to be more sensitive to ionizing radiation than adults as their tissues have more time to express its potentially carcinogenic effects. Plain pelvic radiographs are commonly used for evaluation of a variety of pediatric orthopaedic disorders. A lead shield is typically placed over the patient's gonads to minimize the radiation exposure of these sensitive tissues. However, misplaced pelvic shielding can sabotage such efforts to protect the patient from excessive radiation exposure by either not protecting the radiosensitive tissues at all or obscuring the anatomic areas of interest, prompting a repeat radiographic examination. The purpose of this study was to determine the incidence of misplaced pelvic shielding for pelvic radiographs obtained for pediatric orthopaedic evaluation.

Methods: Children aged 8 to 16 who received an AP and/or frog lateral (FL) pelvic radiograph between 2008 and 2014 were included. Of 3400 patients meeting inclusion criteria, 84 males and 84 females were randomly selected for radiographic review. Shielding was considered correctly placed if it covered the pelvic basin without covering bony landmarks for females and placed just inferior to the pelvic arch with full coverage of the gonadal shadow in males. The percent of incorrectly positioned and missing shields were calculated for both males and females and a Chi Squared Test was used to determine if the frequency of missing or incorrectly placed shields differed by gender.

Results: 668 AP and 488 frog lateral (FL) radiographs were reviewed from 168 patients (mean age 12 ± 3 yrs.) Overall, pelvic shields were misplaced in 55% of radiographs (48% AP and 63% FL). Shielding was misplaced for females more often than males (64% vs. 48%; $p<0.05$). In 8% of radiographs, the pelvic shield obscured a portion of the acetabulum or femoral head of either hip. Further, pelvic shielding was missing in 19% of studies, with females missing the shield more often than males (27% vs. 12%; $p<0.05$)

Conclusion: Pelvic shielding during routine AP and frog lateral pelvic radiographs in pediatric orthopaedic patients is incorrectly positioned over 50% of the time and will not infrequently obscure the hip joint. Errors in shielding are seen more often in females than males. Despite an institutional standard of shield use, the pelvic shield is missing from 19% of studies.

Significance: Misplaced pelvic shielding is frequently encountered in the radiographic evaluation of the pediatric pelvis and allows exposure of these radiosensitive tissues in pediatric patients to ionizing radiation. The practice of shielding for pelvic radiographs needs to be re-evaluated and more effective alternatives need to be investigated.

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Predicting Mrsa Osteomyelitis Based on Clinical Parameters – The Atlanta Experience

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Introduction: Compared to MSSA, MRSA infections are more virulent, deeply invasive and have a higher rate of mortality. Therefore, being able to make an early and accurate diagnosis can certainly affect clinical outcome. Several algorithms for identifying patients with MRSA versus MSSA have been proposed. The purpose of this study is to observe the accuracy of Kocher's previously published prediction criteria to our population in which there is a greater percentage of MRSA infections and to determine if there is a different set of clinical parameters that can be utilized to help predict MRSA osteomyelitis infections in our pediatric population.

Methods: A retrospective chart review over a 6-year period from 2006-2012 was undertaken after IRB approval. A total of 20 clinical parameters were collected including age, gender, symptom duration, weightbearing status, antibiotic use, history of hospitalization, temperature, blood pressure, heart rate, WBC, ANC, Bands, SEGs, hematocrit, platelet count, ESR, CRP, and MRI findings. Univariate and multivariate analysis were performed to identify predictors. ROC curves were used to find an optimal cutoff value for continuous predictors. Sensitivity, specificity, positive and negative predictive value were calculated for both the previously identified algorithm and the new algorithm.

Results: Of the 161 patients reviewed, 97 had MSSA osteomyelitis and 63 had MRSA. Significant univariate clinical parameters differentiating the groups included age, heart rate, WBC, ANC, ESR, CRP, and a subperiosteal abscess identified on MRI. The significant multivariate predictors for MRSA included WBC>9.3, ESR>45, and the presence of a subperiosteal abscess on MRI. Based on these clinical parameters, the predicted probability of MRSA osteomyelitis with 3 predictors is 73%, with 2 predictors is 55%, and with 1 predictor is 44%. When applying Kocher's predicting algorithm to the Atlanta population, having all 4 clinical parameters had a positive predictive value of 80%, 3 predictors was 65%, 2 predictors was 54%, and 1 predictor was 43%.

Conclusions: In our analysis, WBC>9.3, ESR >45, and the presence of a subperiosteal abscess on MRI was most predictable of MRSA in the Atlanta population. Kocher's criteria were also applicable to our population. If a patient presents acutely with these clinical parameters, we would recommend aggressive treatment with antibiotics tailored specifically against MRSA and thorough irrigation and debridement. MRI is a useful adjunct to clinical decision-making and should be used with clinically possible.

Significance: These predictors are clinically useful when identifying patients with MRSA versus MSSA osteomyelitis.

See pages 21- 66 for financial disclosure information.

The Evolving State of Acute Pediatric Septic Arthritis and Osteomyelitis

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Purpose: To evaluate the evolving patterns of pediatric osteoarticular infection in concert with the emergence of community-associated MRSA as a prevalent pathogen.

Methods: The records of all patients treated at our institution for acute hematogenous septic arthritis and osteomyelitis between January 2005 and December 2011 were retrospectively reviewed for demographic, diagnostic, clinical, and radiographic data.

Results: Of the 240 patients who met inclusion criteria, 100 were diagnosed with MRSA osteoarticular infection, 51 were infected with MSSA, and 75 patients had no identifiable pathogen. The overall incidence of infection was 4.29 cases per 1000 hospital admissions, with no significant annual variability. The mean age of MRSA patients was significantly lower (6.4 ±years), compared to MSSA patients (8.9 ± (p=0.002). While MRSA patients experienced more febrile days and longer hospital stays than MSSA patients, there was no significant difference in admission laboratory values, surgical procedures, or long term complications. Subperiosteal abscess was evident in 51% and 45% of MRSA and MSSA patients, respectively, compared to only 17% of culture-negative patients (p=0.0001). Surgical intervention was required in 87% of MRSA patients and 84% of MSSA patients. DVT was identified in 12 MRSA patients, 5 of who subsequently developed septic PE. Eight MRSA patients developed chronic osteomyelitis, as opposed to only one case in MSSA patients. Intramuscular abscess was common to both groups, seen in 9/100 MRSA patients and 4/41 MSSA patients. Empiric antibiotic therapy consisted primarily of clindamycin and/or vancomycin, and was tailored according to microbial sensitivities.

Conclusions: Community-associated MRSA is a leading cause of pediatric osteoarticular infection, responsible for nearly half of all cases at our institution. Virulent strains of MSSA have now begun to produce similar clinical courses. Clinicians must maintain a heightened sense of awareness for the development of myriad morbid complications, particularly subperiosteal abscess requiring surgical intervention, and deep venous thrombosis with subsequent risk of septic pulmonary emboli.

Significance: An original publication from our institution in 2006 highlighted the increasing incidence and severity of community-associated MRSA bone and joint infections in children. While the incidence of these cases seems to have stabilized, patients infected with both MRSA and MSSA continue to experience serious clinical sequelae despite prompt recognition and appropriate antimicrobial therapy.

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The Effect of Foot Alignment on Ankle Power in Children with Cerebral Palsy

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Purpose: In individuals with cerebral palsy (CP), foot type may play **a significant role in** function. The purpose of this study was to examine the relationship between foot alignment and sagittal ankle power and moments in ambulatory children with CP.

Methods: A retrospective study was performed with inclusion criteria of: diagnosis of CP, 5-18 yrs, GMFCS levels I or II, 3-D gait analysis, and no prior surgery. Exclusion criteria included lower extremity contractures > 5° and the uninvolved limb of hemiplegic subjects. Chart review included demographics, ankle physical exam, sagittal ankle kinetics, velocity, tibia kinematics, and plantar pressures. Foot type (neutral, varus, valgus) was defined by clinical exam, static standing posterior video using Dartfish software, and coronal plane pressure index[1] from plantar pressures. An average of $\geq$3 representative gait cycles were calculated in Orthotrak for peak sagittal ankle power and moments during 3rd rocker and average stance tibial torsion(°). Statistical analyses were performed in SAS with $\alpha \leq 0.05$. Multivariate generalized linear models were used to assess patient and clinical factors which predicted ankle power/moment. Factors with $p \leq 0.25$ from univariate tests were included in multivariate models until factors with $p \leq 0.01$ remained. Post-hoc tests were conducted pairwise and adjusted for multiple comparisons with the Tukey-Kramer.

Results: 59 subjects, n=72 feet, were included. Descriptive statistics include: mean age 10 $\pm$ 3.6 yrs; GMFCS level I=33, level II=38, 58% hemiplegia feet, 42% diplegia feet, and foot type: neutral =21, varus=17, valgus =33. The following clinical factors had no effect on ankle power or moments: velocity, BMI, gender, tibial torsion, type of CP, or selective motor control. GMFCS level 1 created more ankle power (p=0.0002) and moments (p= 0.022) than level II subjects. Foot type predicted ankle power (p=0.0047) with varus foot type having the least power at 0.87 watts/kg versus neutral (1.13 watts/kg) or valgus (1.18 watts/kg). Valgus (p=0.0045) and neutral (p=0.0223) had more power than varus foot type.

Conclusion: This study concluded children with CP and GMFCS level I have better ankle kinetics than level II. Additionally children with varus foot type have the most severe impairment in power generation, among children with CP.

Significance: Our findings suggest surgical correction of the varus foot in children with CP may be justified in order to enhance ankle power generation.

See pages 21- 66 for financial disclosure information.

Functional and Radiographic Outcomes of Adductor Myotomy in Patients with Spastic Cerebral Palsy

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Purpose: Hip displacement is the second most common musculoskeletal deformity in children with spastic cerebral palsy (SCP). Adductor myotomy (AM) can delay or prevent worsening hip subluxation and may obviate further procedures. However, considerable debate remains over the success of this preventive intervention in management of SCP. The purpose of this study was to analyze functional and radiographic outcomes of AM and assess risk factors associated with subsequent interventions.

Methods: Retrospective chart review was performed of all patients with SCP who underwent AM by a single surgeon between 1977-2007. Exclusion criteria were <5 year postoperative follow-up, <12 years old at final follow-up, and concomitant bony procedure at index surgery. Charts/radiographs were reviewed for demographics, function (GMFCS), type of AM, hip range of motion (ROM), and Reimer Index (RI). Subgroup analysis comparing GMFC level 1-3 vs. level 4-5 was performed. Multivariate regression, with a 95% confidence interval, was performed to assess the risks associated with subsequent AM and hip osteotomy. Statistical analysis utilized independent T-test for continuous and χ^2-test for categorical variables. Alpha of $p \leq 0.05$ denoted statistical significance.

Results: 134 patients had sufficient data for inclusion. After average follow-up of 8.6 years, 82 (61.2%) did not require further surgical intervention. 17 patients (12.7%) required two or more AM, 12 (8.9%) underwent a bony procedure, and 23 (17.2%) required both an additional AM and an osteotomy. 75% of the GMFCS 1-3 group required only a single AM, compared to 56% in the GMFCS 4-5 group ($p<0.05$). Patients with lower functional capacity (GMFCS 4-5) more often required revision AM than higher functioning patients (38.0% vs 14.6%, $p<0.05$). However, the rate of bony surgery did not significantly differ based upon GMFCS (28.0% vs 18.8%, $p=0.28$). After controlling for demographics, subsequent AM was associated with increased risk of osteotomy ($p<0.05$). At final follow up, average bilateral RI was $\leq 30^{\circ}$ in both groups.

Conclusion: AM is a successful procedure to address hip displacement in ~60% patients with SCP. Need for revision surgery is higher in patients with higher GMFCS. However, need for bony surgery did not correlate with GMFCS level. Our results suggest patients who require >1 AM are at increased risk for bony surgery.

Significance: This study affirms that AM continues to have an important role in the treatment of hip displacement in patients with SCP. This data helps to counsel patients and their families on risk of further surgery based on functional level.

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Table 1 – Characteristics of Patient Population		
Gender	Male 89 (66.4%)	Female 45 (33.6%)
Diagnosis	Diplegia 56 (41.8%)	Quadriplegia 78 (58.2%)
GMFCS - 1 - 2 - 3 - 4 - 5	 11 (8.2%) 20 (14.9%) 23 (17.2%) 17 (12.7%) 38 (28.4%)	
Preoperative Reimer Index Average (SD)	Right 36.15% (18.42)	Left 33.03% (15.45)
Average Age (SD) - First Adductor Myotomy - Last Follow up	 6.8 (6.49) 15.41 (4.37)	
Patients with a primary Adductor Myotomy - Right - Left - Bilateral	134 6 (4.5%) 7 (5.2%) 121 (90.3%)	
Number of Adductor Myotomies per patient - 1 - 2 or more	 94 (70.1%) 40 (29.9%)	
Patients who underwent Osteotomies - Pelvis - Femur - Pelvis + Femur	35 (26.1%) 2 (5.1%) 25 (64.1%) 12 (30.8%)	
Patients with only one intervention	82 (61.2%)	

See pages 21- 66 for financial disclosure information.

O2 Cost and Walking Speed in Youth with Cerebral Palsy

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Background/Objectives: Oxygen (O_2) cost (*mlO$_2$/m*) represents gait economy and is derived by dividing oxygen uptake (*ml/kg/min*) during gait by walking speed (*m/min*). In normal gait it is stable over a modest range of speeds. We know gait in youth with cerebral palsy (CP) is associated with high O_2 cost, but we do not know whether O_2 cost is stable across speeds in this group. Improved economy is a common goal of gait surgery and achieving it requires knowledge of how walking speed and O_2 cost interact for youth with CP. The purpose of this study was to examine the stability of O_2 cost over a range of self-selected walking speeds in youth with CP.

Design: IRB Approved, Cross Sectional, Descriptive Measurement Study, Level I Evidence

Participants and Setting: A convenience sample of youth with CP, GMFCS Levels I-III, ages 6-18 years, without recent orthopedic surgery or Botox injections from two pediatric hospitals.

Materials and Methods: Youth with CP at GMFCS Level I (28), II (16) and III (13) mean age 12.6 (SD=3.3) participated in a single test session performing a range of physical activity (PA) tasks while wearing the Cosmed k4b^2. During three 6-min walk tasks, youth walked at a slow, brisk, and fast pace. Mean VO_2 from the middle 2-min of each walk was divided by velocity (d/t) to calculate O_2 cost. ANOVA was used to analyze differences in walking speed and O_2 cost between the 3 walking tasks.

Results: 53 participants had complete VO_2 and speed data. On average, youth had a 61% change in walking speed from slow to fast. Differences in speed between tasks are significant for all comparisons ($p<.001$). No significant differences exist for O_2 cost between speeds (table 1).

Table 1: Walking Tasks: Speed and O_2 Cost (*p<.001)

Walking Task	Slow	Brisk	Fast
Speed *(m/min)*			
Mean (+/-SD)	46.31 (12.40) *	62.28 (15.34)*	74.07 (18.44) *
Range	15.930-77.390	33.650-97.560	32.910-115.200
O_2 Cost *(ml/m)*			
Mean (+/-SD)	0.335 (0.148)	0.299 (0.101)	0.302 (0.098)
Range	0.171-0.866	0.162-0.546	0.170-0.619

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Conclusions/Significance: Self-paced walking speeds and O_2 costs varied widely among youth in this study who were able to vary speed by more than 60% from slow to fast. Changes in walking speed, however, produced no significant differences in O_2 cost. This supports the use of O^2 cost for pre to post surgical outcome evaluation in the presence of modest speed differences.

See pages 21- 66 for financial disclosure information.

Does Patellar Position Change with Growth After Patellar Tendon Advancement in Children with Cerebral Palsy?

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Purpose: Terminal knee extensor insufficiency is a major contributor to crouch gait in individuals with cerebral palsy. Patellar tendon advancement (PTA) is commonly used prior to skeletal maturity to avoid injury to the proximal tibial growth plate. Both loss of correction (patella alta) and progressive overcorrection (patella baja) with subsequent growth have been a concern. The purpose of this study is to evaluate change in patellar position over time to evaluate if over-correction or recurrence of deformity occurs.

Methods: Radiographic findings of subjects with CP who underwent PTA prior to the end of skeletal growth were reviewed to assess the effect of subsequent growth on patellar position in relation to the knee. Patients had a minimum of 3 years of expected growth remaining at the time of surgery and minimum radiographic follow-up of 3 years. The Koshino Index (KI) was measured on pre-operative, 3 month post-operative, and yearly thereafter until 3 years postop or skeletal maturity. The KI Z-score was assessed for effectiveness of the procedure by comparing the early post-operative to the pre-operative value. Sequential KI Z-score measurements were reviewed to assess patellar position. The final follow up KI Z-score was compared to the pre-operative and the 3 month post-operative values to evaluate the effect of growth on patellar position.

Results: Forty subjects (69 knees) were reviewed. 70% also underwent concomitant distal femoral extension osteotomy (DFEO). Two patients received growth modulation with 8-plates instead of DFEO. Average age was 11.5 +/- 1.3 years. Average length of follow-up was 4.3 years (range 3.0 – 8.9 years). At 3 months post-op, patellar position was overcorrected (average KI Z-score = -1.99 PTA only and -3.93 DFEO+PTA). The majority of patients had change in their KI Z-score between 2 and 6. Variation was noted in the magnitude of over-correction after the initial post-op period. (Figure 1).

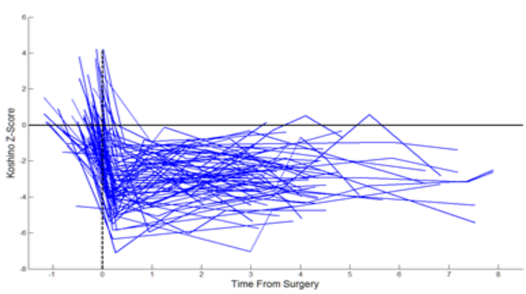

Fig 1: KI Z-scores over time from surgery
Y axis =KI Z-scores; X axis time from surgery

Discussion: Our experience shows that correction of knee extensor insufficiency requires overcorrection of patellar position. These results indicate when PTA is performed prior to skeletal maturity correction of patellar position is maintained over time and is not progressive.

Significance: PTA patients may show a change in radiographic measurements initially, but subsequent measurement does not show progressive over-correction.

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Parental Perception of Quality of Gait in Children with Spastic Diplegia

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Purpose: To determine if the parental perception of overall walking ability as measured by the Gillette Functional Assessment Questionaire (FAQ) correlated with the Gait Profile Score (GPS) calculated from kinematics gathered during gait analysis.

Methods: A retrospective cohort of 116 patients with bilateral cerebral palsy underwent gait analysis using the VICON system. Kinematic data were used to calculate the GPS (using sagittal plane motion of the pelvis, hip, knee and ankle, coronal plane motion of the hip and pelvis, and transverse plane data from the pelvis, hip, and foot progression angle). The GMFCS classification of each child was noted from clinical examination and review of the medical record. GMFCS level 1 and 2 patients were compared to GMFCS levels 3 and 4. Parents were administered the FAQ, and rated their child's walking ability on a scale from 1 to 10.

Results The average age of the patients was 12.9 +/- 2.6 years, and there were 66 males and 50 female patients. The GPS averaged 12.76 for the 71 GMFCS 1 and 2group and 16.99 for 45 GMFCS 3 and 4 patients ($p<0.0001$). The parents of community ambulators rated their child as as such 94.4% of the time, while the more severely affected group was rated by their parents as independent ambulators in 53.3%. In analyzing the group of patients whose parents rated them as most independent in ambulation (FAQ between 7 and 10), the GPS calculated from kinematic data was 12.4 for the GMFCS 1 and 2 ambulators and 16.3 for the GMFCS3 and 4 group.

Conclusions Parents of children who function at the GMFCS 3 and 4 levels rate their children's ambulation more favorably than their kinematic data would support. Parents of children who function at GMFCS levels 1 and 2 more accurately rate their children's ambulatory ability.

Significance Careful assessment of parental opinions for surgical intervention should include discussion of the quality of preoperative gait for realistic goal setting following SEMLS surgery, especially in patients in GMFCS levels 3 and 4.

See pages 21- 66 for financial disclosure information.

Does Gender Affect Outcomes Following Medial and Lateral Hamstring Lengthening in Children Diagnosed with Cerebral Palsy?

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Purpose: The purpose of this study was to assess if there were gender differences in the short-term gait outcomes for children/adolescents following medial and lateral hamstring lengthening when performed either in isolation or as part of single event, multilevel surgery.

Methods: An IRB-approved retrospective study was performed to identify children with spastic diplegia who had pre and post-operative motion analysis studies after medial and lateral hamstring lengthening. Demographic data was collected in addition to GMFM, temporal-spatial and kinematic data. General linear models repeated measures analysis of variance (ANOVA) was performed to assess mean changes over time for all participants and between gender, as well as independent sample t-tests of pre-operative variables. A p-value of <0.05 indicated statistical significance.

Results: 121 patients met the inclusion criteria – 80 male and 41 female. There was no significant difference between the two groups for age, height, time between evaluations, GMFCS classification, pre-operative GMFM scores, or pre-operative kinematic data. The mean age at surgery was 12 years for both male and female patients, and the average time from surgery to post-operative gait study was 1.4 years (0.6-4 years). Post-operatively, walking speed, decrease in cadence, and increased stride length demonstrated non-significant increases with surgery. Both groups demonstrated a significant decrease in anterior pelvic tilt, decrease in hip flexion during stance, and decrease in stance-phase knee flexion (p<0.001). Females demonstrated a larger decrease in knee flexion throughout the gait cycle compared to males (p<0.05). Medial and lateral hamstring lengthening caused a greater proportion of female patients to have knee hyperextension (22% v. 10%, p=0.01) post-operatively. Female patients also demonstrated a decrease in the walking, running, and jumping subset of the GMFM post-operatively compared to males who gained function in this category (p<0.01).

Conclusion: Significant gender differences exist between males and females when performing medial and lateral hamstring surgery. The surgery results in a greater decrease in knee flexion, i.e. crouch, in females, but also significantly increases the risk for knee hyperextension. The result of this leads to lower functional scores on the GMFM in the area of walking, running, and jumping for females, while the same surgery in males improves functional outcome.

Significance: Medial and lateral hamstring lengthening in females should be used in a more judicious manner to avoid hyperextension and maximize their functional outcome.

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The Coagulation Profile During Scoliosis Surgery in Adolescent Idiopathic Patients

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Purpose: Spinal deformity surgery represents a major challenge to patient's coagulation process, and blood loss remains a significant morbidity of the surgical treatment of scoliosis.

Methods: Fifty-eight patients undergoing surgical correction of Adolescent Idiopathic Scoliosis (AIS) by posterior spinal fusion (PSF) with instrumentation had their bleeding profile analyzed. Patients were screened to exclude any patient with suspicion of pre-existing bleeding abnormality. A comprehensive panel of bleeding parameters was obtained at incision and then at each hour mark of operative time plus closure. The panel consisted of hemoglobin/hematocrit, platelet count, PT/T, fibrinogen degradation products (FDPs) and d-dimer levels, and thromboelastogram (TEG). TEG provides a global view of a patient's coagulation system in a rapid "point of care" test. Paired t-tests were used to compare means at different surgical time points. SAS v9.3 was used for analyses.

Results: The mean age was 13.5 years (range 11-17years), mean surgical length was 3 hours and 23 minutes (range 2 hours to 5 hours and 7 minutes), and the gender distribution was typical for idiopathic scoliosis (47 females and 11 males). The PT increased slightly from 14.2 at incision to 16.1 by 3 hours (p-value <0.0001). Platelets were consumed, decreasing from 231 to 184 at closure (p-value <0.0001). Mean hemoglobin remained fairly stable from 11.9 to 9.6 at closure (p-value <0.0001). From the TEG, the R times, representing initial clot formation, decreased from 4.6 to 3.4 minutes at 2 hours (p-value=0.002). The MA (platelet function) remained stable at 66 mm through the 3 hour mark (p-value=0.58). The Lysis at 30 minutes (LY30), an indicator of clot stability, changed from incision 2.2 to 3.9 at 3 hours (p-value=0.23). Indicators of fibrinolysis were detected: FDPs were present in 11 patients by 2 hours and in 24 patients by 3 hours; D-dimer was present earlier, in 33 patients by 2 hours.

Conclusion: The coagulation profile of healthy AIS patients undergoing PSF remained stable throughout the procedure. TEG provided interesting insight into the details of that process. Patients demonstrated increased clot formation through the first 2 hours of the case and showed signs of fibrinolysis by 2-3 hours.

Significance: The comprehensive analysis of patient coagulation during surgery for AIS provides improved understanding of the process and opportunity for further study. Preliminary evidence supports the use of antifibrinolytic therapy in AIS patients.

See pages 21- 66 for financial disclosure information.

Is Preoperative Lumbar Rotation Predictive of Postoperative Curve Behavior in Selective Thoracic Fusions?

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Purpose: The extent of preoperative lumbar apical vertebral rotation (AVR) may influence curve behavior following selective thoracic fusion in adolescent idiopathic scoliosis (AIS) patients with Lenke C curves. The purpose of this study was to determine the effects of preoperative lumbar AVR on postoperative curve behavior, as determined by radiographic measurements.

Methods: This was a multicenter retrospective review of 52 consecutive patients with AIS, Lenke types 1-4, lumbar modifier C, with a minimum follow-up of 2 (mean 4.2) years, who underwent selective thoracic posterior spinal fusions (LIV=L2 or higher). Lumbar AVR was assessed using the Nash-Moe (NM) grading system. Coronal decompensation was assessed as the horizontal displacement of the C7 plumb line (C7PL) from the center sacral vertebral line (CSVL).

Results: Of the 52 patients who met inclusion criteria, 2% (1/52) had a NM grade of 0, 46% (24/52) had a NM grade of 1, 52% (27/52) had a NM grade of 2. The lumbar curve did not appear to derotate following selective thoracic fusion (preoperative mean NM grade 1.5±0.08, postoperative mean NM grade 1.5±0.09, p=0.9335). Preoperative lumbar AVR did not correlate with postoperative lumbar Cobb angle (23.8±10.2°, p=0.56), thoracic Cobb angle (25.0±9.7°, p=0.668), or coronal decompensation (18.9±10.6mm, p=0.098) at final follow-up.

Conclusion: Preoperative lumbar AVR did not exhibit significant associations with post-operative Cobb angles or coronal decompensation at final follow-up in selective thoracic fusion of Lenke type C curves.

Significance: Multiple factors should be considered when planning posterior spinal fusion for Lenke C curves. Predicting the behavior of the uninstrumented curve following selective thoracic fusion remains challenging. Preoperative lumbar rotation does not appear to significantly influence postoperative curve behavior.

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Rib Penetration in Children with Neurofibromatosis and Scoliosis

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Background: Previous case reports have described children with neurofibromatosis type 1 (NF1) and scoliosis developing a complication known as rib penetration, the migration of a rib head through the vertebral foramen into the spinal canal. Rib penetration is associated with spinal cord compression and has been implicated as a cause of paralysis. Prevalence and risk factors of rib penetration in children with NF1 and scoliosis are currently unknown.

Methods: We conducted a retrospective cohort study of all children with NF1 and scoliosis who underwent imaging at the Hospital for Sick Children (Toronto, Ontario) from January 2000-January 2013. Patients were identified using the hospital radiology database, and NF1 was defined using criteria established by the National Institutes of Health. Using a standardized data collection form, data was collected on patient demographics, growth percentiles, complications of NF1, and imaging findings. Rib penetration was defined as any rib head crossing a line tangential to the neural foramen on axial cuts. Baseline characteristics of those with and without rib penetration were compared using Chi-square tests or Fisher's exact tests for categorical variables and Student's t-tests or Wilcoxon Rank Sum tests for continuous variables, as appropriate. Multivariable logistic regression was used to determine factors independently associated with rib penetration.

Results: Ninety-one children with NF1 and scoliosis were followed for a mean of 5.4 years, and 16 (17.6%) developed rib penetration. All children who developed rib penetration had dystrophic curves. In univariate analysis, factors associated with rib penetration were younger age at presentation, presence of optic gliomas, lower weight percentile, lower height percentile, higher presenting Cobb angle, presence of neurofibroma at the apex, and dural ectasia. Multivariable modeling controlling for age at presentation, height percentile, and presenting Cobb angle showed higher presenting Cobb angle to be statistically significantly associated with rib penetration with an Odds Ratio of 1.07 (95% Confidence Interval: 1.03-1.11).

Conclusions: Children with NF1 and scoliosis are at risk of developing rib penetration. Cobb angle at presentation is an independent risk factor for development of rib penetration, with a 7% increased risk for every degree of curvature.

Significance: The prevalence of rib penetration in children with NF1 and scoliosis is higher than previously suggested. Physicians should obtain cross-sectional imaging to evaluate for rib penetration in children with higher presenting cobb angles and dystrophic curves. Further study is required to quantify the risk of neurological complications associated with rib penetration and determine optimal management strategies.

Posterolateral Diskectomies As Alternative to Anterior Posterior Spinal Fusion in Children with Severe Spinal Deformities

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Purpose: Removal of the convex-side PLL, annulus and discs at the deformity apex spinal shortening and posterior-only deformity correction. The aim of this study was to compare the results of posterolateral diskectomies (PLD) at the apex of the deformity as an alternative to anterior releases and posterior spinal fusion (APSF) for significant thoracolumbar deformity.

Methods: We retrospectively compared 18 children (mean age: 15.9±3 years, 8F, 10M, 94±21° coronal Cobb, 63±30° sagittal Cobb) who underwent PLD to 19 children (mean age: 14.5±2.4 years, 14F, 5M, 106±20° coronal Cobb, 70±36° sagittal Cobb) who underwent APSF. There was no significant difference in the mean age (P=0.11), preoperative coronal (P=0.09) and sagittal (P=0.53) Cobb, and number of posterior levels fused (P=0.60). There was a significant difference by diagnosis (P<0.01): idiopathic scoliosis (3 vs 15), neuromuscular or syndromic scoliosis (15 vs 4). In the PLD group, diskectomies were performed at apical levels on the convexity, removing the convex annulus, convex half of the posterior endplate, with rib head resection if it limited convex shortening. Radiographic results and clinical results, and complications were compared. Significance was set at P<0.05.

Results: PLD group had on average 2.6±0.7 diskectomies, and APSF had on average 7.7±2 anterior levels released (P<0.01). PLD group had a lower final coronal Cobb (28° vs 47°, P<0.01); there was no significant difference in final sagittal Cobb (34° vs 41°, P=0.30). There was no significant difference in blood loss (1.65 vs 1.60L, P=0.87). The PLD group had significantly shorter operative time (305 mins vs. 403 mins, P=0.02). There were no intra-operative neuromonitoring changes or neurologic complications in the PLD group. In the APSF group, 2 patients had intraoperative loss of signals requiring removal of implant. The PLD group had significantly shorter overall length of hospital stay (12 vs 25 days, P=0.03).

Conclusion: PLD offers a single-approach alternative to APSF for dealing with moderately large spinal deformities. It can achieve better coronal and equivalent sagittal correction with shorter operative time and a reduced risk of monitoring changes.

Significance: Our aim was to compare posterolateral diskectomies at the apex of the deformity as an alternative to anterior releases and posterior spinal fusion. We found that PLD offers a single-approach alternative to APSF, and can achieve better coronal and equivalent sagittal correction with shorter operative time and a reduced risk of monitoring changes.

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◆ Is There A Relationship Between Lengthening Intervals and Rod Fracture in Traditional Growing Rod Surgery For The Treatment of Early Onset Scoliosis?

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Purpose: Traditional growing rod surgery for the treatment of early onset scoliosis (EOS) requires periodic rod lengthenings typically every 6 months until the patient reaches skeletal maturity. However, due to complications and other unexpected reasons, lengthening intervals can widely vary between patients. FEA studies have shown that patients with shorter lengthening intervals (more frequent lengthenings) result in a lower incidence of rod fracture compared to patients who had longer lengthening intervals.

Methods: To test this hypothesis, a multicenter EOS database was queried. Patients who met the following criteria:1)dual growing rod surgery;2) minimum 2-year follow-up;3)minimum 2 lengthenings were included. Only patients with revision surgery related to rod fracture were included. A total of 138 patients met the criteria. 56 patients experienced at least one rod fracture during the study period (RF group) while the remaining 82 patients had no rod fractures (NRF group). In addition to each patient's lengthening intervals, we also compared demographics, construct details, and radiographic parameters between the groups.

Results: RF and NRF patients had a mean pre-op age of 5.7 years (range 1.3-10.7) and 7.3 years (range 1.6-12.8), respectively ($p < 0.001$). There was no significant association between etiologies and rod fracture and there was no significant difference in lengthening intervals between the RF and NRF group ($p > 0.05$).

	INTERVALS										
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
NRF	8	8.64	9.23	9.77	9	8.15	11.28	9.79	6.74	7.59	--
RF	8.16	8.26	8.06	7.88	9.06	8.39	10.02	6.46	6.77	9.33	14.26

The last lengthening interval prior to fracture in RF was not statistically different from NRF mean lenghtening interval (FR 9.2 months vs. NFR 8.5 months; p 0.610). RF and NRF patients had statistically similar mean pre-op major curve size and max kyphosis (p 0.279; p 0.619, respectively). There was no difference in % curve correction post surgery between the groups (p 0.431). SS rods fractured more frequently compared with Ti rods (SS 49.2% vs. Ti 38%; p 0.004). Rod diameter was not statistically different in two groups (RF 4.6mm vs. NRF 4.8mm p value 0.262).

Conclusions: Lengthening intervals were not statistically different in RF and NRF groups. Hence, shorter lengthening intervals (more frequent lengthenings) should not benefit the dual growing rods in terms of rod fracture prevention. Patients who had rod fracture were younger and had more SS rods.

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Significance: Lengthening intervals did not appear to be a risk factor for the incidence of the rod fracture in the traditional dual growing rods.

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Scoliosis School Screening: Analysis of The Cincinnati Metropolitan Statistical Area

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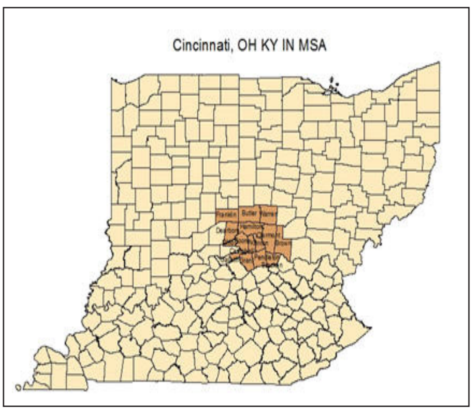
Purpose: The purpose of our study was to assess the status of scoliosis school screening in our metropolitan statistical area (as defined by the US Census).

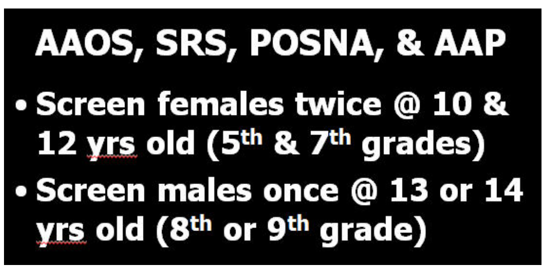
Methods: Scoliosis school screening has a long history in the U.S.A., dating back at least to the 1960's. The results of the BrAIST study have generated renewed interest in school screening. The SRS, POSNA, AAOS, & AAP support scoliosis screening and these four professional societies suggest that females be screened twice at age 10 and 12 (grades 5 and 7), and boys once, at age 13 or 14 (grades 8 or 9). The Cincinnati metropolitan statistical area (MSA) includes 5 OH, 7 KY, and 3 IN counties with an overall population that exceeds 2 million people. We surveyed via phone interview 214 schools (104 elementary, 84 middle, 15 high, 11 K-12 schools) in our MSA regarding scoliosis school screening policies and compared these to SRS/POSNA/AAOS/AAP standards. Fisher's exact test was used for data analysis.

Results: We found that 46% (99/214) of schools performed some type of scoliosis screening for their students. Only 5 of the schools precisely complied with the SRS/POSNA/AAOS/AAP guidelines, while 20 schools "included" the guidelines by over screening up to four additional grades (e.g. screening boys in 5th thru 9th grade instead of just screening 8th grade boys once). KY has legislatively mandated school screening, while OH and IN do not. Surprisingly there was a statistically lower rate (p=0.004) of school screening in KY schools (8%, 1/12) vs OH & IN (53%, 51/96).

Conclusion: The publication of the BrAIST study gives us cause to re-examine scoliosis school screening. We found that even among the 46% of schools that offer screening, less than 1% currently comply with SRS/POSNA/AAOS/AAP standards.

Significance: The BrAIST study has established that we have an efficacious early intervention (bracing), which opens the conversation for implementing screening in schools.





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The Effects of Proximal Hooks Versus Screws on Shoulder Balance in PSIF

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Purpose: Currently, there is no agreed upon standard of care with regard to proximal hooks versus pedicle screws in instrumented fusion constructs. Our objective was to analyze the efficacy of proximal hooks versus pedicle screws in correcting and maintaining shoulder balance in patients with adolescent idiopathic scoliosis treated with posterior spinal instrumentation and to evaluate the effect of each construct on the development of post-operative proximal junctional kyphosis (PJK).

Methods: A total of 40 AIS patients treated with segmental posterior spinal instrumentation and fusion were evaluated: 20 with all screw constructs and 20 with proximal hook constructs with a minimum 2-year follow-up. Radiographic measurements analyzed included sagittal proximal junctional angle (PJA) and shoulder height on pre-op, early post-op, and most recent follow-up standing radiographs. The proximal junctional angle (PJA) was defined as the Cobb angle between uppermost instrumented vertebra (UIV) and two vertebrae supra-adjacent to the UIV. PJK was defined as PJA greater than 10 degrees and at least 10 degrees greater than the pre-op measurement.

Results: There was no significant difference between the screw and hook cohorts with respect to patient age, gender, major Cobb, levels fused, pre-op PJA and shoulder height, or time to follow-up. The incidence of PJK at latest follow-up for both groups was 5% (1 in hook group, PJA = 43; 1 in screw group PJA=34). There was no significant difference in post-op PJA between screws and hooks (11.3 vs 13.3, p=0.29), post-op shoulder height (9.8mm vs 12.7mm, p=0.33), final PJA (13.5 vs 16.3, p=0.26) or final shoulder height (9.5mm vs 9mm, p=0.26).

Conclusion: Both proximal hooks and screws are viable alternatives for the proximal end of posterior spinal constructs. Both are equally effective in correcting and maintaining shoulder balance and neither is significantly more likely to result in the progression of proximal junctional kyphosis.

Significance: In our study we found that hooks and screws were equally effective in correcting and maintaining shoulder balance and preventing proximal junctional kyphosis. As hook constructs tend to be both safer and less difficult to place in the upper thoracic spine and generally require less soft tissue dissection, we advocate the use of proximal hooks.

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Does the "Law of Diminishing Returns" Apply to Guided Growth Shilla Constructs?

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Purpose: In early onset scoliosis (EOS) patients treated with growing rods, Sankar et al. demonstrated progressively less improvement of T1-S1 length over time. This is known as the "law of diminishing returns." Our objective was to determine whether the "law of diminishing returns" applies to EOS patients treated with guided growth Shilla constructs.

Methods: Patients with EOS treated with a Shilla construct at two centers were retrospectively reviewed. Included patients were less than 10 years of age at the time of instrumentation and were followed for a minimum of two years. T1-S1 length was measured on upright radiographs preoperatively, postoperatively, and at annual intervals. Nonparametric analysis of variance and linear regression of the data was performed.

Results: 33 patients met the inclusion criteria. Mean age at index instrumentation was 6.0 years (range 2.0 to 9.9 years). Mean follow-up was 4.8 years (range 2 to 8 years). Postoperative radiographs demonstrated an average gain of 4.7 cm in T1-S1 length from preoperative values. At year 1, however, 73% (24/33) showed a decrease in T1-S1 length when compared to postoperative T1-S1 lengths. On average the T1-S1 length at one year was 1.4 cm less than the postoperative values. There was an overall increase in T1-S1 length in years 2 through 8 (year 2= 1.3 cm, 3=0.72 cm, 4=0.89 cm, 5=1.22 cm, 6=0.83 cm, 7=0.83 cm, 8=4.4 cm). The increase in T1-S1 was statistically significant for years 2 through 5 (p=0.003, p=0.02, p=0.006, p=0.005). A similar increase trended toward significance in years 6 to 8, but was limited by the small number of patients with greater than 6 year follow-up. The change in T1- S1 between year 1 (a decrease) and year 2 was significantly different (p=0.0003). There was no significant difference in the change in T1-S1 over time for the subsequent years (p=0.21, 0.79, 0.78, 0.31, 0.91, 0.27).

Conclusion: With mean follow-up of 5 years, statistically significant annual increases in T1-S1 length were sustained in patients treated with Shilla constructs.

Significance: The law of diminishing returns observed in growing rods does not appear to affect Shilla constructs in the same manner.

See pages 21- 66 for financial disclosure information.

Smaller Patients Lose A Greater Proportion of Their Blood Volume During Posterior Spinal Arthrodesis

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Purpose: Our goal was to analyze the relationship between patient size and proportion of blood volume lost during spinal arthrodesis in patients with a diagnosis of adolescent idiopathic scoliosis, Scheuermann's kyphosis, or cerebral palsy. Because spine surgery involves a linear dimension with standard steps, we hypothesized that smaller patients (those with smaller blood volume) lose a greater proportion of circulating total blood volume during surgery.

Methods: A large multicenter database was reviewed, identifying patients with adolescent idiopathic scoliosis (1832), Scheuermann's kyphosis (106), or cerebral palsy (196) who had undergone posterior spinal arthrodesis surgery for spinal deformity. Blood volume (estimated from body weight) was used as a measure of patient size. Our primary outcome was the proportion of total circulating blood volume lost (percentage intraoperative blood loss/blood volume). We used univariate and multivariate linear regression models to analyze the following covariates: age, sex, levels fused, major coronal curve correction, T2-T12 kyphosis correction, and T12-S1 lordosis correction for the 3 surgical cohorts (significance, $p < 0.05$).

Results: On multivariate analysis, there was a negative relationship between percentage of intraoperative blood loss/blood volume and blood volume in patients with adolescent idiopathic scoliosis (coefficient, -5.8; $p < 0.001$), Scheuermann's kyphosis (coefficient, -2.5; $p < 0.001$), or cerebral palsy (coefficient, -20.3; $p < 0.001$), indicating that, despite adjusting for all other factors, smaller patients lost a greater proportion of their blood volume. In patients with adolescent idiopathic scoliosis or Scheuermann's kyphosis, multivariate analysis showed the percentage intraoperative blood loss/blood volume also increased significantly with male sex and increasing numbers of levels fused.

Conclusion: There is an inverse relationship between the proportion of blood volume lost during deformity correction surgery and size in patients with adolescent idiopathic scoliosis, cerebral palsy, or Scheuermann's kyphosis. Surgical teams should be aware that smaller patients tend to lose a larger proportion of blood volume during deformity correction.

Significance: The findings from this study have substantial implications for perioperative management. The inverse relationship between patient size and percentage intraoperative blood loss/blood volume suggests that smaller patients have a smaller relative reservoir of blood volume in relation to blood loss during surgery.

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There is Variability of Patient Standing Position in Operative Adolescent Idiopathic Scoliosis (Ais) Patients: A Motion Capture Analysis

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Purpose: Radiographic assessment factors into surgical decisions such as fusion levels and corrective strategy in patients with AIS. Radiographs may not accurately capture body alignment since they capture only a single moment in time. Motion capture analysis may better evaluate standing alignment in patients with AIS.

Methods: After institutional review board approval, consecutive enrollment of preoperative patients with AIS was done. Custom reflective spheres with radiopaque centers were applied to surface landmarks. Six, thirty second motion capture trials were performed per patient: three in PA and three in lateral radiographic position. For each position, one trial was performed without the assistance of an alignment jig and two done utilizing a torso alignment jig to standardize position. Radiographs, with the radiopaque markers, were performed immediately following motion capture using the same alignment jigs as the motion capture. Coronal and sagittal balance was measured for each motion capture trial and on the radiograph (sample, figure 1). Agreement between trials was evaluated with Bland Altman plots. Poor agreement was defined as variance of coronal or sagittal balance >20mm.

Results: 34 patients (29 female, 5 male) with a mean age of 14.4 years were included. Over 30 second trials, sagittal and coronal balance ranged, on average, 17.6 ± 10.1 mm (max range=56.5mm) and 8.8 ± 4.3 mm (max range=21.7mm) respectively. Median sagittal balance of unaligned motion capture trials had poor agreement with trials using the alignment jig. Median coronal balance had good agreement between both the aligned trials and the unaligned trial. Retest reliability was strong for sagittal (R=0.92) and coronal (R=0.98) balance when using the alignment jig. Radiographic trials showed poor agreement with all motion capture trials in both planes. No bias or systematic deviations were observed between trials.

Conclusion: Significant change in alignment is observed over 30 seconds despite asking patients to stand still. Even with reliable positioning between motion capture trials, poor agreement was observed upon comparison with radiographs.

Significance: Despite their importance in surgical planning, radiographs capture only a small moment in time and alternative methods to evaluate standing alignment may better reflect the dynamic standing posture.

See pages 21- 66 for financial disclosure information.

Temporary Intraoperative Instrumentation of Lowest Instrumented Vertebra + 1: A Novel Technique to Help Minimize Extent of Arthrodesis in Scoliosis

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Purpose: Limiting the extent of arthrodesis remains a fundamental goal of Adolescent Idiopathic Scoliosis (AIS) surgery, particularly for Lenke 3C, 5C, and 6C curves. To date, no firm guidelines exist for consistently ending fusions at the end vertebra (EV) with considerable variability among surgeons on choosing the lowest instrumented vertebra (LIV). The aim of this study was to present a novel technique to minimize extent of fusion in AIS surgery.

Methods: 3 independent spine surgeons blinded to the study question analyzed preop xrays on 10 consecutive patients to determine their selection of LIV. These responses were compared to the actual LIV of these patients postop. In all patients, a temporary pedicle screw was placed at LIV+1 to help with deformity correction, particularly apical translation, leveling LIV and minimizing disc angulation below LIV. Following placement of rods, this temporary screw was removed intraoperatively. Patient demographics were obtained through chart review and preop and most recent follow-up radiographic outcomes were analyzed.

Results: All patients were female with a mean age of 16.1 years, preop mean major cobb of 64.3° (range 40°-75°), and average follow-up of 10 months (range 3-22). The distribution of EV was L2:1, L3:5 and L4:4 with an average tilt of 28.9°+/-9.8°. Preop apical vertebral translation was a mean 71mm+/-24mm. L4 was the suggested LIV from the independent surgeons in 56.7% of cases, whereas L3 was suggested in 43.3% for this cohort. LIV for all cases (100%) in this series was L3 utilizing the LIV+1 temporary fixation technique. The % curve correction, apical translational correction, and rib/lumbar prominence correction was 80.6%, 85.9%, and 67.4%/57.1%, respectively at final follow-up. The LIV tilt was reduced to 4.5°+/-4.2° and the disc angulation below LIV was a mean 4.1°+/-3.6°[Table 1].

Conclusions: Temporary instrumentation of LIV+1 allows for predictably shorter fusions of lumbar curves than traditional techniques. Significant correction of the EV angulation along with significant improvement in the disc angulation below LIV is achieved without compromising curve correction.

Significance: Limiting the extent of arthrodesis remains a fundamental goal of AIS surgery, particularly for Lenke 3, 5 and 6C curves. We present a novel technique to help preserve lumbar motion which is critical for lumbar disc health in the lifetime of an AIS surgical patient.

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Table 1

Mean	Pre-operative	Post-operative
Lenke Curve (n)	5(5), 3(2), 1 (1), 6(4)	
EV Distribution	L2:1, L3:5, L4:4	
Major Cobb (°)	64.3 +/- 8.8	12.5+/-5
Age (yrs)	16.1 [13.9-21.7]	
Independent Surgeon Selected LIV	L3: 43.3%; L4: 56.7%	
Actual LIV		L3: 100%
T5-T12 Kyphosis (°)	29.3+/-11.3	24.9+/-4.7
T12-S1 Lordosis (°)	52.2+/-12.4	52.1+/-8.7
Apical Vertebral Translation	71mm+/-24mm	10mm+/-0.4mm
EV Angulation (°)	28.9°+/-9.8°	
LIV Angulation (°)		4.5°+/-4.2
Disc Angulation Below LIV (°)		4.1°+/-3.6
Thoracic Rib Prominence (°)	13.8+/-4.4	4.5+/-1.5
Lumbar Prominence (°)	10.5+/-3.5	4.5+/-2.9

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◆ Safety and Efficacy of Apical Resection Following Growth Friendly Instrumentation in Myelomeningocele Patients with Gibbus: Growing Rod Vs. Luque-Trolley

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Introduction: Myelogibbus is a unique deformity with adverse health effects. Kyphectomy and short segment instrumentation is prone to failure and recurrence of the deformity. On the other hand, early long segment fusion causes trunk shortening and thoracic insufficiency. Kyphectomy and growth preservation techniques (GPt) can be used as alternatives to prevent fixation problems and growth retardation. The efficiency and safety of the deformity correction with GPt have not yet been investigated. The aim of this study is to compare the outcome of patients treated with kyphectomy and growing rod (GR) or Luque-Trolley (LT).

Methods: We treated 10 patient with GR and 5 patients with LT following kyphectomy (vertebral column resection or multiple eggshell). Mean age at initial surgery was 6 years and 8,3 years for the GR and LT patients, respectively. Mean age at the last follow-up was 12.5 years for GR patients and 13.1 years for LT patients. GR were lengthened every 6 months. Unplanned surgery was defined as operation for infection or implant failure. Thoracic and local kyphosis and T1-S1 and T1-12 heights were measured pre- and, postoperatively and at final follow-up.

Results: There was an average of 8.1 lengthenings during the mean follow-up of 72,7 months for GR group. There were no deaths. The mean follow-up was 68,6 months for the LT group. Mean T1- T12 heigth gaining was 5.3 cm for GR and 4.0 cm for LT patients during the follow-up period. The lengthening per year was 1.11 cm for GR and 0.7 cm for LT patients (0.297). Mean T1- S1 lengthening was 10,6 cm for GR and 4.2 cm for LT patients (p:0.027). 14 unplanned surgeries were performed in GR group including 10 implant revisions, 5 debridements for 1 deep and 4 superficial infections. An additional 4 implant revisions were done in regular lengthening. 1 debridement was done for deep infection and 3 implant removals were performed in LT group. Measurements are given in table 1.

Conclusions:GPt following kyphosis restoration with kyphectomy provide successful deformity control while allowing spinal growth, especially in the thoracic spine. The GPt further improve the degree of thoracic kyphosis. Both growth preservation and deformity control can be achieved. GR allows more length gain but unplanned surgeries might be required with a relatively higher complication rate in GR patients than the LT patients.

Summary: Kyphectomy and growth preservation techniques applications are safe, effective and growth-friendly with manageable complications for myelomeningocele patients.

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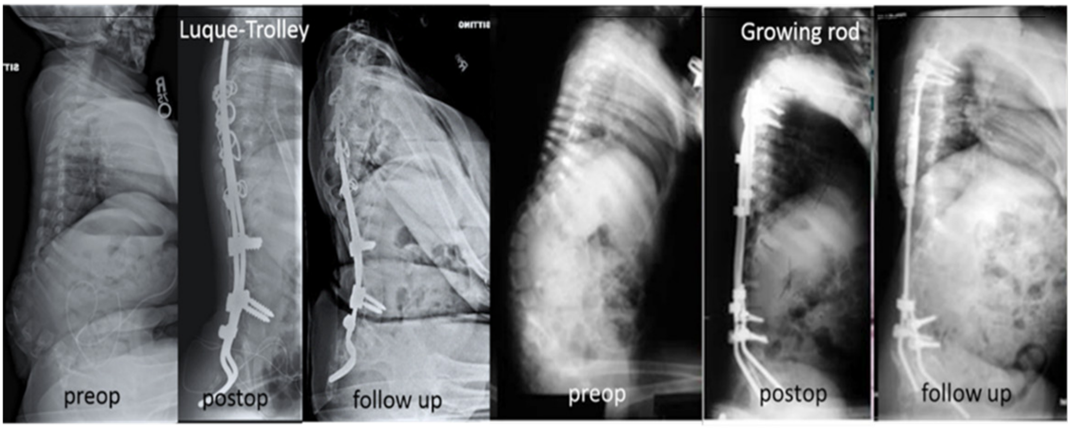
Table 1: Measurements of GR and LT patients

	Pre-op		Post-op		Last follow-up	
	GR	LT	GR	LT	GR	LT
Mean T2-12 kyphosis (degrees)	1 (-25 - +35)	-11.3(-18-0)	17.4 (0 – +35)	19.6 (-14-+50)	20.5 (+6-+45)	35.6 (+21-+46)
Mean local Kyphosis (degrees)	72.3 (10-110)	106.6 (86-132)	16.9 (-50 – +55)	15.6 (-37-+50)	21.6 (-41– +97)	19.2(-42-+38)
Mean T1-12 height (cm)			14.0 (11.2-18.7)	16.1 (14.4-19.7)	20.4(16.1-25.7)	20.1(15.5-24.6)
Mean T1-S1 height (cm)			21.0(17.2-23.2)	25.3(21.4-28.8)	31.6(23.6-41.5)	29.5(25.3-31.2)



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Factors Associated with Non-Accidental Trauma Evaluation Among Patients <36 Months Old Presenting with Femur Fractures

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Purpose: In 2009 the AAOS published practice guidelines on the treatment of pediatric diaphyseal femur fractures recommending a non-accidental trauma (NAT) work-up on all patients presenting <36 months of age. A previous study suggested poor clinical compliance (48%) with this recommendation. We assessed factors associated with a NAT evaluation for femur fractures in this population in an attempt to determine areas for improvement in guideline compliance.

Methods: We performed a retrospective review of all patients presenting to a single pediatric tertiary care hospital with a diaphyseal femur fracture between 2007 and 2013, <36 month old. Medical records were reviewed for documentation of an NAT evaluation, patient characteristics, presence of other fractures or injuries, and hospital of presentation. Radiographs were reviewed for fracture location and pattern. T-tests and Chi-square tests were used to assess for differences overall and before and after CPG publication.

Results: During the study period, 281 children <36 months presented with a femur fracture; 41% underwent an evaluation for NAT. Over the study period, the following factors were significantly associated with receipt of the NAT evaluation: younger age (p<0.001), transfer from an outside facility (p=0.03), and identification of another facture (p=0.004). Prior to publication of the CPG, non-white patients were much more likely to undergo NAT evaluation compared with white patients (43% vs 19%; p=0.01). After publication, this differential disappeared (43% vs 47%; p=0.69). Fracture pattern and patient gender did not influence receipt of NAT evaluation.

Conclusion: In general we found poor utilization of NAT evaluation for patients presenting with femur fracture < 36 months old. Despite CPG publication, only modest improvements in this evaluation occurred over time, with less than half of all patients being evaluated. Patients transferred from other institutions, presenting with concomitant fractures, and very young children were more likely to undergo NAT evaluation, indicating patients with isolated femur fractures and older children should be focused on to improve compliance with this CPG. Interestingly we found an improvement in the utilization of NAT for white patients following the CPG publication, indicating a possible correction of racial bias in initiation of NAT evaluation.

Significance: Evaluation of children < 36 month old for NAT following presentation of a femur fracture is inadequate. Older patients, those presenting initially to tertiary care centers, and those with isolated injuries are at greatest risk for non-evaluation. This CPG publication may have improved racial bias in the use of NAT evaluation.

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Nerve Injury Predicts Worse Functional Outcomes in Supracondylar Humerus Fractures: A Prospective Study

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Purpose: To prospectively evaluate the relationship between neurologic deficit at presentation and functional outcome in children with supracondylar humerus fractures (SCHFX) using validated outcome measures.

Methods: An IRB approved prospective enrollment of consecutive patients with operative SCHFX was performed over a 3-year period. Among other injury parameters, the presence and type of any neurologic deficit was documented by the treating surgeon at presentation and throughout the follow-up period. Functional outcome was assessed at final follow-up using the Pediatric Outcomes Data Collection Instruments (PODCI) and the quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) Outcome Measure. Multiple regression analysis was used to determine the relationship between the presence/type of nerve injury and functional outcome while controlling for other injury parameters including patient age, fracture classification, fracture pattern, vascular abnormality and presence of an open fracture.

Results: 752 patients were enrolled during the study period of which 199 (average age 6.7 years) completed functional outcome measures at final follow-up. Of these 22 (11%) patients had a neurologic deficit at the time of initial presentation with 24 nerve injuries noted: 10 (42%) anterior interosseous nerve (AIN) deficits, 5 (21%) posterior interosseous nerve (PIN) deficits, 4 (17%) ulnar nerve deficits, 3 (12%) median nerve deficits, and 2 (8%) radial nerve deficits. As a group, patients with neurologic injury demonstrated significantly lower PODCI happiness scale scores than those without (85.0 vs. 95.2, $p<0.002$), PODCI sports and physical function scores (79.5 vs. 89.8, $p<0.04$), PODCI upper extremity scale scores (84.4 vs. 93.6, $p<0.01$), and more disability as measured by the QuickDASH scores (21.5 vs. 11.0, $p<0.03$). There were no significant differences in outcomes scores when comparing different types of nerve injuries. All nerve injuries resolved without further intervention with no residual nerve deficits in at final follow-up.

Conclusions: In children with operative supracondylar humerus fractures, the presence of a nerve deficit at presentation is predictive of poorer outcomes with regards to pain, function, mobility and satisfaction at final follow-up despite complete spontaneous resolution.

Significance: This is the first study to prospectively determine an association between neurologic deficit and functional outcome using validated outcome measures following the operative treatment of children with SCHFX.

See pages 21- 66 for financial disclosure information.

Efficacy and Safety of Percutaneous Reduction and Sacroiliac Screw Placement with a Pelvic Reduction Frame: A Review at a Single Institution

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Purpose: Percutaneous techniques for fixation of posterior pelvic ring injuries are well described in the adult literature, but there is scarce data for this technique in the pediatric population. Our aim is to review cases at a single institution and report on complications, operative data, and quality of reduction with a pelvic reduction frame.

Methods: An IRB approved retrospective review was performed of twenty consecutive pediatric patients with posterior pelvic ring injuries and instability that had percutaneous intervention by a single surgeon from 2007-2011. Inclusion criteria were age ≤18 years, and unstable posterior pelvic ring injury that required sacroiliac (SI) fixation. Data parameters reviewed include age, skeletal maturity, operative data, quality of reduction, post-surgical complications, and classification of fracture type using the Young Burgess system, Orthopaedic Trauma Association (OTA) Classification, and the Shore modification of the Torode System.

Results: 8 male and 4 female patients were treated with percutaneous fixation of the SI joint with a mean age of 12.5 years (1-18yrs). All patients exhibited an immature Risser sign (0-4) and 4 patients had open triradiate cartilage. The most common fracture pattern was a Lateral Compression Type fracture with 5 occurrences. There were also 4 vertical shear, 2 Anterior-Posterior Compression fracture types, and 1 mixed mechanism fracture types. All injuries were OTA 61-C and Shore-Torode type 4. Average initial displacement was 9.4mm. All measured postoperative films showed <2mm of displacement, except for a single patient with 3mm of postoperative displacement. When patients who had concomitant open interventions in the same setting were excluded the average estimated blood loss was 9.4ml. The mean anesthetic time was 137 minutes and average length of stay was 14.5 days. 4 patients eventually had screws removed. A single patient, who also sustained a head injury, was found to have painless heterotopic ossification. Average follow up was 18.8 months.

Conclusion: Percutaneous fixation of the unstable SI joint is a viable treatment option in the pediatric population and allows for stable fixation with minimal blood loss and minor complications. Parents and patients should be counseled that in addition to risks already outlined in the adult literature these patients are more likely to require hardware removal.

Significance: To our knowledge, the technique of fluoroscopically guided SI screw placement with a pelvic reduction frame has not been reported in the pediatric literature. Particular importance should be noted of the 4 patients in our cohort with open triradiate cartilage.

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Treatment Outcomes After Pathologic Femoral Diaphyseal Fractures in Non-Ambulant Children

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Purpose: A variety of treatment strategies have been described for the management of pediatric diaphyseal femur fractures (PDFF) in ambulatory children. However, there exists little research on the management of PDFF in non-ambulatory children with low functional demands. Therefore the purpose of this study was to review the surgical treatment of PDFF in a cohort of non-ambulatory children with low functional demands and identify risk factors associated with complications and poor outcomes.

Methods: After IRB approval, a retrospective chart review was performed on all non-ambulatory children (<19 years) with pathologic diaphyseal femur fractures treated at a single pediatric hospital from October 2000 to November 2013. Supracondylar and metaphyseal fractures as well as patients with diagnoses of osteogenesis imperfecta, tumors, fibromas, or other metabolic bone disease were excluded from the analysis. Radiographs, clinical outcomes, and complications were analyzed.

Results: There were 28 patients with 33 fractures reviewed (19 M, 9 F, age 10.7 ± 4.89). 21 patients (75%) had a primary diagnosis of cerebral palsy and the majority were GMFCS IV & V (19/21, 90%). Fractures were treated with locked plate and screws (n=18), flexible intramedullary nails (n=7), rigid intramedullary nails (n=1), or spica cast (n=7). Pre and postoperative radiographic correction was significantly different between the open and casting treatment groups in the coronal and sagittal planes respectively (p=0.03, p=0.005). A complication rate of 27% (9/33 fractures) was observed across our cohort. Complications related to treatment including failure of hardware/prominence (n = 5), wound infection (n = 2) and loss of fixation (n=2). The flexible intramedullary nailing group experienced the highest complication rate (5/7, 71%) compared to the spica casting (3/7, 43%) and plate and screw group (1/18, 5%) (p=0.003). Hardware removal was also most common in the flexible intramedullary nail group (5 patients, 71%) compared to 2 patients in the plate and screw group (2/18, 11%). There were no cases of re-fracture after initial fixation.

Conclusion: The management of pediatric diaphyseal femur fractures in non-ambulatory children is challenging with a high rate of complication. Flexible intramedullary nailing was associated with a high rate of loss of fixation, hardware prominence and malunion; while locked plate and screw fixation resulted in no cases of implant failure or loss of fixation.

Significance: Surgeons treating diaphyseal femur fractures in non-ambulatory children should recognize the higher complication rate associated with treatment and consider locked plate and screw fixation as their first treatment choice.

See pages 21- 66 for financial disclosure information.

Reducing Cost and Radiation Exposure During the Treatment of Pediatric Greenstick Fractures of the Forearm

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Purpose: We hypothesize that after successful closed reduction of pediatric greenstick fractures of the forearm, there is a low rate of loss of reduction requiring intervention. By reducing the frequency of clinical and radiographic follow-up, we can reduce costs and radiation exposure.

Methods: A retrospective chart review was performed of patients ages 2-16 years treated with closed reduction and cast immobilization for greenstick fractures of the forearm at our institution between 2003 and 2013. The frequency of clinical and radiographic follow-up was determined by the treating orthopaedic surgeon. The primary endpoint was loss of reduction requiring intervention based upon the judgment of the treating provider. Acceptable radiographic alignment was defined as angulation of ≤10 degrees for all proximal third forearm fractures regardless of age. For middle and distal third forearm fractures, alignment was considered acceptable in patients ≤ 8 years of age with ≤20 degrees of angulation and in patients >8 years of age with ≤10 degrees of angulation. Time-derived activity-based costing (TDABC) was used for cost analysis. We estimated radiation exposure in consultation with our hospital's radiation safety office.

Results: One hundred and nine patients (41 females, 68 males) with average age of 6.9 years (range 2-15 years) met inclusion criteria. Both bones were fractured in 68% of cases, with initial fracture angulation averaging 19 degrees (range 2-55 degrees). All patients underwent closed reduction within five days of injury. Patients were followed for an average of 60 days (range 19-635 days) after initial injury. On average, patients received 3.6 follow-up clinical visits following immediate emergency department care and a total of 4.9 sets of radiographs during treatment. Ninety-five percent of patients met criteria for acceptable radiographic alignment. Only one patient (0.9%, 95% CI =0.2%-5.0%) underwent re-reduction, as determined by the treating physician ten days after injury. No patient required operative fixation. Based upon this data, if clinical follow-up was limited to two visits and three sets of radiographs total (injury films and two follow-up radiographs), there would be an 11% reduction in total cost of fracture care and a 41% reduction in radiation exposure.

Conclusion: This retrospective study suggests that pediatric greenstick fractures of the forearm rarely require intervention after initial successful closed reduction. We propose that two clinical follow-up visits and three sets of radiographs, comprised of initial injury films and two follow-up radiographs, would reduce overall care costs and radiation exposure without compromising care.

Significance: The results of this study suggest that cost and radiation exposure may be safely reduced during non-operative care of pediatric greenstick forearm fractures.

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◆ Evaluation of Limb Lengths and Physeal Growth: The Use of Low Dose Biplanar Radiography (EOS) and Tantalum Bead Implantation

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Purpose: CT scanogram is the gold standard for diagnosing limb length discrepancy and evaluating growth following epiphysiodesis. Assessing growth following epiphysiodesis is a challenge due to lack of naturally occurring landmarks to measure between. Tantalum beads have previously been used with traditional plain radiography and radiosterometric analysis to assess growth and alignment. Tantalum bead implantation in conjunction with CT scanogram or EOS imaging has not previously been described. The purpose of this study was 1) to assess the accuracy of EOS compared with CT scanogram for length measurement, and 2) to assess inter and intra rater reliability of length measurements on both EOS and CT scanogram.

Methods: Ten skeletally immature cadaveric lamb femurs were procured, and 0.8 mm tantalum beads were inserted into the cortex at various positions. CT scanogram and EOS imaging were obtained. Measurements of total bone length on the AP and lateral views, and measurements between each bead pair were recorded on AP and lateral views. Measurements were made by two orthopedic surgeons on two separate occasions. Repeat measures were made two weeks apart. EOS was compared to CT scanogram using pairwise Pearson correlations. Intra- and inter-rater reliability was assessed using pairwise Pearson correlations. All analyses were performed using STATA 12.0.

Results: EOS measures showed near perfect correlation to CT scanogram (Table 1), while intra-rater (Table 2) and inter-rater (Table 3) reliability were also excellent for both total length and intra-bead distances on both EOS and CT scanogram.

Conclusion: EOS is comparable to CT scanogram in the assessment of total limb length and intra-bead measurements. Intra and inter rater reliability was excellent for all measurements. In many instances there was perfect correlation between observers for intra-bead measurements, and perfect correlation between repeat measures for intra-bead measurements. The benefits of EOS compared to CT scanogram may include the ability to assess both the AP and lateral planes, evaluation the legs in a weight-bearing position, and lower radiation exposure.

Significance: The combination of EOS imaging and tantalum bead implantation allows for accurate and reliable measurement of both overall limb growth and distances between surgeon implanted markers.

See pages 21- 66 for financial disclosure information.

Table 1. Accuracy of Length Measurements by EOS Compared to CT scanogram

	Pearson r	95% CI
AP Total	0.967	0.864, 0.992
AP Medial	1.000	1.000, 1.000
AP Lateral	1.000	0.999, 1.000
SAG Total	0.995	0.979, 0.999
SAG Medial	0.999	0.997, 1.000
SAG Lateral	0.998	0.991, 1.000

Table 2. Intra-Rater Reliability of EOS and CT scanogram

	Pearson r	95% CI
EOS		
AP Total	0.999	0.993, 1.000
AP Medial	1.000	1.000, 1.000
AP Lateral	1.000	0.999, 1.000
SAG Total	0.999	0.995, 1.000
SAG Medial	1.000	1.000, 1.000
SAG Lateral	1.000	0.999, 1.000
CT Scanogram		
AP Total	0.997	0.985, 0.999
AP Medial	1.000	1.000, 1.000
AP Lateral	1.000	0.998, 1.000
SAG Total	0.998	0.991, 1.000
SAG Medial	1.000	1.000, 1.000
SAG Lateral	1.000	0.999, 1.000

Table 3. Inter-Rater Reliability of EOS and CT scanogram

	Pearson r	95% CI
EOS		
AP Total	0.994	0.972, 0.999
AP Medial	1.000	1.000-1.000
AP Lateral	1.000	1.000. 1.000
SAG Total	0.992	0.967, 0.998
SAG Medial	0.999	0.997, 1.000
SAG Lateral	0.999	0.994, 1.000
CT Scanogram		
AP Total	0.998	0.991, 1.000
AP Medial	1.000	1.000, 1.000
AP Lateral	1.000	0.999, 1.000
SAG Total	0.997	0.988, 0.999
SAG Medial	1.000	1.000, 1.000
SAG Lateral	1.000	0.998, 1.000

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Misinterpretation of "Negative" Results of Superiority Trials in Orthopaedic Literature: The Need For Non-Inferiority Trials

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Purpose: A commonly misunderstood principle in medical literature is statistical significance. Often, statistically non-significant or negative results are thought to be evidence for equivalence; mistakenly validating treatment modalities and putting patients at risk. This study examines the prevalence of misinterpretation of negative results of superiority trials in orthopaedic literature and outlines the need for a non-inferiority or equivalence research design.

Methods: Four orthopaedic journals - *Journal of Pediatric Orthopedics A, Journal of Bone and Joint Surgery American Volume, Journal of Arthroplasty and Journal of Shoulder and Elbow Surgery* - were hand searched to identify all randomized control trials (RCTs) published within the time periods 2002-2003, 2007-2008 and 2012-2013. The identified RCTs were read and classified by study methodology, results obtained, and interpretation of results.

Results: A total of 238 RCTs were identified. When analyzing the primary outcomes, 104 (44%) studies yielded negative results and 134 (56%) yielded positive results. Out of the 238 articles, 206 (87%) used superiority methodology and 32 (13%) used non-inferiority or equivalence methodology. Of the 206 studies that used superiority methodology, 93 (45%) obtained negative results; 41.9% misinterpreted the negative results for equivalence. There were no statistical differences seen across each time period but an upward trend in utilizing non-inferiority and equivalence methodologies was apparent.

Conclusion: Given the frequency of misinterpreted negative results, the need for a more appropriate research methodology that shows equivalence of treatment methods can be seen. A non-inferiority or equivalence study design can address orthopaedic clinical dilemmas more suitably when we are trying to show one treatment is no worse or is equal to another treatment.

Significance: Regarding orthopaedic treatment modalities as equivalent when studies show negative statistical results can be detrimental to our patients and their clinical outcomes. A non-inferiority methodology can be used to accurately depict no difference between treatment methods rather than attempting to show one treatment method as superior.

See pages 21- 66 for financial disclosure information.

Determination of LIV Utilizing Prone AP XR Allows For Shorter Fusion in AIS

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Purpose: Standing/ bending AP XR are limited by bending technique and force compared to prone XR. We hypothesized that utilizing prone XR allows for proper determination of LIV.

Methods: AIS patients who underwent PSF from 2004-2010 were reviewed retrospectively. Pre-op standing AP, prone AP, and supine left/right bending XR were retrospectively reviewed to assess LIV. Pre and post-op XR were used for coronal/sagittal balance, % correction, LIV tilt/translation, and disc angulation. Group A patients had LIV=SV (Stable Vertebrae) and group B had LIV=SV-1 on prone XR.

Results: 181 AIS patients, 64 met inclusion criteria. Group A : 42pts (34F:8M) and group B: 22 (19F:3M), p= 0.59. In group A, 33/42 (78.6%) had a T3(12) or T4(21) as UIV, p=0.35. The SV was not different between group A &B, p=0.25. LIV, however, was significantly different, p=0.001. In group A, LIV was L4 in 22 pts (52.4%), L3 in 9 (21.4%), and L2 in 10 (23.8%). In group B, LIV was L4 in 3(13.6%), L3 in 6(27.3%), L2 in 6(27.3%), and L1 in 5(22.7%). LIV tilt was 0° in group A and 6° in group B, p=0.008, LIV translation, LIV translation was 0.3 for group A and 0.7 in group B and, p=0.03, while the disk angle was 0° in group A and 2° in group B, p<0.001.There was no difference between 2 groups in shoulder height, clavicle angle, coronal or sagittal balance.

Conclusion: Prone XR in AIS patients allows shorter fusion by two vertebrae levels with similar cobb correction, coronal balance, sagittal balance and restoration of kyphosis. However, LIV at LV at SV-2 on standing XR increases disk angulation (2° vs. 0°) and slightly less LIV translation (0.7 v 0.3). While disc angulation may potentially lead to early degeneration, saving two motion segment levels potentially has greater impact than horizontal with longer fusion.

Significance: LIV is determined on standing/bending XR. This study showed that using prone XR to determine LIV allows for a significantly shorter fusion than standing/ bending XR with similar correction, coronal balance, sagittal balance and kyphosis restoration.

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Reliability of the Anterior Humeral Line and the Wilkins Classification for Supracondylar Humeral Fractures

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Purpose: To examine the reliability of the anterior humeral line (AHL) index and the Gartland classification of pediatric supracondylar humerus (SCH) fractures, and to assess the consistency of treatment recommendations based on these classifications.

Methods: With IRB approval, 50 consecutive SCH fracture radiographs were compiled in an internet survey. 11 observers (9 attending, 2 residents) from a single pediatric orthopaedic program classified the radiographs according to Gartland classification (Type 1, 2, 3, or unsure) and where the AHL intersects the capitellum (AHL0-anterior to the head, AHL1-anterior 1/3, AHL2-middle 1/3). Observers recommended treatment (CR/immobilization, CRPP, ORIF), and specified when other factors e.g. rotation influenced their recommendations. 5 observers repeated the classifications and recommendations 4-6 weeks later. Inter and intra-observer reliability was scored using kappa statistics (1=perfect agreement, -1=perfect disagreement).

Results: Overall agreement on Gartland fracture type was fair (K 0.33). Type 3 had the best agreement, though only moderate (K 0.45). Type 2 fractures had the lowest agreement (K 0.27). Interobserver agreement for AHL index with AHL1 and AHL2 combined (AHL1/2) was excellent (K 0.67). The interobserver agreement for treatment was fair (K 0.39). The intraobserver reliability for AHL was almost perfect (K 0.86), and substantial for fracture type (K 0.71) and treatment (K 0.72). CRPP was recommended in 2% of Type 1 cases and in 68% of Type 2 cases. In AHL1 and AHL2 combined, CRPP was recommended 31% of the time. In AHL0, CRPP was recommended 87% of the time. 55% of cases where the AHL passed through the capitellar head were classified as Type 2 rather than Type 1, therefore having surgery recommended rather than conservative management. Citing anterior gap or extension, raters frequently characterized an AHL 1/2 case as a Type 2, increasing the likelihood that it will be treated with CRPP.

Conclusion: There was greater agreement among raters for AHL0 versus AHL1/2 than for Gartland SCH Type 1 versus 2. Confusion with the Gartland classification leads to inconsistent treatment recommendations for Type 1 and Type 2 fractures.

Significance: The AHL index is a more consistent method than the Gartland classification in differentiating SCH fractures that are not Type 3.

See pages 21- 66 for financial disclosure information.

Outcomes of Isolated Radial Osteotomy for Volar Distal Radioulnar Joint Instability Following Radial Malunion in Children

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Purpose: Slight apex dorsal radial bow is normal and allows for full forearm pronosupination. However, malunion of radius fractures can lead to reversal of the radial bow, which can cause volar instability of the distal radioulnar joint (DRUJ), predominantly in supination. This study assessed the outcomes of isolated radial osteotomy for volar DRUJ instability following radial malunion in children.

Methods: This multicenter retrospective study reviewed the charts of 7 children (3 boys, 4 girls) treated with radial osteotomy for volar DRUJ instability following a radius fracture/deformity. Demographic, diagnostic, treatment, and complication information was collected. Radiographs at initial injury, fracture union, diagnosis of DRUJ instability, and final follow-up were reviewed and measured for sagittal and coronal plane length and angulation.

Results: Five fractures involved the radius shaft, one involved the distal radius metaphysis and one was a plastic deformation of the radial shaft. Volar DRUJ instability was diagnosed an average of 2.7 years (range: 1-6) after fracture and at an average age of 13.9 years (range: 11-17). One of seven patients had previous soft tissue surgery for DRUJ instability with persistent symptoms. All patients demonstrated volar subluxation of the ulnar head during supination. Radial osteotomy was performed on all patients (3 dorsal, 4 volar approaches), with an average sagittal plane correction of 26±11° (range: 14-40). Osteotomy site varied (2 proximal-third, 1 middle-third, 4 distal-third) based on the apex of maximal deformity. Patients were followed an average of 1.8 years (range: 0.6-5.6). Radial bowing reversed from apex volar at fracture union (13±9°) and DRUJ instability diagnosis (12±3°) to apex dorsal at final follow-up (-7±9°). One patient with plastic deformation developed recurrent radial malunion and volar DRUJ instability after proximal radial osteotomy, necessitating repeat osteotomy at a more distal level with resolution of symptoms. At final follow-up, all patients had a stable DRUJ joint on pronosupination.

Conclusion: Apex volar malunion of radial fractures can result in volar instability of the DRUJ. Radial osteotomy can restore the normal apex dorsal radial bow and effectively stabilize the DRUJ without the need for soft tissue repair. One patient required revision osteotomy due to incomplete restoration of the radial bow after initial plastic deformation injury.

Significance: Volar DRUJ instability due to reversed radial bow deformity can be effectively treated by osteotomy alone without soft tissue stabilization in pediatric patients. Care must be taken to ensure that the radial bow is corrected in order to avoid revision surgery.

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The Anabolic Effects of Electrical Stimulation on Endochondral Bone

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Purpose: Electrical stimulation (ES) has an inhibitory or a stimulating effect on endochondral bone formation; however, literature on the mechanism is limited. The purpose of this investigation is to determine if different ES currents, specifically direct current (DC) and capacitive coupling (CC) can accelerate endochondral ossification through distinct mechanisms.

Methods: Thirty-four femurs for culture from 3-week old C57BLK6 mice were obtained, suspended on stainless steel mesh, and maintained in a BGJb medium. After 2 days, the femurs were divided into 3 groups (DC, CC, and control) and were transferred daily to a silicone chamber with phosphate buffered saline. The DC and CC group received 10 minutes of DC and CC at 16Hz, respectively; the control group received no current. After 7 days in culture, all specimens were terminated and either placed in ethyl alcohol followed by 4% paraformaldehyde for micro-computed tomography (μCT) analysis and histomorphometry, or frozen immediately in liquid N_2 for RNA isolation and gene expression analysis using quantitative polymerase chain reaction (qPCR). Data was analyzed using ANOVA with $p < 0.05$ considered significant.

Results: Compared to control specimens, there were significant increases in bone volume/tissue volume and bone area in both ES groups, in trabecular thickness (Tb.Th) in the DC group, and trabecular number (Tb.N) in the CC group. Histomorphometric analysis of von Kossa-stained specimens demonstrated comparable growth plate height in all specimens. However, there was a significant decrease in the hypertrophic zone and increase in resting and proliferative zones in the ES specimens compared to controls. On Safranin O-stained sections, there was deeper staining and an increased area of red in the ES specimens compared to controls, indicative of a higher proteoglycan content within matrix collagen. On qPCR analysis (n = 2 in each group), there was a statistically significant increase in Col1 expression in the DC group and an increase in Sox9 and Col10 gene expression in the CC group, when compared to controls.

Conclusion: Some previous studies demonstrated that ES applied under controlled conditions stimulates endochondral bone formation. However, the currents used in this investigation stimulated different types of bone formation suggesting that DC and CC stimulation work through different mechanisms. DC stimulation appears to enhance osteoblast function (increased Tb.Th, Col1 expression) while CC stimulation increases chondrocyte function (increased Tb.N and Sox9 and Col10 expression).

Significance: ES may prove to be an alternative method of growth plate modulation; however, further investigation is warranted.

See pages 21- 66 for financial disclosure information.

Biomechanical Comparison of Two Spinopelvic Fixation Constructs

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Purpose: Spinopelvic fixation is used in the correction of pelvic obliquity, high-grade spondylolisthesis, and long spinal fusions. With the development of pedicle screw fixation, the iliac screw has been used as an anchor point to the pelvis. The associated morbidity with this fixation has led to the development of the sacral-alar-iliac (SAI) screw. Many studies have examined the biomechanical properties of iliac and SAI screws; however, a direct comparison has not been performed. The purpose of this study is to compare the biomechanical properties of the iliac and SAI screw in a similar spinopelvic fixation construct.

Methods: Eight cadaveric spines were instrumented with pedicle screws bilaterally at L5 and S1. Four specimens were further instrumented with iliac screws placed with a starting point at the posterior superior iliac spine and four specimens were instrumented with SAI screws placed with a starting point 1 mm inferolateral to the S1 foramen. Screws were connected with 6.35 mm rods. Subfailure testing was performed by loading at 1°/sec to a torque of 10Nm in four directions – left bending, right bending, extension, and flexion. Specimens then underwent a monotonic load to failure under flexion at a rate of 1°/sec.

Results: There were no significant differences for torsional stiffness in extension, flexion, left bending or right bending between SAI and iliac screw constructs. There were no significant differences in SAI vs. iliac screws for failure torque (30.9±12.00Nm vs. 22.61±6.25Nm) and yield torque (11.86±0.41Nm vs. 12.01±1.70Nm).

Conclusion: Iliac screws have been associated with increased dissection, wound complications, an additional construct failure point and hardware prominence. The SAI screw was developed as an alternative and has been associated with less morbidity. This study has demonstrated no difference in the iliac and SAI screw in stiffness and load-to-failure in a spinopelvic fixation model.

Significance: Biomechanical equivalence along with less clinical morbidity makes the SAI screw superior for spinopelvic fixation.

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How We Can Learn to Use Foot and Ankle Motion Analysis in Treating Equinovarus Foot Deformity in Spastic Hemiplegic Cerebral Palsy?

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Purpose: Tendon transfers and musculotendinous lengthenings are useful to correct equinovarus foot deformity when conservative interventions fail. The effectiveness of these procedures in children with hemiplegic cerebral palsy demonstrates variable success rates from 67%-82%, and no procedure has demonstrated a consistently good and lasting result. The purpose of the current work is to develop foot and ankle motion analysis tools that can be used to evaluate the effectiveness of soft tissue balancing procedures for equinovarus secondary to hemiplegia.

Methods: Multi-segment foot and ankle kinematics using the Milwaukee Foot Model (MFM) were collected during gait in 24 children/adolescents with equinovarus and 20 typically developing children/adolescents. Fifteen of the participants with equinovarus received soft tissue balancing procedures, and post-operative follow up was conducted at an average of one-year. Principal component analysis (PCA) was used as a data reduction technique on forty pre-operative variables to create deviance scores from the control group. Deviance scores were then calculated using the post-operative data. Individual and mean post-operative results were evaluated to identify whether individuals presented with corrected, partially corrected, or uncorrected post-operative gait deviations.

Results: Six principal components of segmental foot position and range of motion accounted for 92% of the variance of the dataset and all of the participants fit within 5 subgroups (Table 1). Surgical soft tissue balancing procedures including split posterior tibial tendon transfer (SPOTT), split anterior tendon transfer (SPLATT), and gastrocnemius lengthening resulted in improved hindfoot and forefoot motion at follow up of one year. With improvement in the degree of deformity, surgery resulted in reduced post-operative range of motion at the hindfoot in both the sagittal and coronal planes. In individual cases where under or over-correction was identified, the deviations were attributed to severe pre-operative deformity or an unaddressed principle component which was present in the preoperative data. The most common residual deformity was the persistence of transverse forefoot adduction.

Conclusion: It is possible to develop objective measures of the effectiveness of soft tissue balancing procedures in correcting foot and ankle motion during walking in children with equinovarus secondary to hemiplegic CP.

Significance: Foot and ankle motion analysis can determine which treatments are most effective for each specific subgroup of foot deformity found in hemiplegic CP depending on the shape and range of motion of the foot during gait. We have identified five distinct subgroups of the equinovarus foot which are useful in making surgical decisions and evaluating treatment results.

See pages 21- 66 for financial disclosure information.

Table 1. Description of 5 Subgroups

Subgroup (n=44)	Description
#1 (n=18)	Control Group (Rectus)
#2 (n=5)	Flexible equinovarus deformity with hindfoot involvement
#3 (n=8)	Equinovarus deformity with hindfoot and forefoot involvement
#4 (n=8)	Flexible varus deformity with both hindfoot and forefoot involvement (Cavus)
#5 (n=5)	Varus deformity with forefoot involvement

Level of Evidence: Level II Diagnostic Study

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The "Skinny" SCFE

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Purpose: Much has been made of the link between obesity and slipped capital femoral epiphysis (SCFE). However, little data exists in the literature on patients with SCFE who are underweight/normal weight. The purpose of this study was to determine if underweight/normal weight patients differ from overweight and obese patients with SCFE.

Methods: This was a multi-center, retrospective review of all patients presenting for treatment of a slipped capital femoral epiphysis from January 1, 2003 through December 31, 2012. Patients were excluded if they received previous surgical treatment at an outside institution or did not have a height and weight recorded in their charts. Body mass index (BMI) was calculated and categorized for each patient.

Results: A total of 202 patients met inclusion criteria. Average BMI was 27.9 (range: 14.1-45.0). Sixteen patients (7.9%) were underweight, 47 (23.3%) were normal weight, 67 (33.2%) were overweight, and 72 (35.6%) were obese. Demographic characteristics were similar between those patients who were underweight/normal weight and those who were overweight/obese. Underweight/normal weight patients were no more likely to have pre-existing medical comorbidities known to be associated with SCFE (p=0.144). They were also no more likely to present with bilateral involvement (p=0.374). Underweight/normal weight patients were significantly more likely to present with an unstable slip compared to overweight/obese patients (26% versus 14%, p=0.04). In addition, underweight/normal weight patients presented with a much shorter duration of symptoms (8.5 weeks versus 24.1 weeks, p<0.001). There was no significant difference between the two groups with regards to Southwick angles and Wilson percent displacement. Underweight/normal weight were not more likely to undergo prophylactic pinning of the contralateral hip (p=0.983).

Conclusion: Underweight/normal weight patients are more likely to present with an unstable SCFE and tended to have a shorter duration of a symptoms when compared to their overweight/obese peers.

Significance: SCFE does occur in underweight and normal weight patients, with similar demographic characteristics and radiographic findings. However, in underweight/normal weight patients, these slips are more commonly unstable.

See pages 21- 66 for financial disclosure information.

Long-Term Outcomes and Rates of Arthroplasty After Pediatric Treatment of Developmental Hip Dysplasia

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Purpose: The long-term outcomes of pediatric developmental hip dysplasia are not well-described in the literature. We sought to determine the rates of total hip arthroplasty (THA) and function following surgical treatment of developmental hip dysplasia in a novel cohort of patients with 20+ year follow-up.

Methods: Our center treats hip dysplasia in both children and adults. Records were retrospectively reviewed to identify patients who underwent surgery for developmental hip dysplasia prior to age 10. Patients were treated with closed or open reductions, pelvic osteotomies (Salter and Pemberton), femoral osteotomies or a combination of the above. 226 patients met inclusion criteria. Patients with syndromes and neuromuscular disorders were excluded. Follow up information was obtained from mailed surveys and/or the medical record.

Results: Of the 226 patients, recent follow-up information was available for 96 dysplastic hips (85 patients) at a mean 29 year follow-up. Of these, 33 were treated with open or closed reduction alone, 46 were treated with pelvic osteotomies (43 Salter, 3 Pembertons), 37 of which only had pelvic osteotomy and 9 with combined pelvic and femoral osteotomies. 17 patients had only femoral osteotomies. Mean age at treatment was 2.6 years old.

Of the 96 hips, 21 had gone on to THA at a mean of 26 years after surgery (mean patient age, 32 years old). In addition, 12 patients needed additional surgery (pelvic or femoral osteotomy) for residual dysplasia, and five underwent periacetabular osteotomy as an adult. No patients in the open or closed reduction subgroup went on to arthroplasty. THAs were performed in 7/17 (41%) of hips treated with femoral osteotomy alone, 11/37 (30%) of patients treated with pelvic osteotomy alone, and 3 (33%) of hips treated with combined pelvic and femoral osteotomy. Using a Kaplan-Meier survival analysis for only the pelvic osteotomy patients, rate of THA was 22% at 20 years of follow-up and 40% at 30 years of follow-up.

Conclusions: Total hip arthroplasty was a common outcome in patients who had pelvic and/or femoral osteotomies in childhood for developmental hip dysplasia. Our study is limited by patient loss to follow-up. However, at mean of 29 years after pediatric surgery for DDH, more than 30% of those patients located had gone on to joint replacement.

Significance: More long-term outcomes studies are needed to determine whether pediatric osteotomies prevent THA in adulthood.

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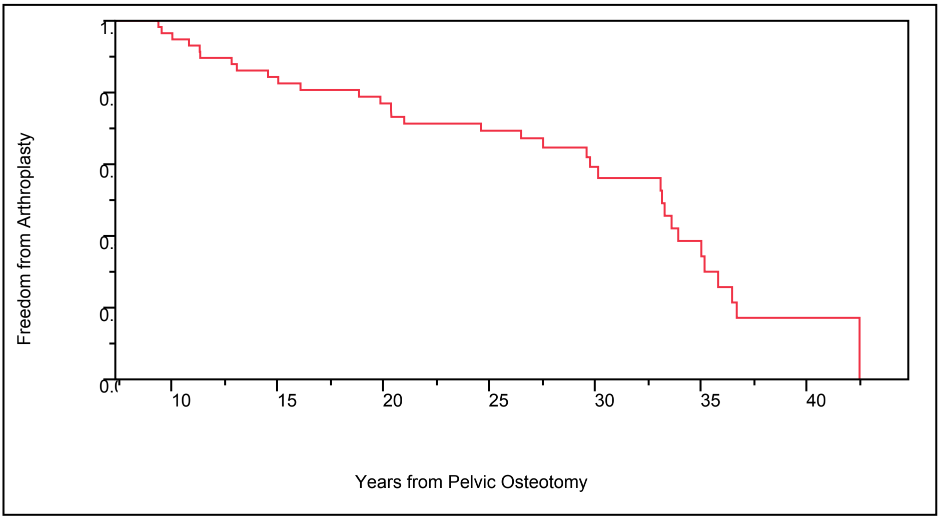

Figure. Kaplan-Meier analysis - % survival from total hip arthroplasty after childhood pelvic osteotomy for developmental hip dysplasia.

See pages 21- 66 for financial disclosure information.

Cam Deformity Not Associated with Conventionally Held Risk Factors for Femoroacetabular Impingement

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Purpose: Conventionally held risk factors for Femoroacetabular Impingement (FAI) include femoral and acetabular retroversion with the theory that relative retroversion leads to impingement and secondary cam deformity. We hypothesized that cam deformity is mostly primary in etiology and not associated with these risk factors. The purpose of this study was to utilize multiple regression to assess the relationship between femoral and acetabular version with two markers of cam deformity, alpha angle and anterior offset.

Methods: We randomly selected 1013 cadaveric hips from a historical osteologic collection. Hemipelves were reassembled with sacra to reproduce the pelvic ring. Acetabular version was then directly measured from specimens in a standardized fashion. Digital images were obtained of each femur from an axial view perpendicular to the femoral neck in order to measure alpha angle and anterior offset. Cam deformity was defined as alpha angle greater than 60 degrees. A direct axial view of the femur was also obtained in order to measure femoral version. Multiple regression analysis was performed to determine whether alpha angle or femoral offset are related to age, femoral version, acetabular version. Significance level was set at $p<0.05$.

Results: The mean alpha angle and anterior offsets for the sample population were 48.1±10.4 degrees and 0.76±0.18 cm, respectively. 223/1013 specimens demonstrated cam deformity (alpha angle >60 degrees). Multiple regression analysis did not demonstrate any statistically significant association between femoral version, acetabular version, and alpha angle. However, multiple regression analysis demonstrated a small, but significant association between increasing femoral and acetabular version with decreased anterior offset (both $p<0.01$). While this relationship was statistically significant, its clinical relevance was mild as all factors combined only explained 9% of the variance in anterior offset.

Conclusion: Conventionally accepted risk factors for development of cam deformity include relative femoral and/or acetabular retroversion. Our study did not observe these associations in a large and random population. Our data suggests cam deformity is generally a primary lesion rather than a contre coup lesion secondary to impingement. It is important to note that our population presumably did not have any increased FAI symptomatology as compared to any random sampling. Given this, we propose that relative acetabular or femoral retroversion may instead increase the risk for a symptomatic hip by mechanically increasing the risk for impingement.

Significance: An evolving understanding of the etiology of FAI may lead to changes in evaluation and management of adolescents and young adults with this pathology.

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Classification of Slipped Capital Femoral Epiphysis Deformity in the Hip Impingement Era

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Purpose: Slipped capital femoral epiphysis (SCFE) commonly causes obligatory external rotation deformity and impingement of the hip. Current classifications do not include acetabular morphology or femoral version. A grading system based on clinical deformity was evaluated.

Methods: 106 consecutive SCFE hips in 79 patients were graded using a classification based on internal rotation at 90 degrees of flexion (FIR) and the least invasive treatment option with the potential for restoration of at least 10 degrees of FIR. Grade 1 - Mild deformity with FIR > 10 degrees. Grade 2 -Moderate deformity with FIR < 10 degrees and enough bone stock to restore 10 degrees of FIR with femoral neck osteoplasty. Predicted alpha angle improvement provided an objective measure. Grade 3 - Severe deformity requiring an osteotomy to restore FIR of 10 degrees. Minimum follow up was two years for 81 hips out of the 83 hips that followed the treatment recommendation.

Results: Grade 1 - 13 patients with FIR of 10-25 degrees and slip angle of 5-13 degrees. All were treated with in-situ screw fixation alone. 11 patients were followed for 2 years. 10 had no pain or limitation of activities. One patient had mild discomfort with activities.

Grade 2 – 45 patients showed FIR of 5 to -40 degrees. Slip angle was 10 – 37 degrees. Alpha angle was 74-95 degrees. Potential decrease of alpha angle based on the femoral neck morphology was used to predict the potential increase in FIR. Open or arthroscopic osteoplasty was recommended in all hips in addition to screw fixation in the hips with open physes. 31 hips underwent osteoplasty, 27 achieved 10 or more degrees of FIR, and 29 were asymptomatic at 2 years.

Grade 3 – 48 patients showed FIR of negative 23 to 70 degrees, slip angle of 28 to 74 degrees. 43 underwent a femoral neck osteotomy. All achieved > 20* of FIR and 39 followed for two years. Two of the 39 lost FIR from heterotopic ossification and two more with good FIR had pain with activities.

Conclusion: FIR was useful in grading impingement from slipped capital femoral epiphysis. The indicated treatment resulted in lack of impingement in all Grade 1 and 3 hips and 87% of Grade 2 hips where further improvement was needed.

Significance: The clinical classification with further validation can guide treatment of hip impingement from SCFE.

See pages 21- 66 for financial disclosure information.

A New Method to Analyze the Development of Acetabular Surface Area and Femoral Head Coverage in Childhood

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Purpose: Orthopedists who treat childhood hip disorders such as developmental dysplasia of the hip often wish to normalize pathologic morphology but currently have no method to quantitate the location and amount of weight bearing surface area. This study applies a three-dimensional radial quantification technique to document acetabular surface area and orientation in asymptomatic children during normal hip development.

Methods: A consecutive series of 157 3D pelvic CTs were reconstructed from abdominal CTs obtained for non-orthopedic reasons in a pediatric emergency room. Custom software was developed to identify acetabular surfaces on the pelvic reconstructions. Cotyloid fossa/articular surface boundaries were traced using a custom interface (Fig.). The surface areas of the acetabular articular surface and cotyloid fossa were recorded. Acetabular coverage angles were calculated for eight regions of the acetabulum. Acetabular direction vectors were calculated and used to determine tilt and version. Three age groups were used for comparison purposes: 8-10, 10-13, and 13-17 yrs.

Results: Acetabular tilt and anteversion are greater in females than males in all age groups. Near maturity, this difference was especially evident for anteversion (ages 13-17; 14.4˚ vs 20.4˚, $p<0.001$). Increases in tilt were correlated with increases in superior coverage angles ($r=0.797$, $p<0.001$). Increases in anteversion correlated with increased posterior coverage angles ($r=0.805$, $p<0.001$). Posterior and superior coverage increased during the final stages of acetabular development, which occurs earlier in females than males. By age 10-13 males have statistically more articular cartilage surface area than females (21.8 vs. 19.6 mm^2, $p<0.001$) and this difference increases during the final stages of acetabular growth (ages 13-17; 24.4 vs 20.6mm^2, $p<0.001$). Furthermore, the surface area of the male acetabulum is still increasing from ages 13-17; whereas growth is almost complete in females.

Conclusion: Acetabular development occurs earlier in females than males. The postero-superior region of the acetabulum is the final region to develop. The articular cartilage surface area and articular cartilage coverage of the femoral head is increasing in addition to total coverage of the femoral head during the final stages of acetabular development.

Significance: This new technique provided effective quantification in the development of normal acetabular morphology. We are now applying the method to pathologic conditions. Quantification of hip joint shape and coverage abnormalities will allow a surgeon to customize surgical planning for complex hip deformities which should improve long term hip joint durability.

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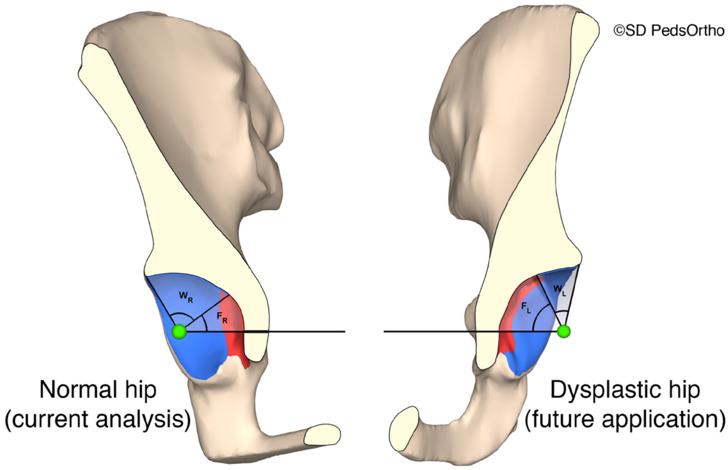

Model illustrating method used to study surface areas.
(W= weight bearing, F= fossa, R&L= right and left)

See pages 21- 66 for financial disclosure information.

The Serial-Mri Evaluation of Soft Tissue Interpositions After Closed Reduction in DDH

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Purpose: There are few papers about natural changes of soft tissue interpositions after closed reduction in DDH. The purpose of this paper is to investigate temporal changes of soft tissue interpositions by serial MRIs.

Methods: Forty six patients (47 hips) were treated by gradual reduction (GR) using overhead traction and casting between 2008 and 2013. To all patients, serial MRIs were performed prospectively after the reduction. MRIs were routinely examined at the next day of the casting and at five weeks after the casting. If the second MRI showed no improvement, the third MRI was examined in 3-6 months after the reduction. T2-weighted coronal and axial images of both hips were gained by MRI (Philips Intera 1.5T). All hips were examined in the casting position. We digitally measured MRI-head-acetabular distance (MHAD Fig.1) which was a distance between an acetabular floor and a cartilaginous femoral head at mid-coronal or mid-axial sections in millimeter. The shapes of limbs in three areas (anterior, superior and posterior) were classified to normal, inverted or hypertrophied. The ligament of head of femur whose width was >5mm in mid-axial section was classified into hypertrophy.

Results: Seven patients were excluded because of only once MRI and 39 patients (40 hips) were evaluated. In 23 hips MRI was performed twice and in 17 hips three times and more. The average age at the reduction was 14 months (7-33 months). Twenty nine hips were unsuccessful by RB and 11 hips were late-diagnosed. Four hips (10%) showed avascular necrosis but were not related to MHAD or soft-tissue interpositions at the first MRI. An average MHAD of the unaffected side was 2.1±0.8mm (axial) and 1.8±0.5mm (coronal). Those of dislocated side were 6.1±2.5mm (axial) and 4.9±1.9mm (coronal) at the first MRI, 3.1±1.9 mm and 2.7±0.2mm at the second MRI and 3.1±1.9 mm and 2.7±0.2mm at the third MRI. Although 4 hips (10%) in anterior area, 31hips (78%) in posterior part and 37 hips (93%) in superior area showed hypertrophied limbs at the first MRI, 4 hips in anterior part, 21 hips in posterior part and 15 hips in superior part were changed to normal shapes at the second MRI. Twenty hips (50%) showed hypertrophy in the ligament of head of femur at the first MRI, but 15 hips were changed to normal size at the second MRI. Until the third MRI, soft-tissue interpositions disappeared in 35 hips (87%).

Conclusion: Most of soft-tissue interpositions gradually overcome if the head is kept against the acetabulum with casting or bracing. We think open reduction for soft-tissue interpositions should be reserved for the very few cases.

Significance: We demonstrated the natural disappearance of soft-tissue interpositions in DDH after the closed reduction by serial MRIs prospectively.

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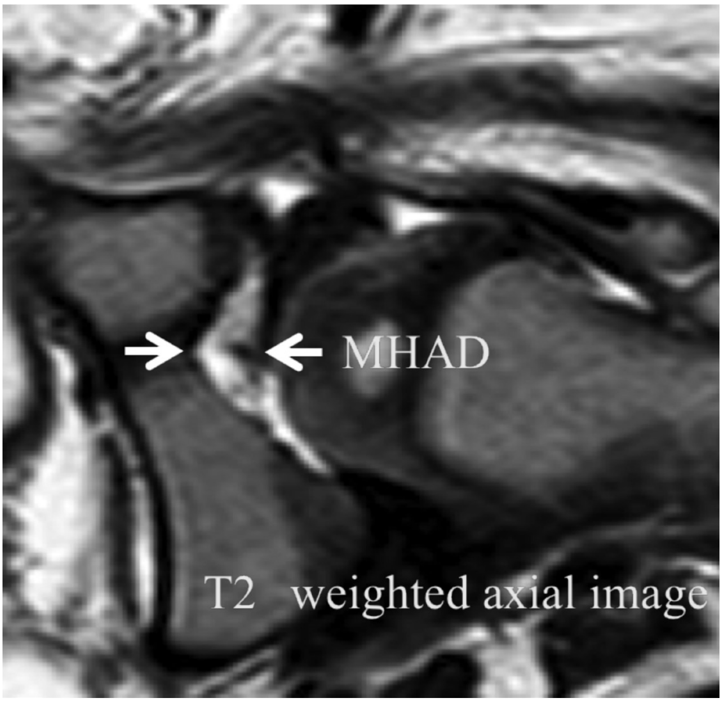
Fig 1



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Continued Delay in Diagnosis of Slipped Capital Femoral Epiphysis

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Purpose: More than a decade ago, both Skaggs and Kocher et.al. reported significant delays in the diagnosis of slipped capital femoral epiphysis (SCFE). The purpose of this study was to identify if the time to diagnosis has improved.

Methods: A retrospective review was performed of patients admitted with a diagnosis of SCFE at three large pediatric hospitals between January 2003 and December 2012.

Results: 478 patients with average age 12 years (range 5-18 years) at presentation met the inclusion criteria. Over the entire study period, the average time from symptom onset to diagnosis was 16 weeks (range 0-169), and did not differ significantly between sites (p=0.3549). Separated into 2 year intervals there were the following delays in diagnosis: 2003-2004=11.4 weeks; 2005-2006=16.4 weeks; 2007-2008=18.4 weeks; 2009-2010=13.9 weeks; 2011-2012=19.8 weeks (p=0.1312). Average BMI was 28.7 (range 14.1-44.9). 357 patients (74%) presented to a primary care clinic or the emergency room initially. Of those 357, 158 (44%) had documentation of date of initial evaluation. The average delay from initial evaluation by primary care or the ER to diagnosis was 5.2 weeks (range 0-52 weeks). Severity of the Southwick angle (p=<0.0001) and grade of slip (p=0.0002) correlated with time from symptom onset to diagnosis. At the time of presentation, 15% (70/475) had bilateral slips. There was no significant correlation between insurance status and delay in diagnosis. 56 patients (11%) developed a second SCFE after treatment of the first SCFE. There was an average of 10 weeks between onset of symptoms and diagnosis for the second SCFE, significantly less than the overall mean for the initial SCFE (p<0.0001). 87% presented for their second SCFE while they were still mild as defined by Wilson classification.

Conclusion: Despite reports documenting a lag in the diagnosis of SCFE over a decade ago, there has not been any improvement in the delay in diagnosis of SCFE. In fact, delay in diagnosis trends toward worsening over the decade of this study and these delays were similar at all three geographically distinct locations across the U.S. Slip severity and slip grade increased with time to diagnosis, so a delay in diagnosis may worsen outcomes.

Significance: Decreased time to diagnosis in patients with a second SCFE suggests that patient education of at risk children may be a more effective strategy to improving this delay.

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Table 1 - Time from symptom onset to diagnosis by two-year interval

Years	Mean (weeks)
2003-2004	11.4
2005-2006	16.4
2007-2008	18.4
2009-2010	13.9
2011-2012	19.8

See pages 21- 66 for financial disclosure information.

Diagnosis and Treatment of Pediatric Septic Hips: is There Consensus?

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Purpose: Pediatric septic hips are one of the few true emergencies within pediatric orthopaedics. However, it is unknown how surgeons diagnose and treat this condition. The purpose of this study was to investigate differences among POSNA members regarding the work-up and treatment of patients with a presumed septic hip.

Methods: A standardized questionnaire composed of 14 questions was sent to all POSNA members regarding the work-up and treatment of patients with a potential septic hip. Case scenarios were included to assess the importance of various Kocher criteria upon decision-making.

Results: 322 POSNA members completed the survey. Nearly all respondents agreed that labs including a CBC (99%), ESR (97%) and CRP (99%) should be obtained. 73% responded that blood cultures should be routinely obtained. 18% of respondents reported that the Kocher criteria are not followed at their institution. 89% of respondents routinely obtain plain radiographs of the pelvis and 69% routinely obtain an ultrasound, which is performed by an in-house tech in 47% of respondent's institutions and by a tech who is called in for 25% of respondents.

If an aspiration is needed, it is performed by the orthopaedic attending physician who is called in, 53% of respondents, with only 12% of respondents having the aspiration performed by an in-house radiologist and 14% by a radiologist who comes in. 70% of respondents have an in-house anesthesiologist should operative intervention be necessary.

If a septic hip is suspected at 1AM, 54% of respondents would operate in the middle of the night, while the remaining 46% would wait until the next morning.

A child with 1 Kocher criteria, refusal to bear weight, would have imaging obtained as the next step by 58% of respondents, while 18% would obtain additional lab studies. If a fever (103F) was added to the clinical picture, 70% would obtain imaging studies and 17% would obtain additional labs. 3% of respondents would go directly to the OR. With the addition of a WBC of 14 (3Kocher criteria), 11% would go directly to the OR and no respondents would discharge the child. When all 4 Kocher criteria are positive, only 25% of respondents would go directly to the operating room.

Conclusion: There is wide variability regarding the diagnosis and treatment of pediatric septic hips among POSNA members.

Significance: Standardized guidelines may lead to improved quality and safety and as well as cost savings/value when evaluating and treating pediatric septic hips.

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Is It Worth The Effort? – The Outcomes of a Multidisciplinary Clinical Care Guideline for Acute Pediatric Musculoskeletal Infections

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Purpose: This study is a quality improvement project designed to evaluate the efficacy of implementation of a multidisciplinary clinical care guideline (CCG) for management of acute pediatric musculoskeletal infections regarding patient outcomes and utilization of hospital resources.

Methods: Retrospective chart review was performed and data analyzed of patients admitted to a large pediatric tertiary referral center with a diagnosis of acute osteomyelitis, septic arthritis, pyomyositis, before and after implementation of the guideline. Multiple measures were compared between the two cohorts including radiological, laboratory and treatment data, demographics, as well as resource utilization information. Wilcoxon rank-sum tests were used to assess statistical significance.

Results: Forty-seven patients were identified in the pre-implementation cohort and compared with 14 patients in the post-implementation group. Earlier consultation of orthopedic surgery (13.1 hours pre vs. 3.9 hours post, $p=0.01$), hospital length of stay (7 days pre vs. 5 days post, $p<0.007$), placement of central venous catheters (66% pre and 14% post, $p<0.05$), and number of days of IV antibiotics (12.5 days pre vs. 4.0 days post, $p<0.007$) were all significantly improved after implementation. A trend towards significance was noted in additional measures including earlier positive culture results, earlier return of CRP to <2.0 mg/dL, and a decreased number of antibiotics used.

Conclusion: Implementing a CCG for treatment of acute musculoskeletal infections resulted in earlier specialist involvement and a decrease in hospital stay, decrease in intravenous antibiotic use, appropriate use of microbiology and radiologic studies, and a decrease in invasive procedures performed. Based on these short-term results, a multidisciplinary and systematic approach to the diagnosis and management of acute pediatric musculoskeletal infections improves patient and economic outcomes in a hospital setting.

Significance: Multidisciplinary involvement in the formation and execution of a clinical care guideline for management of acute pediatric musculoskeletal infections improves outcomes, and we anticipate this will become the standard of care in the future based on this and similar studies.

Level III: retrospective comparative study

See pages 21- 66 for financial disclosure information.

The Utility of Screening MRI for Pediatric Patients with Suspected Musculoskeletal Infection

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Purpose: Soft tissue, bone and joint infections present a diagnostic challenge in children. In an effort to accurately diagnose and manage patients presenting with musculoskeletal infections at our institution, a screening MRI protocol was developed. The purpose of this study is to describe our imaging protocol and report on a cohort of patients who underwent a screening MRI for suspected musculoskeletal infection prior to any procedural intervention. We also sought to determine which clinical or laboratory values would be predictive of patients presenting with septic arthritis versus multifocal musculoskeletal infection.

Methods: A retrospective chart review was performed on all patients less than 19 years old who were evaluated for suspected musculoskeletal infection and underwent a screening MRI during 2008-2014. A group of patients presenting with septic arthritis of the hip, septic arthritis of any joint and multifocal musculoskeletal infection were analyzed utilizing independent variables including age, gender, weight bearing status upon presentation, WBC, CRP (mg/dL), hemoglobin, ESR, temperature upon admission, and number of positive Kocher criteria.

Results: 88 patients were included in the study. 53 (60.2%) patients were diagnosed with musculoskeletal infection, 19 (21.5%) with septic arthritis alone, and 13 (14.7%) with multifocal musculoskeletal infection. The average age of patients with septic arthritis was 3.3 years of age and 7 years of age ($p=0.09$) in those with multifocal infection. There were significantly different CRP (13.1 vs 4.5 mg/dL) and WBC (12.1 vs 13.8) values between those with multifocal infections and those with septic arthritis alone. There was no significant difference in age, gender, weight bearing status, hemoglobin, ESR, temperature, or number of positive Kocher criteria among the septic arthritis alone versus multifocal musculoskeletal infection groups.

Conclusion: A screening MRI is useful in the diagnosis and management of patients presenting with musculoskeletal infection. The odds of having a multifocal musculoskeletal infection on MRI versus an isolated septic arthritis was 9.7 times higher with a CRP > 11, however no other clinical factors were useful in determining the presence of an associated bone or soft tissue infection on MRI.

Significance: The use of MRI is recommended in the evaluation and management of children with musculoskeletal infections as clinical factors alone may not be helpful in determining the presence of multifocal infection. The early recognition of a multifocal infection allows one to make the appropriate diagnosis and provide proper surgical care at the initial operation.

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Long-Term Follow Up of Deep Infection in Cerebral Palsy Spine Surgery: Recurrence Rare But Lower HRQOL

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Purpose: The main objective of this study is to assess: [1] rate of infection, [2] differences by causative organisms, [3] the difference in CPCHILD score between the deep surgical site infection (DSSI) group and no infection (NI) group and [4] effect of management strategies in children with cerebral palsy (CP) who developed deep surgical site infection after spinal fusion surgery.

Methods: A multicenter prospectively collected database of 151 children with CP who underwent spinal fusion surgery included 11 who developed DSSI and had minimum two year follow up after infection. They were compared to patients with no infection (NI). Causative organisms were: E.Coli in 2 children, polymicrobial infection in 5, P. Mirabilis, S.Aureus, E.Faecelis and peptostreptococcus in 1 each. All 11 required irrigation and debridement (I&D) and received minimum 6 weeks of antibiotics. 6 patients had wound VAC; the others had primary closure. T tests were used to analyze deformity and repeated measures ANOVA was used to analyze CPCHILD scores in both groups at pre-operative and 2 year follow up.

Results: At mean 4 year follow up (range 3-5 years) no patients had recurrence of infection after management of initial infection. From early post-operative to 2 year follow up, no patient had significant loss of major coronal correction (P=0.77) or pelvic obliquity correction (P=0.71). However, at 2 year follow up comfort &emotions, overall QoL and total scores in DSSI group were significantly lower compared to NI group(P=0.005,0.04 and 0.03 respectively).

Conclusion: In children with CP with early DSSI after spinal fusion, we observed no recurrence of infection or deformity after infection management, regardless of organism. There is no difference between pre-operative I&D with primary closure versus wound VAC. However, comfort & emotions, overall QoL and total scores in CP patients with DSSI were slightly lower compared to NI group.

Significance: Deep surgical site infection after PSF (Posterior Spinal Fusion) in CP (Cerebral Palsy) has sustained resolution with prompt operative care, regardless of organism. However, HRQoL scores remain significantly lower in than patients without infection.

See pages 21- 66 for financial disclosure information.

Differentiating Between Simple and Complex Pediatric Musculoskeletal Extremity Infections: Identifying Predictors Early in the Hospital Course

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Purpose: Complex pediatric musculoskeletal infections are presenting more frequently in this age of antibiotic resistance and bacterial virulence. These infections correlate with longer hospital stays, increased surgical need, and poor outcomes compared to simple superficial soft tissue infections. Pediatric musculoskeletal infections often have an ambiguous presentation complicating timely diagnosis and treatment. The goal of this study is to identify predictors of complicated infections to allow for quick differentiation from the simple extremity infections and early aggressive treatment.

Methods: A level III retrospective analysis was performed using International Classification of Diseases- 9th revision and Current Procedural Terminology codes to identify patients treated for musculoskeletal infections at a single pediatric hospital from 2009 to 2012. Institutional IRB approval was obtained. Immunosuppressed patients and infections of the axilla, trunk, or groin were excluded. A total of 152 patients were identified, with 128 simple superficial infections and 24 complex subfascial infections. Complex infections were identified on MRI or intraoperatively. Demographics, 10-point pain scales, vital signs, laboratory tests at time of admission as well as number of procedures, microbiology results, and length of stay (LOS) were statistically analyzed.

Results: Analysis of admission parameters showed patients with complex infections have significantly higher 10-point pain scores (5.77 vs 3.01 $p=0.003$) and were more often febrile on admission (38.2 vs 37.6, $p=0.003$). Complex infections had significantly higher admission laboratory values including C-reactive protein (15.3 vs 4.2, $p<0.0001$), white blood cell count (16.5 vs 13.7, $p=0.041$), and absolute neutrophil count (12.1 vs 8.5, $p=0.008$). Complex infections had a significantly higher requirement for narcotic pain medication (83.3% vs 7.2%, $p<0.001$). Thirty-two simple infections required surgery (range 1-3, avg 1.14) while all of the complex infections required operative treatment (avg 3.4 operations (1-8), $p<0.0001$). Complicated patients had a higher incidence of Methicillin resistant *Stapholycoccus Aureus* (MRSA) infections (66.6% vs 38.3%) and had significantly longer LOS (13 days (4-45) vs 3.1 days (1-15), $p<0.0001$).

Conclusion: Children with complex musculoskeletal infections present with higher laboratory values, body temperature, and pain scores compared to simple infections. Complex infections all required surgery, had a higher incidence of MRSA infection, and longer LOS. These values may help to quickly identify and appropriately treat complex infections.

Significance: Early identification of complex pediatric extremity infections with the use of vital signs, laboratory values, and pain scales will prevent delays of treatment, likely decreasing length of stay and complications for those with high-virulence infections.

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Low Risk of Physeal Damage from a Medial Patellofemoral Ligament (MPFL) Reconstruction Technique That Uses an Ephiphyseal Socket in Children

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Purpose: The purpose of this study was to assess short-term distal femoral growth plate safety associated with femoral sockets for hamstring autograft fixation in pediatric MPFL reconstruction.

Methods: We retrospectively reviewed a consecutive series of 31 patients (22 females, 9 males) that underwent MPFL reconstruction by one surgeon at a tertiary care academic medical center between 2008 and 2014. Study inclusion criteria consisted of patients who were skeletally immature at the time of surgery, who had greater than 1 year radiographic follow-up and who had a femoral socket introduced during their procedure. Femoral socket location was verified by intraoperative fluoroscopy. All patients received a post-operative x-ray and a clinical follow-up. For the 12 patients that obtained post-operative MRI, growth plate safety was assessed by examining the location of the femoral socket relative to the physis to rule out growth plate injury (Figure 1). Development of lower limb angular deformities or limb length discrepancies was evaluated by examining post-operative standing hip-to-ankle anteroposterior radiographs, patient records, and clinical assessments.

Results: The average age at surgery of 13.0 years. The average length of radiographic follow-up was 1.5 years and the average length of clinical follow-up was 1.78 years. At most recent clinical follow-up, 90% (28/31) of patients reported no subsequent patellar dislocations in the treated knee. No patients showed evidence of an angular deformity or limb length discrepancy. Of the 12 patients with postoperative MRI, all showed femoral sockets positioned distal to the physis without growth plate disturbance.

Conclusions: The use of an epiphyseal femoral socket for graft fixation presents minimal risk of physeal violation and ensures patellar stability in the majority of pediatric patients. We have demonstrated that using fluoroscopic assistance to place the femoral socket distal to the distal femoral physis is a reliable and safe method for avoiding physeal injury in children with patellar instability.

Significance: Anatomic MPFL reconstruction with hamstring autograft can be performed safely in children with open growth plates.

Figure 1.
Coronal proton-density MRI showing femoral socket distal to distal femoral physis.

See pages 21- 66 for financial disclosure information.

Nonossifying Fibromas of The Distal Tibia: Fracture Risk and An Etiologic Relationship to The Interosseous Membrane

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Purpose: This study describes a series of 44 nonossifying fibromas (NOFs) of the distal tibia with respect to their radiographic features, fracture risk, and response to treatment.

Methods: We reviewed charts between January 2003 and March 2014 and characterized lesions as diagnosed either incidentally or due to fracture. We reviewed initial and follow-up radiographs (XR), computed tomography (CT), and magnetic resonance imaging (MRI) for lesion size, cortical involvement, and anatomic distribution.

Results: We identified 44 distal tibia NOFs in 43 patients (28 male, 15 female; mean age 12.4 years, range 6.9 – 17.8). Mean follow-up was 18.3 months (range 1.1 – 121.6). Thirty-one lesions had CT, and nine had MRI. Thirteen (30%) were diagnosed by pathologic fracture. Those that fractured were significantly larger by bone diameter percentage on AP and lateral x-ray, as well as axial CT scan; no significant difference was seen in cephalad-caudad height. Several incidentally diagnosed lesions were large (seven demonstrated > 50% bone diameter on AP and lateral XR with height > 33 mm) or continued to grow (see figure below). Cortical breach was seen in the majority of lesions with no significant difference between groups; CT was more sensitive for this finding (84% vs 59%). Ten (77%) fractured vs 13 (42%) incidental lesions underwent curettage and grafting ($p = 0.034$). Those that underwent grafting were significantly larger in all dimensions and were significantly more likely to resolve at final follow-up (100% vs 39%, $p < 0.001$). Forty-two (95%) lesions were located in a distinct niche of the distal lateral tibia, and all nine with MRI showed communication with the interosseous membrane; in some, the membrane split and here the anterior slip inserted more substantially into the lesion.

Conclusion: The vast majority of distal tibial NOFs occur in a distinct anatomic site in direct communication with the interosseous membrane. While pathologic fracture risk is associated with larger size, radiographic dimensions and cortical breach were not consistently predictive.

Significance: This relationship to the interosseous membrane may provide insight into the etiology of tibial NOFs. CT scans provide a better means to see cortical breach. As these lesions can demonstrate growth over time, with unpredictable fracture risk, we observed predictable consolidation with curettage and bone grafting.

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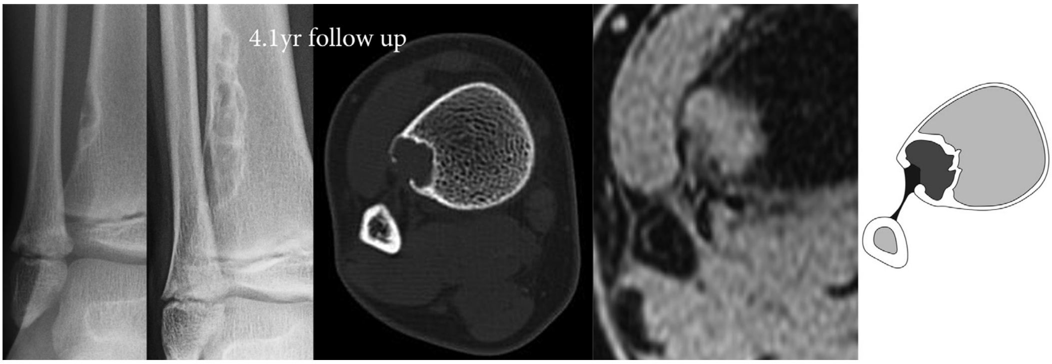

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Predicting Short-Term Morbidity in Patients Undergoing Posterior Spinal Fusion for Neuromuscular Scoliosis

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Purpose: Neuromuscular scoliosis (NMS) is a serious orthopaedic condition for which posterior spinal fusion (PSF) is often recommended. The purpose of this study is to determine the incidence and risk factors for short-term morbidity following PSF for NMS using a large, national cohort of patients.

Methods: A retrospective cohort study was conducted. Patients who underwent PSF for NMS during 2012 were identified from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Pediatric database. Patient characteristics were tested for association with adverse events, infectious complications, perioperative blood transfusion, extended length of stay (LOS), and readmission using multivariate logistic regression.

Results: A total of 418 patients met inclusion criteria. The average age was 13.1 ± 2.4 years (mean ± standard deviation). Forty-nine patients (11.7%) had an adverse event and 35 patients (8.4%) had a severe adverse event. On multivariate analysis (Table 1), any adverse event and severe adverse events were associated with ASA classification ≥ 3 (ORs 7.6 and 4.2, respectively). Severe adverse events were also associated with the presence of nutritional support (OR 2.2, p=0.044). Infectious complications were associated with previous cardiac surgery (OR 4.2, p=0.021) and ASA classification ≥ 3 (OR 8.9, p=0.035). A decreased rate of blood transfusion was associated with a 1-6 level fusion (OR 0.3, p=0.002). One hundred patients (23.9%) stayed longer than one week. Extended LOS was associated with ASA classification ≥ 3 (OR 4.4, p<0.001) and operative time ≥ 452 minutes (OR 3.2, p<0.001). Thirty patients (7.2%) were readmitted within 30 days, predominantly for infection and wound issues. Readmission was highly associated with the occurrence of any inpatient complication (OR 20.9, p<0.001).

Conclusion: This study found that increased ASA classification was strongly associated with adverse events, infection, and extended LOS in NMS patients that underwent PSF. Inpatient complications were strongly associated with an increased risk of readmission.

Significance: The identified factors associated with poor shortterm outcomes after PSF for NMS may serve as benchmark data, be useful for optimizing patient care, and can inform future studies in these patients.

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Table 1. Results of multivariate analyses.

Outcome/Risk Factor	Odds Ratio	P Value
Any adverse event		
ASA classification ≥ 3	7.6	0.001
Severe adverse event		
ASA classification ≥ 3	4.2	0.025
Nutritional support	2.2	0.044
Infectious complication		
Previous cardiac surgery	4.2	0.021
ASA classification ≥ 3	8.9	0.035
Blood transfusion		
1-6 levels instrumented versus 7-12 levels	0.3	0.002
Length of stay > 7 days		
ASA classification ≥ 3	4.4	<0.001
Operative time ≥ 452 minutes	3.2	<0.001
Readmission		
Any inpatient complication	20.9	<0.001

CI = Confidence Interval; ASA = American Society of Anesthesiologists.

See pages 21- 66 for financial disclosure information.

Explaining Missing Signals: Cerebral Anatomy Predicts Intraoperative Neuromonitoring in Cerebral Palsy Scoliosis Correction

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Purpose: To determine factors limiting intraoperative neuromonitoring (IONM) signals in patients with cerebral palsy (CP) undergoing scoliosis correction.

Methods: IONM data from 150 pediatric patients with CP and surgically corrected scoliosis at a single institution between 2002 and 2013 was categorized into three categories: 'no sensory' if somatosensory evoked potentials (SSEP) were limited, 'no motor' if transcranial motor evoked potentials (TcMEP) were limited, and 'no signals' if both SSEP and TcMEP were limited. We analyzed preexisting neuroimaging, available for 93 patients, and neurologic status of the full cohort against these categories. Statistical analysis of univariate and multivariate associations was performed using logistic regression. Odds ratios were calculated with significance set at $p<0.05$.

Results: Multivariate analysis revealed significant associations of periventricular leukomalacia (PVL), hydrocephalus, and encephalomalacia with lack of signal obtainability. Focal PVL (Figure 1) was associated with 'no motor' (OR=39.95, p=0.04). Hydrocephalus, regardless of severity, was associated with 'no motor'. Both moderate and marked hydrocephalus were also associated with 'no signals'. Marked hydrocephalus (Figure 2) was associated with 'no motor' (OR=20.46, $p<0.01$) and 'no signals' (OR=8.83, p=0.01). Moderate hydrocephalus was associated with 'no signals' (OR=32.35, $p<0.01$), 'no motor' (OR=10.14, p=0.04) and 'no sensory' (OR=8.44, p=0.03). Mild hydrocephalus was associated with 'no motor' (OR=8.62, p=0.05). Finally, encephalomalacia (Figure 3) was associated with 'no motor' (OR=6.99, p=0.01) and 'no signals' (OR=4.26, p=0.03).

Conclusion: Neuroanatomic findings of PVL, hydrocephalus, and encephalomalacia are significant predictors of limited IONM signals, especially TcMEP.

Significance: IONM is an indispensable technique in reducing post-surgical neurologic deficits in the surgical treatment of scoliosis. Patients who have findings of hydrocephalus, encephalomalacia, or PVL are less likely to have obtainable TcMEP or SSEP.

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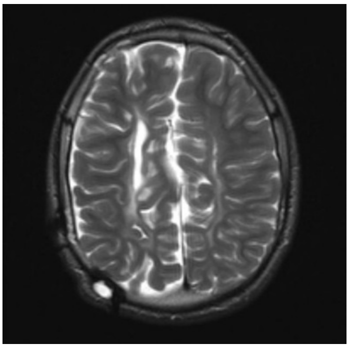

Figure 1. T2 MRI sequence of focal PVL.

Figure 2. Non-contrast CT of marked bilateral hydrocephalus with ventriculoperitoneal shunt.

Figure 3. Non-contrast CT of left hemisphere cystic encephalomalacia

See pages 21- 66 for financial disclosure information.

Long-Term Effects of Patellar Tendon Advancement Based on Tibial-Physeal Angle

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Introduction: Tightening the extensor mechanism using patellar tendon advancement (PTA) is an essential aspect of the treatment of crouch gait in children with cerebral palsy. When performed prior to skeletal maturity, the patellar tendon is shaved from the tibial tubercle preserving the proximal tibial growth plate. Concerns exist for potential altered growth and early epiphyseal closure. The influence of the altered loads on the skeletally immature anterior tibia has not been fully evaluated through the end of growth. The purpose of this study was to examine the long term effects of PTA on the proximal tibia.

Methods: A retrospective radiographic review was conducted of patients who underwent PTA prior to skeletal maturity. Patients had a minimum of 3 years of expected growth remaining at the time of surgery and minimum radiographic follow-up of 3 years. All had a diagnosis of cerebral palsy. The tibial-physeal angle (TPA) was measured to assess the physeal slope of the proximal tibia on pre-operative, 3 month post-operative, and yearly thereafter for 3 years or until skeletal maturity. The change of TPA over time was evaluated. A step-wise linear regression model was used (predictor variables: age at surgery, time from surgery, surgery type, amount of deformity, and amount of correction).

Results: Forty subjects (69 knees) met criteria & radiographs were reviewed (average age: 11.6±1.5 years; 25 male, 15 female). Average length of follow-up was 4.3 years (3.0 – 8.9) from surgery. 67% of the subjects had concomitant distal femoral extension osteotomy (DFEO) procedures. 57 knees in 33 subjects (83%) had reached skeletal maturity (closed tibial physes) at terminal measurement. All had TPA measurements within typical limits on pre-operative x-ray. Growth arrest was identified in 5 patients (9 knees (13%)) 2-3 years after initial surgery. Change in TPA was greater in those subjects. Regression analysis revealed main effects for age at surgery, time from surgery, and amount of correction, but not whether DFEO was performed (p<.001). Significant interactions were noted bewteen:1) age at surgery and time from surgery; 2) age at surgery and amount of correction; and 3) time from surgery and amount of correction (p<.001).

Conclusion: Age at surgery, time from surgery, and amount of correction predict the change in TPA observed. Mechanisms leading to growth plate injury are not understood. Further study is warranted.

Significance: Change in TPA over time can be used to monitor proximal tibial growth status after PTA.

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Neuromonitoring For Ais: An Analysis of Critical Changes and Predictive Factors to Define Patients At Risk

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Summary: Review of a consecutive series of 592 AIS patients, the incidence of neuromonitoring changes was 1.9%, occurring predominantly during deformity correction and identified by motor monitoring in the majority of cases. The timely response of warming the patient, raising the MAP, administrating steroids, and sequentially reversing the steps if changes occurred during implant placement resulted in no permanent neurologic deficits.

Introduction: In AIS surgery, critical intraoperative neuromonitoring (IONM) changes are uncommon and permanent deficits are rare. Few studies identify risk factors for these changes or strategies to limit their occurrence.

Methods: A retrospective review of a consecutive series of AIS patients at a single institution undergoing a posterior surgery using SSEP, NMEP and TcMEP monitoring was performed. Those patients who had critical intraoperative changes were identified and each was carefully reviewed to determine timing of change, associated factors, response to changes and ultimate outcome.

Results: There were 592 patients who were 14.9 years at surgery (483 F/109 M). The major Cobb was 59.5° and corrected by 54.1% at 2 years. Overall, critical IONM changes occurred in 11 (1.9%) patients- 8 girls/3 boys. A preoperative MRI was obtained in 9 of 11; all were normal. The critical monitoring changes were motor only (54.5%), sensory only (9.1%), and motor/sensory (36.4%). Critical changes occurred during anchor placement (18.2%), rod placement with correction (63.7%), pure distraction (9.1%) and epidural placement (9.1%). The mean arterial pressure (MAP) just prior to the change was 75.6 and dropped to 61.4 mm Hg at the time of change. The surgical team's responses to the changes were: increasing the patient's temperature (100%), raising MAP to an average of 81.9 mm Hg, administration of steroids (72.7%), and implants and/or rod alteration (63.6%). Surgery was aborted in 18.2% due persistence of abnormal monitoring. Two awoke with mild neurologic changes – 1 complained of hyperesthesia not requiring medical treatment resolving at 16 weeks; 1 complained of unilateral subjective weakness which resolved overnight.

Conclusion: The incidence of IONM changes during surgery for AIS is 1.9% with the vast majority having at least motor monitoring changes and occurred predominantly during rod placement and correction. Appropriate responses to increase MAP, administer steroids and alter implants resulted in no permanent neurologic deficits. Surgeons should understand the risk factors and appropriate responses to critical changes to avoid permanent neurologic deficits during AIS surgery.

See pages 21- 66 for financial disclosure information.

Reduction in Spinal Motion Following Posterior Fusion in Double Major AIS Curves

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Purpose: Previous work has shown that spinal fusion leads to a 25% reduction in total spinal motion in single adolescent idiopathic scoliosis (AIS) curves, with limited motion in the region of fusion and no hypermobility of unfused segments. The reduction in spinal motion in AIS patients who underwent spinal fusion for double major curves has not been reported.

Methods: This was an IRB-approved prospective analysis of AIS patients treated with anterior or posterior spinal fusion. All subjects underwent motion analysis while performing three tasks: forward bending, backward bending (extension) and left/right (summed) lateral bending. Thoracic, lumbar and overall spinal motion (thoracic+lumbar) was determined for each task; total spinal motion across all tasks was then summed using the thoracic and lumbar movement in each primary plane of motion. Healthy, non-scoliotic controls, unfused AIS patients, and single curve spinal fusion AIS patients were compared to fused AIS patients with double major curves.

Results: 76 AIS patients (32 unfused AIS patients (UN)) and 25 healthy non-scoliotic (CON) were evaluated. Fused patients were seen an average of 4 years post-operatively. The single curve fusion group (SF, N=34,average age at surgery 14yrs, range: 12-20) consisted of 15 anterior, 17 posterior and 2 combined fusions, with an average of 8 instrumented levels (range: 3-12); the double majors group (DM, N=10, average age at surgery: 14yrs, range: 12-18) were all posterior fusions with an average of 13 instrumented levels (range: 11-14). Total spinal motion was decreased 52% in the DM group compared to controls and unfused patients (110° DM v. 228° UN v. 231° CON, $p<0.05$), and decreased 36% compared to the single curve fusion group (173° SF, $p<0.05$). The double major group had significantly reduced motion in the thoracic, lumbar and total spine during lateral bending, and in the lumbar and total spine during forward bending. During extension, there was no significant difference between the single curve fusion and the double major group.

Conclusions: The increased number of instrumented vertebrae in double major AIS curves leads to a significant reduction in range of motion of the spine. Since extension of fusion into the mid lumbar spine decreases spinal motion 36-52% compared to thoracic-only fusions and unfused AIS subjects, avoiding fusion into the lumbar spine should be a major goal of scoliosis surgery whenever possible.

Significance: Preservation of distal unfused levels and selective thoracic fusion should be considered when appropriate in surgical decisions of extent of fusion.

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Effects of Serial Casting Prior to Growing Rod Instrumentation in Patients with Early Onset Scoliosis

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Purpose: Serial, derotational casting for early-onset scoliosis (EOS) has been proposed as a delay tactic in patients with significant curves in order to limit the number of growing rod surgeries. This study seeks to determine the effect casting has on the surgical outcomes of patients who transition from casting to growing rod surgery.

Methods: An IRB-approved, retrospective review was performed to identify patients with EOS treated with growing rod surgery. Congenital scoliosis patients were excluded. The study population had treatment with serial casting prior to surgery and the control population was treated primarily with growing rod surgery. Demographic data (age at time of surgery, height %, weight %, etiology) and clinical data such as curve type, Cobb angle, concave and convex chest width, space available for the lung (SAL) ratio, T1-T12 length, L1-S1 length, T1-S1 length, T1-S1/pelvic width(PW), number of lengthening procedures, and complications was collected. Statistical analysis was performed to identify differences between groups.

Results: Nineteen patients met inclusion criteria. Nine patients had serial casting prior to growing rod surgery (average of 3.5 casts), and 10 underwent surgery primarily. The two groups had similar age, height %, and weight % ($p>0.05$). The casting group consisted of 6 idiopathic and 3 syndromic patients, while the control group had 2 idiopathic patients and 8 syndromic patients. The casting group had a higher pre-operative major Cobb angle (82.4^{o} v. 72.8^{o}, $p=0.23$), and had a similar initial post-op Cobb angle (45.6^{o}; 44.7% curve correction v. 42.4^{o}; 41.8% curve correction, $p=0.54$). The casting group underwent an average of 6.0 lengthening procedures compared to 5.4 in the initial surgery group and had similar improvement in chest diameter, SAL, T1-T12 length, L1-S1 length, T1-S1 length, and T1-S1/PW from lengthening ($p>0.05$). The final percent curve correction of the pre-operative Cobb angle was 33.0% in the casting group versus 20.3% in the primary lengthening group ($p=0.31$). Complications occurred in 8/9 casting patients and 5/10 primary lengthening patients ($p=0.14$).

Conclusion: Serial casting prior to growing rod instrumentation does not seem to hinder the ability to obtain initial correction or improve growth parameters throughout the lengthening process.

Significance: This data supports the use of serial, derotational casting as a delay tactic in infantile scoliosis without having a negative effect on future growing rod surgery.

See pages 21- 66 for financial disclosure information.

Increased Rate of Acute Post-Operative Wound Problems Following Posterior Spinal Fusion For Overweight/Obese Patients with Adolescent Idiopathic Scoliosis

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Purpose: Obesity is a national epidemic that can have detrimental effects on medical treatment outcomes. The primary study purposes were: 1) to assess the rate of adverse wound events in individuals with adolescent idiopathic scoliosis (AIS) who underwent posterior spinal fusion (PSF) and 2) to determine if obesity was related to number of adverse wound events. Additionally, pre-, intra- and post-operative factors were assessed in relation to wound events and weight status.

Methods: Data were obtained through an IRB approved retrospective chart review of patients with the diagnosis of AIS that underwent PSF during 2001-2013. Pre-, intra- and post-operative parameters thought to potentially link to increased risk of wound problems were extracted. Individuals were grouped using the CDC categories into overweight/obese (BMI%≥85%) and normal/underweight. Acute (<3months post-op) wound problems were defined as drainage, dehiscence, and superficial or deep infections. Chi-square analyses were performed to determine if weight status was related to rates of wound problems. T-tests assessed difference between groups.

Results: Data from 178 individuals (Female=155; White=173; mean age at surgery 14.2±1.8years) were analyzed. 73 (41%) were overweight/obese and 105 (59%) were underweight/normal. 36 (20%) patients had acute post-op wound problems (2 deep infections; all others healed with non-operative management). The overweight/obese group had a higher rate of post-operative wound problems (34% (25/73) than the normal/underweight group (11% (11/105) (p< 0.0001); Odds ratio=0.25 (95%CI: 0.102 to 0.495) indicating that the relative risk of a post-op wound problem for overweight/obese patient is 3.3(95%CI = 1.7 to 6.2) times more likely than the normal/underweight patient. Age at surgery, number of levels fused, size of primary curve angle, blood loss, amount of intra-operative wound drainage, total time in the OR, total days before discharge, Lenke classification, type of antibiotic administered during surgery were not related to wound problems in our population. Similarly, no differences in these variables were found between the two study groups.

Conclusion: Individuals with AIS and BMI percentages >85% are at an increased risk of acute post-operative wound problems following PSF. This study was not able to identify any factors beyond weight status category that were related to increased rates of acute post-operative wound problems.

Significance: Obesity is an important risk factor that should be considered by clinicians prior to PSF for AIS. Strategies are needed to decrease the risk of wound problems in the obese. Further analysis into the long term consequences of these complications is needed.

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Ultra Low Dose Imaging for the Follow-Up of Idiopathic Scoliosis

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Introduction: In adolescent idiopathic scoliosis (AIS), repeated radiological monitoring is required to determine curve prognosis and the best therapeutic strategy. Radiosensitivity of the organs in pediatric patients is higher, and a greater risk of breast cancer has been demonstrated in this population. Therefore, minimizing radiation exposure according to the ALARA concept (as low as reasonably achievable) is essential. A biplanar slot scanning system, previously validated in the literature, allows significant dose reduction with three dimensional (3D) reconstructions. With recent technical advances, further dose reduction can be obtained with this system, at a cost of a slight reduction in image quality. The aim of our study was to analyze the reproducibility of this new protocol and evaluate its use in routine clinical practice.

Methods: In this single center prospective study, pediatric patients with idiopathic scoliosis were included. All the patients underwent full spine EOS imaging (EOS imaging, Paris, France) using a micro dose protocol. Three observers performed two times each 3D reconstructions of the spine with “fast spine” SterEOS software (EOS imaging, Paris, France). Usual coronal and sagittal spinopelvic parameters were measured. Reproducibility and accuracy of the measurement was assessed with the ISO norm 5725-2.

Results: Thirty six patients were included, with a mean age of 12.8 years, and a mean Cobb angle of 25° (10° to 68°). Radiation dose with EOS microdose was 6 times less than with standard EOS (63 μGy). The mean time needed for 3D “fast spine” reconstruction was 5 minutes. Interobserver reproducibility was 2° to 5° for spinal parameters, and 1° to 5° for pelvic parameters. Intraclass coefficients of correlation were between 0.86 and 0.98.

Conclusion: Measurement reproducibility of EOS “fast spine” microdose is similar to standard EOS reproducibility reported in the literature. 3D reconstructions of the main spinal parameters are faster. While the quality of images is slightly inferior, the radiation dose is very low: 40 times less than a standard x-ray. Therefore, EOS “fast spine” microdose is as reliable as standard EOS and can be considered for routine radiographic follow-up of AIS patients.

Significance: level 3

See pages 21- 66 for financial disclosure information.

Is Serial Derotational Casting an Effective Treatment for Children with Early Onset Scoliosis?

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Purpose: Serial Mehta derotational casting has emerged as a potentially curative technique for some patients with Early Onset Scoliosis (EOS). The purpose of this study is to examine the effectiveness of scoliosis casting and to identify factors that will affect the efficacy of casting treatment for children with EOS.

Methods: This retrospective study reviewed patients who underwent serial Mehta/Cotrel derotational casting for EOS at a single institution from 2009 to 2014. 16 patients with age 1-5 years old, a diagnosis of EOS (including etiologies of idiopathic, congenital/structural, syndromic), and radiographic evaluation between casting treatments were included. Patients with prior spine casting or pertinent surgical interventions were excluded. Diagnosis, time in cast, Cobb angles, and number of casts were recorded.

Results: The mean age at initial casting was 2.4 years old (range of 1 – 5yo) with mean major curvature of 50.3^o (range of 32 - 81°). Patients had an average of 4.4 derotational casts (range of 3-8). At final casting, 50% (8/16) had ≥ 10% of curvature improvement, 31% (5/16) maintained their curve, and 19% (3/16) had significant progression (>10%). Patients with an initial curvature < 50^o were five times more likely to have at least 10% curvature improvement after the final cast compared to patients with initial curve ≥ 50^o. Patients under 20 months of age at initial casting were five times more likely to have at least 10% curvature improvement after the final cast compared to patients over 20 months old. The average curvature improvement among all 16 patients from initial casting until the patients were out of the first cast and out of the third cast was 17.2% and 22.4%, respectively. For the 10 patients who required ≥ 4 derotational casts, the average curvature improvement from initial casting until the patients were out of the final cast was 8.3%.

Conclusion: In our experience, 50% of patients undergoing serial derotational casting demonstrated an improvement in curvature; another 31% did not progress. Children younger than 20 months or with major curvature < 50^o are more responsive to scoliosis casting treatment.

Significance: This retrospective data provides strong support for the implementation of serial derotational casting, particularly for children younger than 20 months old or with major curvature < 50°.

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◆ Pelvic Anchors in Growing Rod Constructs: Better Pelvic Obliquity Correction with Iliac Fixation Compared with Sacral Fixation At A Minimum of 4 Years of Follow-Up

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Purpose: The purpose of this study was to evaluate which distal anchors provide the best correction of pelvic obliquity, sagittal balance, thoracic kyphosis, and lumbar lordosis in patients with growing rod constructs with at least 4 years of post-operative follow-up. In addition long-term complications were evaluated based upon the type of distal anchor used.

Methods: Records and radiographs of 38 patients, with ≥ 4 years of follow-up, from a multi-center database with growing rods anchored to the pelvis were evaluated. Underlying etiologies included 26 neuromuscular, 11 syndromic, and 1 congenital. Pelvic obliquity was defined as the angle formed by a line traversing the midpoint of T1 to S1 and a line that is tangential to the iliac crests, subtracted from 90°. Statistical analyses included the Student t test, analysis of variance, and Fisher's exact test. Significance was set at $p \leq 0.05$.

Results: Mean follow-up time was 5.1 ± 1.7 years. Distal fixation constructs included 23 iliac screws, 8 iliac rods, and 7 sacral screws/rods (Figure). At final follow-up 6 patients were converted from iliac rods to iliac screws, 1 had their iliac screws removed, and 1 was converted to a VEPTR construct. The mean improvement in pelvic obliquity, major Cobb angle, and sagittal balance at final follow-up was 73%, 45%, and 44% respectively. In comparison to distal constructs anchored to the sacrum only, constructs anchored to the ilium offered a greater correction in pelvic obliquity ($p= 0.03$). There was no statistically significant difference between any of the distal fixation constructs in regards to major Cobb angle, T1-S1 length, thoracic kyphosis, lumbar lordosis, or sagittal balance at final follow-up. Complications included 12 patients with post-operative infections, 6 with prominent pelvic hardware, and 7 with distal anchor pullout or failure. There was no statistically significant difference in presence or type of complications between all distal fixation constructs.

Conclusion: Growing rod constructs anchored distally to the ilium offer significantly greater improvement in pelvic obliquity on long-term follow-up as compared to growing rod constructs anchored to the sacrum only. In contrast to patients with 2 years of follow-up, at ≥ 4 years of follow-up there is no significant difference in complications with regards to iliac screws, iliac rods, or sacral screws/rods in growing rod constructs.

Significance: This is the first study to evaluate outcomes in growing rod constructs anchored to the pelvis or sacrum in patients with ≥ 4 years of follow-up.

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Rigid Spinopelvic Fixation for Neuromuscular Scoliosis Improves Deformity Correction without Increased Complications

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Purpose: To evaluate the rigidity of spinopelvic fixation for neuromuscular scoliosis in terms of deformity correction, complications, and implant cost.

Methods: Patients treated with posterior spinal fusion to the pelvis for neuromuscular scoliosis with minimum 1-year follow-up from 1998-2012 were reviewed. Constructs were defined as non-rigid (greater than 50% sublaminar wire fixation with Galveston or iliac screw pelvic fixation) and rigid (at least 50% pedicle screw fixation with iliac or sacral alar iliac screw pelvic fixation).

Results: 80 patients were identified: cerebral palsy (55%), myelomeningocele (16%), syndrome (8%), muscular dystrophy (15%), or other disorders (6%). 95% were non-ambulatory. Mean follow-up 3.9 years. Construct types were 23 non-rigid and 57 rigid. Estimated construct cost was greater in the rigid group at $15,581 as compared to $3,128 despite the lower anchor density in the rigid group (1.38 vs. 1.80, p<0.001). Open anterior releases were more frequent in the non-rigid group (13/23 vs. 5/57, p<0.001). Final correction was significantly greater for both Cobb angle and pelvic obliquity in the rigid group. The rates of infection (15%), dehiscence (19%), implant prominence (10%), and pelvic fixation failure (13%) were not significantly different. The pseudarthrosis rate was 22% in non-rigid group and 7% in the rigid group (p=0.059).

	Non-Rigid (n=23)	Rigid (n=57)	p-value (* <0.05)
Operative time (minutes)	465	401	0.092
Anterior Release	13/23	5/57	<0.001*
Anchor Density	1.80	1.38	<0.001*
Implant Cost	$3128	$15488	
<u>Cobb Angle</u>			
Preop	77.9°	75.5°	0.595
Immediate Postop (% correction)	39.6° (47%)	34.8° (56%)	0.131
Final (% correction)	49.7° (32%)	36.9° (54%)	0.004*
<u>Pelvic Obliquity</u>			
Preop	22.5°	25.6°	0.610
Immediate Postop (% correction)	12.7° (24%)	11.3° (5%)	0.107
Final (% correction)	19.7° (-35%)	13.2° (44%)	0.011*

Conclusion: Advances in spinopelvic fixation have resulted in improved deformity correction with lower rates of pseudarthrosis and a decreased need for anterior release.

Significance: Modern, rigid instrumentation for neuromuscular scoliosis improves results; however, implant costs are approximately 5 times greater.

See pages 21- 66 for financial disclosure information.

Blood Transfusion Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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Purpose: While the use of hypotensive anesthesia, appropriate positioning and fibrinolytics may help mitigate the need for transfusion associated with posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS), the incidence of blood transfusion remains high and has been previously reported as nearly 50%. Complications associated with blood transfusions are rare but can be serious, including transmission of communicable infection, transfusion reactions, surgical site infection and coagulopathy. The purpose of this study was to identify preoperative conditions, operative characteristics and post-operative complications that increase the risk of transfusion following PSF for AIS.

Method: Using the American College of Surgeons-National Surgical Quality Improvement Program (NSQIP) - Pediatric data for 2012, a study population was identified using the International Classification of Diseases (ICD-9) code for idiopathic scoliosis (737.30) and the Current Procedural Terminology (CPT) codes for PSF (22800, 22802, 22804). Patients with chronic diseases/conditions associated with non-idiopathic scoliosis were excluded. The sample was stratified into those who did and did not receive perioperative blood transfusions. Demographic variables, preoperative comorbidities, laboratory values, operative characteristics, and surgical outcomes were compared between the groups using univariate and multivariate logistic regression models.

Results: Of the 797 patients identified, 552 (69%) received red blood cell transfusion intraoperatively and/or within 72 hours postoperatively, including allogenic and autogenic (cell-saver) transfusion. Independent risk factors for transfusion identified included the use of local autograft (odds ratio, 2.432 [95% CI, 1.629 to 3.631] $p < 0.001$) and protracted operative time (odds ratio, 1.007 [95% CI, 1.005 to 1.009]; $p < 0.001$). A BMI-for-age >85th percentile was associated with decreased risk (odds ratio, 0.635, [95% CI, 0.421 to 0.957]; $p = 0.030$). Neither the amount of segments fused nor the amount of instrumented segments was independently associated with increased transfusion risk. There was no noted association between transfusion and any post-operative complications.

Conclusion: The risk of perioperative transfusion in PSF for AIS is associated with increased operative time and the use of local autograft but is decreased in overweight adolescents. Surprisingly, the number of fused segments is not associated with an increased transfusion risk.

Significance: This report is one of the first studies using NSQIP - Pediatric to evaluate outcomes of PSF for AIS. While far from comprehensive, this database may allow for future evaluation of this and other common pediatric procedures to decrease complications and improve outcomes. Our methods may serve as a model for such analysis.

Level of Evidence: Prognostic Level III

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Radiographic Resource Utilization in Patients Referred for Idiopathic Scoliosis

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Purpose: Pediatric spine surgeons rely on referrals for a large percentage of patients. A standard pre-referral (PR) patient evaluation is not universally accepted, leading to a variety of resource utilization. An understanding of current PR resource utilization may help improve the cost effectiveness of this testing. We undertook a cohort study to assess the use and utility of PR radiographs in patients referred to a tertiary pediatric hospital for idiopathic scoliosis.

Methods: All new patients referred for assessment of idiopathic scoliosis to our institution were included in this study. Exclusion criteria included a diagnosis of non-idiopathic or early onset scoliosis. The treating physician recorded information regarding the use and utility of PR radiographs on a standardized data collection form.

Results: Data was collected over a six month period in 2013, during which time 130 consecutive patients were enrolled. The average age of the cohort was 12+11 years (±31 months) with 72% being female. 59% (77) of patients had prior radiographs to assess the spine, but only 74% (57) actually brought the radiographs to the visit. Of the films available, 75% (43) were deemed adequate for assessment of the deformity by the treating surgeon. Reasons for inadequacy were: unable to measure deformity (7), more of spine needed on the film (7), lateral view not obtained (8), unable to determine Risser sign (7), unable to open the digital file (1), radiograph too old (2). Only 14% of radiographs were taken with breast shielding and 7% with gonadal shielding.

Conclusion: In a cohort of patients referred for the evaluation of idiopathic scoliosis we found only 33% had adequate PR radiographs of the spine. Of particular concern was the high number of patients who had inadequate or insufficient radiographs requiring additional radiation exposure at the time of the referral visit (14/57 patients, 25%). A large portion of prior radiographs lacked appropriate breast or gonadal shielding. Development of an educational program or protocol to assist referring physicians to avoid inappropriate resource utilization and radiation exposure in pediatric patients referred for scoliosis appears warranted and may lead to significant cost savings.

Significance: We found a high incidence of inadequate or insufficient radiographs at the time of referral for scoliosis evaluation. An educational program detailing a standardized method of radiographic evaluation to assist primary care physicians prior to scoliosis referral is warranted.

See pages 21- 66 for financial disclosure information.

Pelvic Incidence is Associated with Proximal Junctional Kyphosis in Patients Treated with Growing Rods

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Purpose: Pelvic incidence is considered a constant parameter in the child, and abnormal pelvic incidence has been associated with increased risk of failure in scoliosis growing rod surgery. We investigated whether pelvic incidence can vary during growing rod treatment, and if it is associated with failure in children with growing rods.

Methods: We studied 48 patients treated for early onset scoliosis who underwent growing rod treatment with at least two year follow up from our prospective database. Age, gender, type of scoliosis (idiopathic, neuromuscular, congenital), and duration of follow up were recorded. Pelvic incidence was measured on 25 preoperative, 40 first upright and 48 final postop radiographs which included visible hip joints. Proximal junctional kyphosis and lordosis was defined based as a 10^{o} or greater increase in the proximal junctional angle on final postop images compared to preoperative images. Failures included rod fracture, pedicle screw pullout, hook dislodgement, hook erosion, and proximal junctional kyphosis.

Results: Average age at initial treatment was 7±3 years, with 35 females and 13 males. 13 patients were idiopathic, 30 were neuromuscular and 5 were congenital. Mean follow up was 97 months (range: 24 – 264 months). Mean pelvic incidence was 48°±17°, 49°±14° at first upright, and 51°±19° at final follow up. Repeated measures ANOVA on 22 patients with all three values found no statistical difference in pelvic incidence throughout the three films (P=0.66). Twenty-two patients had an average of 2 failures. Of 22 patients with measureable preop and final postop images, eight fulfilled criteria for proximal junctional kyphosis. Multiple regression analysis with Bonferroni correction found that: younger age (P<0.0005) was associated with increased overall failure and congenital etiology (P=0.022) was associated with decreased overall failure rate. Younger age (P=0.017), female gender (P=0.001) and lower pelvic incidence (P=0.021) were all associated with increased proximal junctional kyphosis.

Conclusion: Pelvic incidence remained constant throughout the course of growing rod treatment. Lower pelvic incidence was associated with increased proximal junctional kyphosis.

Significance: Pelvic incidence is a relatively constant parameter even in children undergoing prolonged spinal treatment with growing rods. When treating growing rod patients with decreased pelvic incidence, increased attention should be paid to sagittal plane balance to avoid proximal junctional kyphosis.

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Comparison of Deformity Correction and Complications with VEPTR and Early Primary Posterior Spinal Fusion in Young Children with Idiopathic Scoliosis: A Retrospective Matched Cohort Analysis

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Purpose: To compare outcomes and complications of VEPTR surgery versus early primary posterior spinal fusion (PSF) in young children with idiopathic scoliosis (IS).

Methods: After institutional review board approval, prospectively collected data from two multicenter registries was retrospectively queried. One registry identified patients aged 8-11 at time of initial VEPTR surgery. The other identified patients aged 8-11 having primary PSF and open tri-radiate cartilage. Each VEPTR patient was matched with 1-4 patients from the fusion cohort by age, gender, and major Cobb angle. Charts and radiographs were then reviewed to collect Cobb angles, coronal balance, sagittal balance, thoracic height, total number of operations, unexpected reoperations, and complications. Linear and multiple regressions were used to compare the outcome variables.

Results: The VEPTR cohort contained 6 patients with mean age 9.8 years (range 8-11), an average follow up time of 3.2 years, and 6.83 cumulative operations (range 5-9). The PSF group contained 12 patients with mean age 10.8 years (range 10-11), an average follow up time of 2.2 years, and 1.08 cumulative operations (range 1-2). The pre-operative Cobb angle was not different between VEPTR (66º) and PSF (65º) cohorts. At last follow-up, the PSF group had a significantly smaller mean Cobb angle (25º) when compared to the VEPTR group (64 º), $p<0.0001$. The thoracic height at final follow up in the VEPTR group was significantly shorter than the PSF group by 52.65 mm after controlling for preoperative thoracic height ($p=0.032$). The VEPTR group had 2/6 patients with complications, a patient with superficial wound complication treated medically and a patient with rib anchor failure requiring unexpected revision surgery. The fusion cohort had 2/12 patients with complications, pulmonary edema treated with medication and a patient with proximal hook failure requiring unexpected revision surgery.

Conclusion: VEPTR and early primary PSF both provide control of IS, however, patients with VEPTR undergo more surgical procedures. Complications and unexpected re-operations are frequent, but not significantly different between VEPTR and early primary PSF in this small matched cohort. Cobb angle at last follow-up was significantly lower in the primary PSF group, however, 5/6 VEPTR patients have not yet had a definitive PSF.

Significance: Both VEPTR and early primary PSF are reasonable surgical options for operative magnitude IS in young children. Further study is needed to determine if there are significant differences in complications and unexpected re-operations between the two treatments.

See pages 21- 66 for financial disclosure information.

Recovery of Muscle Strength and Function in Pediatric Patients After Anterior Cruciate Ligament Reconstruction

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Purpose: To explore the factor influencing muscle recovery in pediatric ACL reconstruction patients.

Methods: We retrospectively reviewed the records on all patients under 18 years of age presenting to our institution with ACL tears and Biodex System® muscle testing data from January 2009 to October 2013 for sex, age, height, weight, concomitant injuries, and graft selection. Muscle recovery was defined at >85% peak torque in side-to-side comparison. Normal weight and obese/overweight patients (defined as > 85 %ile Body Mass Index (BMI) for age) were compared. Statistical analysis was performed with Mann-Whitney tests.

Results: The study group consisted of 332 patients, of which 199 (60%) and 228 (68.6%) met quadriceps and hamstring recovery criteria at their last testing. On average, this group recovered quadriceps strength at 6.1 months and hamstring strength at 5.3 months.

Obese and overweight patients made up about 1/3 of the study group. Muscle recovery averaged 6.4 months for quadriceps, 5.7 months for hamstring in the obese and overweight group, compared to 5.9 month and 5.1 months respectively. This did not reach statistical significance.

Recovery of muscle function after ACL reconstruction was not negatively impacted by meniscal tears, collateral ligament injuries, or use of hamstring autograft.

Conclusion: BMI, meniscal tears, collateral ligament injuries, and graft choice does not play a factor in the rate of recovery after ACL reconstruction in the pediatric population, where recovery of muscle strength returns on average at 6 months.

Significance: Obesity, BMI, meniscal tears, collateral ligament injuries, and graft choice do not delay the pediatric ACL reconstruction patient from recovering muscle strength by 6 months.

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The Anterolateral Ligament of the Knee: An Inconsistent Finding in Pediatric Cadaveric Specimens

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Purpose: The anterolateral ligament (ALL) of the knee has been identified as a structure that limits internal rotation, and thus, affects the pivot shift mechanism. This structure has been designated "Segonds Pearly Band", which is described as "clearly distinguishable from the antero-lateral joint capsule". Several groups are now advocating reconstruction of this extra-articular ligament with primary and revision intra-articular ACL reconstruction. A recent report identified this structure in 40 out of 41 adult cadaveric knee specimens. The purpose of the current study was to evaluate whether the ALL could be identified on pediatric cadaveric knee .

Methods: Eight skeletally immature cadaver knee specimens were examined through gross dissection: ages 3 months, 4 months, 1 year, 2 years, 3 years, 3 years, 8 years, and 10 years. There were 3 male and 5 female (7 right, 1 left) specimens. The presence or absence of the ALL was documented in each specimen, through dissection, and intermittent internal and external rotation of the tibia to produce tension of the joint capsule. These dissections were performed by a group of fellowship trained orthopedic surgeons.

Results: The entire lateral joint capsule and LCL were readily identified in each specimen. In 7 specimens, a distinct structure consistent with the ALL in the antero-lateral joint capsule was not present. The ALL was identified in only 1 of 8 specimens (1-year-old female, right knee). This structure was noticeable after gross dissection of the lateral capsule. The ALL was further delineated under applied internal rotational stress.

Conclusion: Previous research has suggested that this ligament is present in the vast majority of adult specimens. This finding was not reproduced in a smaller group of pediatric cadaveric specimens, where only one out of eight specimens had an identifiable ALL. This suggests that this ligament may develop later in life, after physiologic loads are applied to the joint capsule.

Significance: In pediatric and adolescent patients, rates for ACL injury, ACL reconstruction, and failure of ACL reconstruction are amongst the highest for all patient groups. Further research needs to be conducted to further elucidate the development of this ligament, the role of this structure may play in pediatric knee stability, and whether reconstruction of this ligament in skeletally immature patients is appropriate.

See pages 21- 66 for financial disclosure information.

Safe Drilling Paths in the Distal Femoral Epiphysis for Pediatric Medial Patellofemoral Ligament Reconstruction

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Purpose: Anatomic surgical reconstruction of the medial patellofemoral ligament (MPFL) is becoming increasingly popular for treatment of patellar instability in the skeletally immature population. The femoral attachment point of the MPFL is in close to proximity to the distal femoral physis. The safe zone angles for drilling the femoral epiphysis for graft placement have not yet been defined.

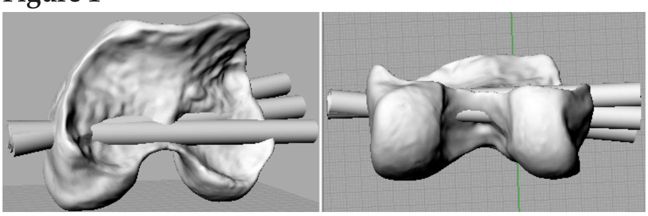
Methods: 23 cadaveric distal femoral epiphyses were scanned into high-resolution three-dimensional surface images. Using computer-aided design, the femoral insertion site of the MPFL was identified and 8mm diameter tunnels were drawn at varying angles to simulate the drill paths for placement of 6mm interference screws with a 1mm buffer on all sides, as shown in Figure 1. The distance from the MPFL footprint to where the drill paths violated the physis or the intercondylar notch was measured.

Results: Mean age was 11.2 ± 4.1 years. The percentage of samples where a 20mm long drill tunnel at the given angles does not violate the physis or notch is shown in Table 1. For unsafe tunnels angled 5^{o} distally or less, violation was almost always at the physis (129/131 tunnels, 98.4%). For tunnels angled distal ≥15^{o} degrees but anterior 5^{o} or less, there was substantial risk of violation of the notch (25/92 tunnels, 27.1%).

Conclusion: Due to the undulating nature of the distal femoral physis, drilling into the epiphysis from the MPFL attachment site without angling risks damage to the physis. Angling the drill distal and anterior leads to less risk to the physis and notch respectively.

Significance: In order to minimize risk of trauma to the physis or notch, it is safest to angle the drill distal and anterior approximately 15-20^{o} in each plane from the MPFL attachment site.

Figure 1



Cadaveric distal femoral epiphysis with drill paths for MPFL graft fixation. The attachment site of the MPFL is marked. The drill can violate both the physis and the intercondylar notch if it is not inclined appropriately distal and anterior.

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Table 1. Number of Safe 20mm Tunnels (%)		**Distal Inclination**				
		0°	5°	10°	15°	20°
Anterior Inclination	0°	6 (26)	13 (56)	16 (61)	16 (61)	13 (56)
	5°	5 (22)	15 (65)	17 (74)	20 (87)	18 (78)
	10°	6 (26)	14 (61)	17 (74)	21 (91)	20 (87)
	15°	6 (26)	14 (61)	17 (74)	21 (91)	22 (96)
	20°	6 (26)	14 (61)	18 (78)	21 (91)	21 (91)

See pages 21- 66 for financial disclosure information.

Height, Weight, and Age Predict Quadriceps Tendon Length and Thickness in Skeletally Immature Patients

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Purpose: As anterior cruciate ligament (ACL) reconstruction becomes more common in skeletally immature patients, several new reconstruction techniques and grafts have been described. Quadriceps tendon autografts have been used with success in adults and are becoming a popular graft option in pediatric patients due to size, decreased donor site morbidity, ease of harvest, and favorable biomechanical characteristics. Little is known about the length and thickness of the quadriceps tendon in pediatric patients. The purpose of this study was to determine whether quadriceps tendon length and thickness follows a predictable pattern of development based on height, weight, age, and body mass index (BMI) in skeletally immature patients.

Methods: After recording the height, weight, age, and gender of each participant, ultrasound measurements of bilateral quadriceps tendons of 151 children ages 4 - 16 were performed. Using ultrasound machines with 10-12 megahertz (MHz) transducers and extended view technology, a single technician sonographically measured tendon length and thickness. The extended view function was then used to visualize and measure the entire length of the tendon from the most distal point of the rectus to the superior pole of the patella. A saggital view of the quadriceps tendon was taken 3 centimeters(cm) proximal to the superior pole of the paella to measure tendon thickness.

Results: Average quadriceps tendon length and thickness were 6.87 ± 1.49cm and 0.37 ± 0.12cm respectively. Tendon length averaged 3.89cm at 4 years and 7.98cm at 16 years of age while thickness averaged 0.24cm at 4 years and 0.40cm at 16 years of age. There was no significant difference in tendon length or thickness between males and females ($p=0.97$), nor was there a difference in length or thickness between right and left legs ($p=0.6$). Tendon length and thickness increased significantly with age ($p<0.01$). Additionally both tendon length and thickness varied significantly based upon weight and height ($p<0.01$). Tendon thickness and length showed a strong correlation with BMI, ($p=0.06$ and $p=0.05$).

Conclusions: The size of the quadriceps tendon graft is highly predictable using the age, height, and weight of the patient. Graft length and thickness can also be easily confirmed using ultrasound.

Significance: The quadriceps tendon is of sufficient length and thickness to be used as an autograft for nearly all pediatric patients. Given the quadriceps tendon's size, favorable biomechanical characteristics, minimal donor site morbidity, and post ACL reconstruction functional outcomes, it is a viable, and predictable, autograft for pediatric patients.

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Is Non-Operative Treatment of Pediatric Type I Open Fractures Safe and Effective?

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Purpose: There is limited literature on non-operative treatment of open type I pediatric fractures. Our purpose was to evaluate the rate of infection in pediatric patients with type I open fractures treated non-operatively at our institution without admission from the emergency department.

Methods: We performed a retrospective chart review of all patients who sustained a type I open fracture of the forearm or tibia from 2000 to 2013. Forty patients fit the inclusion criteria: <18 years old with type I open fracture treated non-operatively with irrigation and debridement, followed by closed reduction and casting of the fracture under conscious sedation in the emergency department. All patients were discharged home. The primary outcome was presence of infection. Secondary outcomes included occurrence of a delayed union, time to union, complications, and residual angulation.

Results: There were no reported or documented infections. There was one case of a retained foreign body (<1 cm) in a mid-diaphyseal forearm fracture, which was removed in clinic at 4 weeks after the patient developed a granuloma with no infectious sequela. There was one case of a delayed union; all patients eventually had complete bony union. There was minimal residual angulation in both upper and lower extremities at last follow-up.

Conclusions: Non-operative treatment of type I open fractures in pediatric patients can be performed safely with little risk of infection. This preliminary evidence may serve as a foundation for future prospective studies.

Significance: This is the first study to report non-operative outcomes in pediatric patients with open fractures who were discharged from the emergency room, without admission for intravenous antibiotics.

See pages 21- 66 for financial disclosure information.

Developing Injury Prevention Strategies Through Accident Scene Analysis in an Urban Setting

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Purpose: While some researchers have delineated general details about injury scenes, fine details, such as proximity to bus stops or playgrounds, are not commonly included in auto-versus-pedestrian injury analyses. The purpose of our study is identifying the circumstances at the scene and injury types of patients struck by motor vehicles. Based on the findings, targeted community outreach proposals and injury prevention campaigns to improve safety may then be implemented.

Methods: Retrospective analysis of all auto-versus-pedestrian cases that presented via ambulance and treated by both our orthopedic and trauma surgical services from 01/01-12/31, 2012. Ambulance dispatch data, patient demographics, procedure(s), diagnoses, and length of stay were recorded. Narratives by first-responders and healthcare providers were reviewed for descriptions of the scene of the accident. Google Maps was used to identify clusters of injury sites, and to obtain individual street characteristics.

Results: Our study group included 100 patients (79 males and 21 females) with an average age of 8 years (range: 16m-20y). The mean length of stay was 1.98 days. The most common orthopedic diagnoses were tibial shaft fractures (26), femoral shaft fractures (6), and ankle fractures (6). A parent or guardian was absent in 60% of cases. Accidents most commonly occurred around school dismissal (29% 2-5pm) and evening hours (42% 5-9pm), with the greatest number of injuries occurring in June (13%). Forty-four cases with sufficient details of the street showed 70% (31) occurred mid-block, 18% (8) at crosswalks, and 9% (5) on private property, sidewalk or in a parking lot. Clusters were identified near schools and bus stops used by students for transportation. The mean distance between each accident and the nearest school was 0.19 miles, and the nearest park or recreation center, 0.22 miles. Nine cases were bus-related. Eight of which correlated with school dismissal times, and required orthopedic intervention.

Conclusion: Automobile-versus-pedestrian accidents occur most commonly when no parental supervision is present from the time of school dismissal until the early evening hours. Injuries tend to occur during warm months and cluster near schools and bus stops located near schools.

Significance: Injury prevention efforts should focus on improved supervision at school dismissal and transportation safety in school zones.

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Is Smartphone Technology Adequate and Reliable to Assess Pediatric Elbow Trauma?

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Purpose: The use of mobile imaging has become increasingly prevalent in the clinical setting, however, data are not available regarding the reliability of smartphones in transmitting adequate images for establishing a diagnosis and directing treatment. The purpose of this study was to assess the adequacy of smartphone technology for the diagnosis and treatment decision-making for pediatric elbow factures.

Methods: Standard AP and lateral radiographs of 50 pediatric elbow trauma cases were evaluated by 2 fellowship trained pediatric orthopaedic surgeons and 2 senior orthopaedic residents. Raters were asked to classify the case as normal or a supracondylar humerus, lateral condyle, medial epicondyle, or radial neck fracture, or posterior fat pad. Additionally, raters chose operative or conservative treatment of the elbow. After a temporal lag, pictures of the same images were then taken from a standardized distance from a computer monitor with an iPhone 5 camera and transmitted by MMS to each rater. The same questions were again posed to raters. Inter and intra-observer reliabilities were calculated by Cohen's kappa statistics with bootstrapped 95% confidence intervals.

Results: Baseline inter-observer reliability of classification of injuries based on PACS images was excellent between residents and attendings with a kappa of 0.85 (95% CI 0.76 - 0.93). The inter-observer reliability of treatment decision between the two groups was also high with a kappa of 0.79 (95% CI 0.67 - 0.91). Intra-observer reliability of classification of injuries on PACS compared to smartphone images was excellent, with kappa ranging from 0.89 (95% CI 0.80 - 0.95) to 0.94 (95% CI 0.87 - 0.99) for residents and attendings, respectively. The overall kappa was 0.91 (95% CI 0.86 - 0.95) when comparing ratings of all participants on PACS versus smartphone technology. Treatment decision also demonstrated excellent intra-observer reliability (PACS versus smartphones) with kappa ranging from 0.80 (95% CI 0.67 - 0.92) to 0.916 (95% CI 0.84 - 0.99) for residents and attendings respectively, with an overall kappa of 0.86 (95% CI 0.79 - 0.93) for all raters.

Conclusion: The diagnosis and treatment decisions regarding pediatric elbow injuries can be made equally reliably based on either PACS or transmitted MMS images taken with an iPhone from a computer screen (smarthphone technology).

Significance: As MMS images become increasingly prevalent in communication between residents and attendings or emergency department providers and consultants, this commonly employed practice can be effective in establishing a diagnosis and directing treatment.

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