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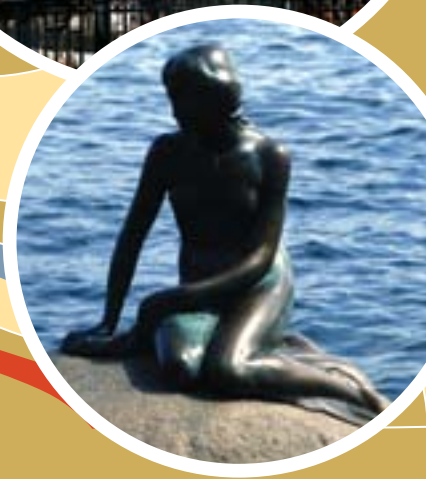
Scoliosis Research Society presents

IMAST

18th International Meeting on Advanced Spine Techniques

FINAL PROGRAM



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COPENHAGEN

DENMARK July 13-16, 2011

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We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2010. Support levels are based on total contributions throughout the year and include the Annual Meeting, IMAST, Worldwide Conferences, Global Outreach Scholarships, Edgar Dawson Memorial Scholarships, SRS Traveling Fellowships and the Research Endowment Fund. Their support has helped SRS to offer high quality medical meetings and courses throughout the world, fund spinal deformity research, develop new patient materials, and provide educational opportunities for young surgeons and those from developing nations.

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Table of Contents

Welcome 2

General Information

- Meeting Outline 5
- General Meeting Information 6
- Bella Center Floorplans 7
- Faculty Affiliations & Disclosures 8
- Author Disclosures 13

Meeting Agenda 31

- Wednesday, July 13, 2011 31
- Thursday, July 14, 2011 31
- Friday, July 15, 2011 40
- Saturday, July 16, 2011 48

Paper Abstracts 57

E-Poster Index 127

Exhibits & Hands-On Sessions

- Exhibit Hall Floorplan 177
- Exhibitors 178
- Hands-On Demonstrations 184
- Hands-On Workshops 185

About SRS 205

Future Educational Events

46th Annual Meeting & Course

September 14-17, 2011 • Louisville, Kentucky, USA

19th International Meeting on Advanced Spine Techniques

July 18-21, 2012 • Istanbul, Turkey

47th Annual Meeting & Course

September 5-8, 2012 • Chicago, Illinois, USA

20th International Meeting on Advanced Spine Techniques

July 2013 • TBD

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Welcome

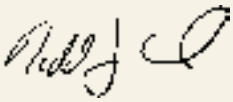
Dear Participant:

I want to personally welcome you to Copenhagen and to what should be a spectacular venue and a wonderful academic meeting. On behalf of the SRS and the Board of Directors, we have tried to make the most academically stimulating, diverse, and provocative program. We estimate that there will be more than 800 participants from around the world with 135 paper presentations, more than 500 e-posters and 20 Instructional Course Lectures with three to five lectures in each. We will have roundtables and plenty of time for discussion and open debate.

Copenhagen is a beautiful city with a wonderful history and people. While the hotel is beautiful, I encourage you to go out to the city centre, enjoy the restaurants, the museums and the excellent shopping. The Course Reception in the Opera House will be remarkable, with its gorgeous views of the harbor.

I have truly enjoyed my three years as IMAST Chairman. I want to thank Dr. Lenke and Dr. Betz for the gem they created in IMAST, the SRS Board of Directors for their dedication to the Society and their guidance, and the IMAST Committee for its hard work over these years. It has been an honor and privilege to serve the Society in this manner and I hope this is the best IMAST program to date.

With warmest personal regards,



Todd J. Albert, MD — IMAST Chair

CME Information

CME certificates will be available immediately upon the close of the meeting online at www.srs.org imast/2011/.

Delegates should log onto the website listed above and enter their last name and the ID# listed at the top of the IMAST Registration Confirmation form. The system will then ask delegates to indicate which sessions they attended, to complete evaluation forms for each of those sessions, and then will generate a PDF certificate which may be printed or saved to the delegate's computer. Session attendance and evaluation information are saved in the database, and certificates may be accessed again, in the event the certificate is lost or another copy is required. Please note that certificates will not be mailed or e-mailed after the meeting. The online certificate program is the only source for this documentation. If you have any questions, please contact SRS at meetings@srs.org. SRS asks that all CME certificates be claimed no later than October 31, 2011.

NEW! - Debates Sessions

During the concurrent sessions of the program, new Debates sessions will be offered. The Debates replace the former Fundamentals sessions, and are intended to present the advantages and disadvantages of various treatment options available for specific conditions. More information on the Debates sessions can be found in the Scientific Program, beginning on page XX.

Instructional Course Lectures (ICLs)

There will be five (5) sessions of ICLs highlighting the latest in surgical techniques and technologies. Each session will feature four (4) didactic ICLs programmed around thematic areas and will include a balanced discussion of multiple products, techniques and advances relevant to that topic.

E-Posters

There are over 500 E-Posters available for your review at the E-Poster computer kiosks just outside the Exhibit Hall. The E-Posters are also available on the CD-ROM included with your registration materials.

Exhibits & Hands-On Sessions

Many new spinal systems and products are on display in the Exhibit Hall. We encourage you to visit the exhibits throughout the meeting to learn more about the technological advances.

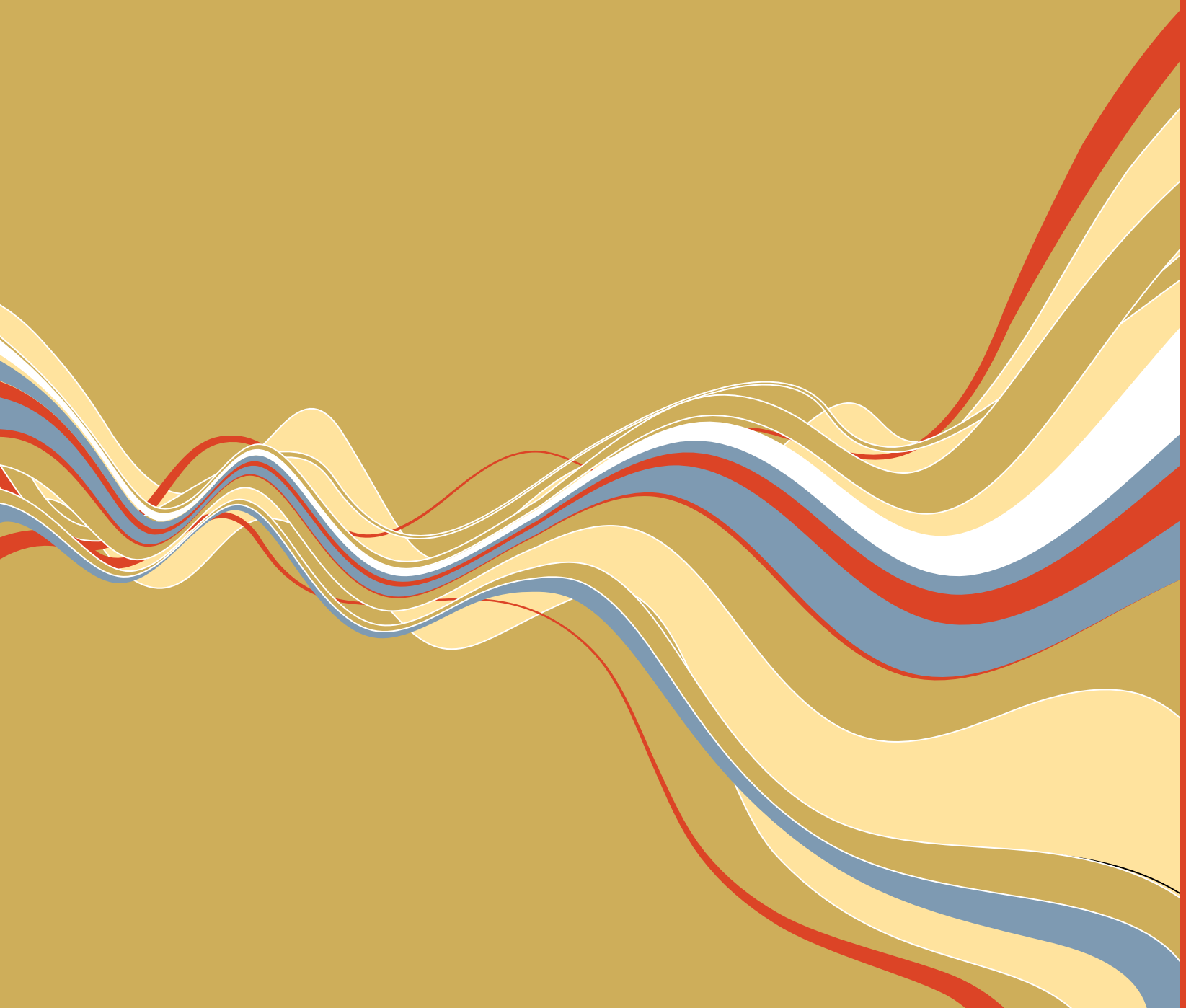
IMAST is pleased to continue the Hands-On Demonstrations (HODs) introduced in 2009. The HODs are 90-minute sessions serving as a link between the Scientific Program and the Exhibit Hall, designed to afford delegates the opportunity for personal contact with the technologies they're learning about in the ICLs, paper sessions and Debates. Delegates are encouraged to take advantage of the opportunity to learn about multiple products from multiple companies all in one location. The HODs will be held at the back of the Exhibit Hall on the Ground Floor of the Bella Center.

Hands-On Workshops (HOWs) will return to the IMAST program in 2011. Each 45-minute workshop is supported and programmed by a single supporting company and will feature presentations on topics and technologies selected by the Corporate Partner. Breakfast will be served in the HOWs, as noted in the program.

Internet Access

Delegates without laptops may access complimentary Internet kiosks just outside Exhibit Hall. In addition, complimentary wireless internet access is available in the Exhibit Hall.

General Information



The Scoliosis Research Society gratefully acknowledges K2M, Inc. for their support of the E-Poster CD-ROM, and Registration Area.

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Meeting Outline

	Wednesday, July 13	Thursday, July 14	Friday, July 15	Saturday, July 16
Morning	8:00 – 12:00 **Exhibit Set-Up** **BOD Meeting**	7:00 – 16:45 **Exhibits Open** **Registration Open** 7:00 – 7:45 ***Hands-On Workshops w/ Breakfast** **Breakfast & Exhibit Viewing** 7:50 – 9:15 **General Session** 9:45 – 10:45 **ICLs 1A-D** 11:00 – 12:00 **Concurrent Sessions & Debates**	7:00 – 16:15 **Exhibits Open** **Registration Open** 7:00 – 7:45 ** Hands-On Workshops w/ Breakfast** **Breakfast & Exhibit Viewing** 7:45 – 8:00 **Walking Break** 8:00 – 9:00 **Concurrent Sessions & Debates** 9:00 – 9:15 **Walking Break** 9:15 – 10:15 **ICLs 3A-D** 10:15 – 10:30 **Walking Break** 10:30 – 11:30 **Concurrent Sessions & Debates** 11:30 – 11:45 **Walking Break** 11:45 – 12:45 **Roundtable Case Discussions**	**Exhibits Closed** 7:00 – 9:30 **Registration Open** 7:00 – 7:45 ***Hands-On Workshops w/ Breakfast** **Breakfast & Exhibit Viewing** 8:00 – 9:00 **ICLs 5A-D** 9:00 – 11:00 **Concurrent Sessions** 11:00 – 11:15 **Walking Break** 11:15 – 13:20 **General Session** 13:20 **Adjourn**
Afternoon	12:00 – 15:00 **Exhibit Set-Up** **BOD Meeting**	12:00 – 13:00 **Lunch** **Exhibit Viewing** 13:00 – 14:00 **Concurrent & Debates Sessions** 14:00 – 14:15 **Walking Break** 14:15 – 15:15 **ICLs 2A-D** 15:15 – 16:45 ***Hands-On Demonstrations** **w/ Cocktails, Snacks**	12:45 – 13:45 **Lunch** **Exhibit Viewing** **Membership Info Session** 13:45 – 14:45 **ICLs 4A-D** 14:45 – 16:15 ** Hands-On Demonstrations** **w/ Cocktails, Snacks**	
Evening	17:00 – 19:30 **Registration Open** **Welcome Reception**	**Free Evening**	19:00 – 22:00 **Course Reception** *Supported, in part, by a grant from Medtronic* (Shuttles depart Bella Hotel at 18:30)	

*CME credits are not offered for indicated sessions

General Meeting Information

Meeting Description

IMAST gathers leading spine surgeons, innovative research, and the most advanced spine technologies for all areas of spine (cervical, thoracic, and lumbar), most spinal conditions (degenerative, trauma, deformity, tumor), and a variety of treatment techniques. The IMAST program will include didactic presentations, panel discussions, papers, and posters on current research, roundtable case discussions, and Instructional Course Lectures all led by an international and multidisciplinary faculty. IMAST is jointly-sponsored by University of South Florida (USF) and Scoliosis Research Society (SRS).

Learning Objectives

Upon completion of IMAST, participants should be able to:

- Assess the most recent advances in surgical techniques for the treatment of spinal disorders and when to use them, in the interest of providing optimal patient care.
- Analyze the indications and potential complications for various spine fixation systems including spinal arthroplasty.
- Recognize emerging technology that has the potential to improve patient outcomes for specific indications and populations.

Target Audience

Spine surgeons (orthopaedic and neurological surgeons), residents, fellows, nurses, nurse practitioners, physician assistants, engineers and company personnel.

Accreditation Statement

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of USF Health and SRS. USF Health is accredited by the ACCME to provide continuing medical education for physicians.

USF Health designates this live activity for a maximum of 15.25 *AMA PRA Category 1 Credit(s)* ™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Disclosure of Conflict of Interest

It is the policy of USF Health and SRS to insure balance, independence, objectivity, and scientific rigor in all of their educational activities. In accordance with this policy, USF Health and SRS identify conflicts of interest with instructors, content managers, and other individuals who are in a position to control the content of an activity. Conflicts are resolved by USF Health and SRS to ensure that all scientific research referred to, reported, or used in a CME activity conforms to the generally accepted standards of experimental design, data collection, and analysis. Complete faculty disclosures are listed on page XX.

FDA Statement (United States)

Some drugs and medical devices demonstrated during this course have limited FDA labeling and marketing clearance. It is the responsibility of the physician to be aware of drug or device FDA labeling and marketing status.

Insurance/Liabilities and Disclaimer

SRS will not be held liable for personal injuries or for loss or damage to property incurred by participants or guests at IMAST including those participating in tours and social events. Participants and guests are encouraged to take out insurance to cover loss incurred in the event of cancellation, medical expenses or damage to or loss of personal effects when traveling outside of their own countries. SRS cannot be held liable for any hindrance or disruption of IMAST arising from natural, political, social or economic events or other unforeseen incidents beyond its control. Registration of a participant or guest implies acceptance of this condition.

The materials presented at this Continuing Medical Education activity are made available for educational purposes only. The material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement, or opinion of the faculty that may be helpful to others who face similar situations.

SRS and USF Health disclaim any and all liability for injury or other damages resulting to any individual attending a scientific meeting and for all claims that may arise out of the use of techniques demonstrated therein by such individuals, whether these claims shall be asserted by a physician or any other person.

Language

Presentations and course materials will be provided in English.

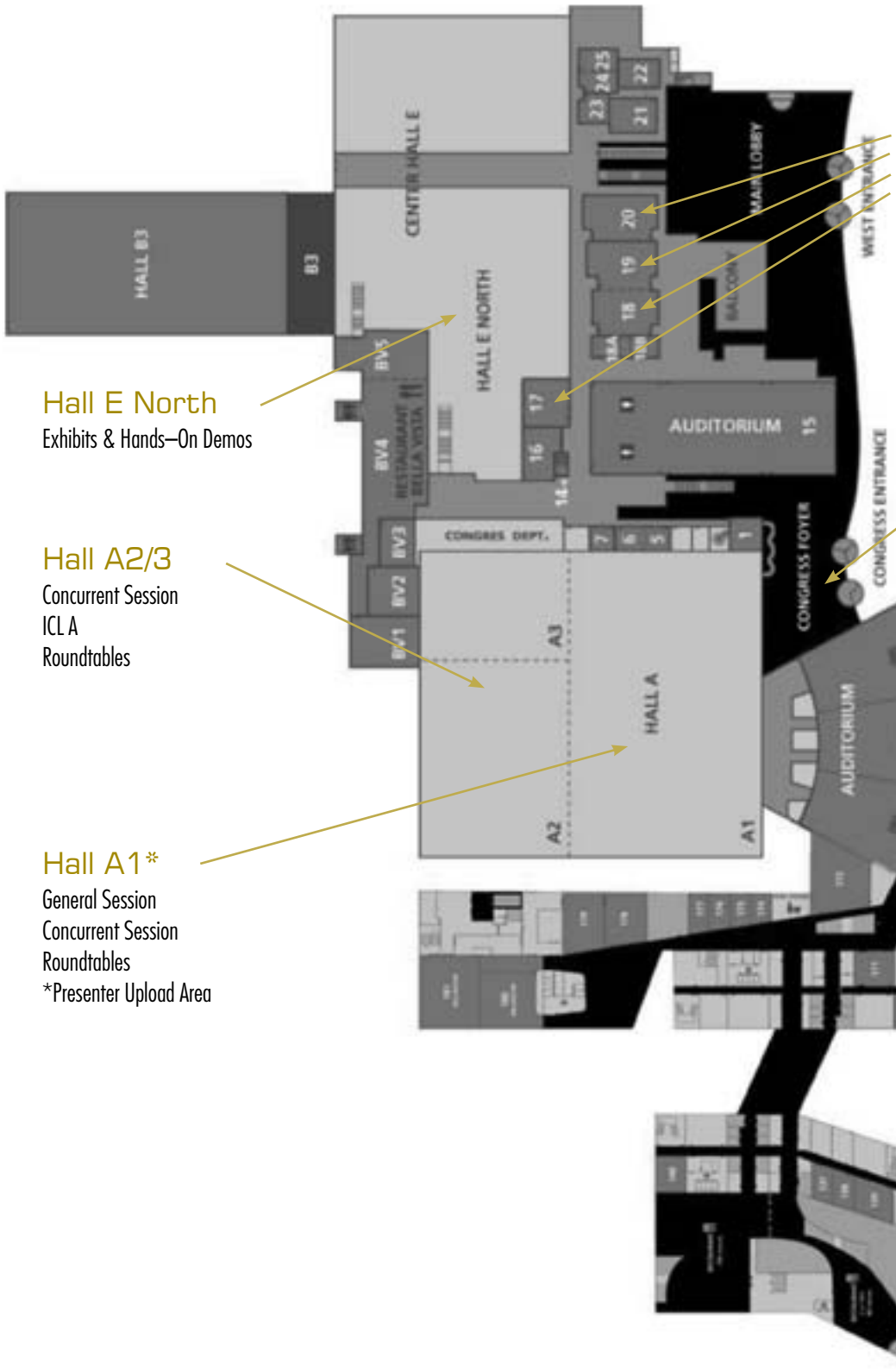
No Smoking Policy

Smoking is not permitted during any IMAST activity or event.

Attire

Business (suits) or business casual (polo or dress shirts, sport coats) are appropriate for IMAST sessions. Formal or cocktail attire is recommended for the Course Reception.

Bella Center Floorplans



Faculty Affiliations & Disclosures

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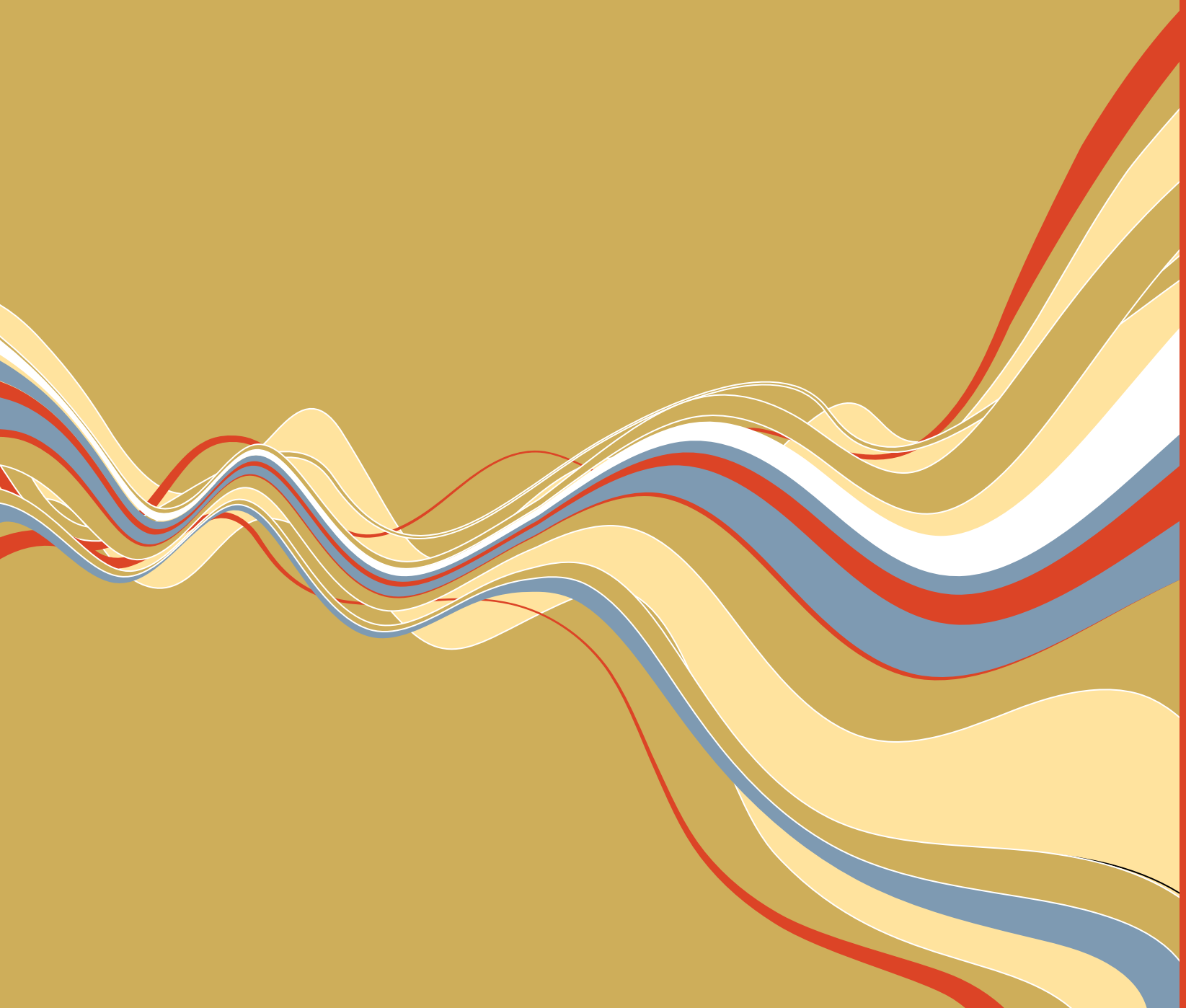
Meeting Agenda

Meeting Agenda



The Scoliosis Research Society gratefully acknowledges Medtronic for their support of the Course Reception.

Meeting Agenda

† = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper

Wednesday, July 13, 2011

17:00-19:30

Registration Open
Congress Foyer, Bella Center

Welcome Reception
Exhibit Hall, Bella Center

Thursday, July 14, 2011

7:00 – 16:45 Registration, E-Posters & Exhibits Open

7:00 – 7:45

Hands-On Workshops
Rooms 17, 18, 19, 20
First Floor
See "Exhibits and Hands-On Sessions" section for more information.

Breakfast & Exhibits Viewing
Exhibit Hall, Bella Center

7:50 – 9:15 General Session #1: Whitecloud Award Nominees - Clinical
Hall A1
Moderators: Christopher I. Shaffrey, MD
Benny Dahl, MD

7:50 Welcome
Todd J. Albert MD
IMAST Committee Chair

8:00 †Paper # 1: Are Anti-Fibrinolytics Effective at Reducing Peri-Operative Blood Loss in Adolescent Idiopathic Scoliosis?
Kushagra Verma, MD; Thomas Errico; Christian M. Hoelscher, BS; Joseph W. Dryer, MD; Tessa Huncke, MD; Kirsten Boenigk, MD, PhD; Baron S. Lonner

8:04 †Paper # 2: Preoperative Vitamin D Status in Adults Undergoing Spinal Fusion Surgery
Geoffrey E. Stoker, BS; Jacob M. Buchowski, MD, MS; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; K. Daniel Riew, MD; Lukas P. Zebala, MD

8:08 †Paper # 3: Clinical Outcomes and Complications of Posterior Vertebral Column Resection (PVCR) for Severe Adult Spinal Deformity
Woo-Kie Min, MD, PhD; Lawrence G. Lenke, MD; Yutaka Nakamura, MD, PhD; Dong-Ho Lee, MD, PhD; Moon Soo Park, PhD; Brenda A. Sides, MA

8:12 Discussion

8:20 †Paper # 4: Can Less Invasive Lateral Interbody Fusion with Transpsoas ALL Release (LIFTAR) Replace Three Column Osteotomy for Correction of Adult Focal Sagittal Plane Deformity?
Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Payam Moazzaz, MD; Nima Kabirian, MD; Ramin Bagheri, MD; Robert K. Eastlack, MD; Jeff Pawelek

8:24 †Paper # 5: The Effect of Surgery on Health Related Quality of Life and Functional Outcome in Patients with Metastatic Epidural Spinal Cord Compression- Initial Results of the AOSpine North America Prospective Multicenter Study
Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Alexander R. Vaccaro, MD, PhD; Paul Arnold; Charles G. Fisher, MD, MHSc, FRCSC; Ziya L. Gokaslan, MD; James Schuster, MD, PhD; Mark B. Dekutoski, MD; Joel Finkelstein, MD FRCSC; Laurence Rhines

Meeting Agenda

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8:28	†Paper # 6: Balloon Kyphoplasty Improves Quality of Life, Bodily Pain and Vertebral Body Height Among Cancer Patients with Vertebral Compression Fractures Compared to Non-Surgical Management: Results from a Multicenter, Randomized Trial *Frank D. Vrionis, MD, PhD; Ioannis Papanastassiou, MD; Robert Pflugmacher; James R. Berenson, MD; Jeffrey Zonder; John Tillman, PhD; Kenneth Schechtman, PhD; Leonard Bastian, MD; Talat Ashraf, .MD, MS; Peter Jarzem, MD*
8:32	Discussion
8:40	†Paper # 7: The AOSpine North America Cervical Spondylotic Myelopathy Study: Perioperative Complication Rates Associated with Surgical Treatment Based on a Prospective Multicenter Study of 302 Patients *Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Paul Arnold; S. Tim Yoon; Alexander R. Vaccaro, MD, PhD; Darrel S. Brodke, MD; Michael Janssen, DO; Jens R. Chapman, MD; Rick C. Sasso, MD; Eric J. Woodard, MD; Robert Banco; Mark B. Dekutoski, MD; Ziya L. Gokaslan, MD*
8:44	†Paper # 8: Lessons Learned on Cervical Total Disc Replacement after Seven Years Follow-Up *Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD*
8:48	†Paper # 9: Technique of Cervicothoracic Junction Pedicle Subtraction Osteotomy for Cervical Sagittal Imbalance: Report of 11 Cases *Vedat Deviren, MD; Justin K. Scheer, BS; Christopher P. Ames, MD*
8:52	Discussion
9:00	Keynote Address Introduction *B. Stephens Richards, III, MD* *SRS President-Elect* Optimizing Neurologic Safety during Spinal Deformity Surgery *Lawrence G. Lenke, MD* *SRS President*
9:12	Preview of the 46th Annual Meeting & Course and 19th IMAST

9:15 – 9:45 Refreshment Break & Exhibit Viewing

Exhibit Hall, Bella Center

9:45 – 10:45 Instructional Course Lectures 1A-D

1A – Spondylolisthesis

Room: Hall A2/3
Moderator: John R. Dimar, II MD

9:45 – 10:00	The Importance of Pelvic Incidence, Sacral Slope, & Sagittal Balance and Their Incorporation into New Spondylolisthesis Classification System *Hubert Labelle, MD*
10:00 – 10:15	The Identification & Treatment Options of Traumatic Spondylolisthesis *Benny Dahl, MD*
10:15 – 10:30	The Treatment of Spinal Stenosis Associated with Degenerative Spondylolisthesis & the Outcomes of Non-Surgical vs. Surgical Treatment *J. Abbott Byrd, MD*
10-30 – 10:45	The Treatment of High Grade Spondylolisthesis: What are the Risks vs. Benefits of Reduction When Combined with an Instrumented Fusion? *John R. Dimar, II, MD*

Meeting Agenda

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1B – Early Onset Scoliosis I

Room: Auditorium 10
Moderator: Ahmet Alanay, MD

9:45 – 9:50 Overview and Treatment Classification system
Ahmet Alanay, MD

9:50 – 10:00 Why do we Treat EOS? Effects of EOS on Spinal Growth and Thorax
David S. Marks, FRCS

10:00 – 10:10 Non-Operative Treatment
- *How best to measure spinal growth*
- *Casts and braces*

Richard E. McCarthy, MD

10:10 – 10:20 Who Should be Treated Surgically and When?
- *Indications for operative treatment*
- *Preoperative evaluation*
- *Anesthesia and neuromonitoring ?*

George H. Thompson, MD

10:20 – 10:45 Case Studies/Discussion

1C – Adult Deformity I: Surgical Management of Lumbar Degenerative Deformity

Room: Auditorium 11
Moderator Sigurd H. Berven, MD

9:45 – 9:57 Adult Degenerative Deformity- Clinical Presentation and Informed Choice on Options for Care
Sigurd H. Berven, MD

9:57 – 10:09 Operative Strategies- Choosing Levels and Strategies for Correcting Coronal Deformity
Sean Molloy, MBBS, MSc, FRCS, DC

10:09 – 10:21 Operative Strategies- Sagittal Plane Considerations and Strategies for Successful Outcome
Frank Schwab, MD

10:21 – 10:33 Adjacent Segment Complications Above and Below Fusions for Degenerative Scoliosis
Khaled Kebaish, MD

10:33 – 10:45 Case Discussions

1D – Principles and Practice in the Treatment of Kyphotic Problems

Room: Auditorium 12
Moderator: Peter O. Newton, MD

9:45 – 9:55 Analyzing and Planning for Sagittal Plane Correction
Steven M. Mardjetko, MD, FAAP

9:55 – 10:05 Scheuermann's Kyphosis Treatment
Peter O. Newton, MD

10:05 – 10:15 Cervical Kyphosis Treatment
Tyler Koski, MD

10:15 – 10:25 Adult Kyphosis Treatment
Michael F. O'Brien, MD

10:25 – 10:35 Managing Junctional Kyphosis
Brian A. O'Shaughnessy, MD

10:35 – 10:45 Questions/Discussion

Meeting Agenda

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11:00 – 12:00 Concurrent Sessions #1 A&B and Debates

Concurrent Session #1A: Whitecloud Award Nominees – Basic Science

Hall A1
Moderators: Kenneth MC Cheung, MD
Jacob Buchowski, MD, MS

11:00 *Paper # 10: Would CoCr Rods Provide Better Correctional Forces than Stainless Steel or Titanium for Rigid Scoliosis Curves?
Devdatt Mhatre; Peter O. Newton, MD; Paul A. Giorgio; Peter Sturm, MD; Hassan Serhan, PhD

11:04 *Paper # 11: Biomechanical Effectiveness of Three Types of Pedicle Screws for the Spinal Instrumentation of Adolescent Idiopathic Scoliosis
Xiaoyu Wang, PhD; Carl-Eric Aubin, PhD, PEng; Hubert Labelle, MD; Dennis Crandall, MD; Stefan Parent, MD, PhD

11:08 *Paper # 12: Does Pedicule Screw Fixation Under Age Five Disrupt Vertebral Growth? A Computerized Tomography Study
Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Mehmet Tezer; Emre Karadeniz; Azmi Hamzaoglu, MD

11:12 Discussion

11:20 *Paper # 13: Retrieval Analysis of Cervical Total Disc Replacements - A Study of In Vivo Wear, Surface Properties, and Fixation
Darren R. Lebl, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD; Samantha M. Lee; Timothy Wright, PhD; Celeste Abjornson, PhD

11:24 *Paper # 14: Biocompatibility of CFR-PEEK Particle Debris in Epidural Space
Koroush Kabir, MD

11:28 *Paper # 15: Cartilage Biomarkers in Degenerative Lumbar Scoliosis
Naobumi Hosogane, MD; Kota Watanabe; Takashi Tsuji; Takeshi Miyamoto; Ken Ishii, MD, PhD; Yasuo Niki, MD; Masaya Nakamura; Yoshiaki Toyama; Kazuhiro Chiba, MD, PhD; Morio Matsumoto, MD

11:32 Discussion

11:40 *Paper # 16: Can Monitoring Spinal Cord Blood Flow (SCBF) Identify Pre-Injury State During Surgery? A Porcine Study Correlating MEP's with LASER Doppler Measurements
Vishal Sarwahi, MD; Adam L. Wollowick, MD; Seth A. Grossman, MD; Terry D. Amaral, MD; Farzin Kabaei, MD; Etan P. Sugarman, MSIV; Christian Keller, MD; Alan Legatt, MD, PhD

11:44 *Paper # 17: Capacitive Coupling Reduces Instrumentation Infection in a Rabbit Spine Model
Mohit Gilotra, MD; Cullen Griffith, MD; Daniel E. Gelb, MD; Steven Ludwig, MD

11:48 *Paper # 18: Cadaveric Radiographic Analysis of Indirect Spine Decompression: Comparison of Lateral Plating vs. Pedicle Screws
German Marulanda, MD; Ryan Murtagh, MD, MBA; Aniruddh Nayak, MS; Antonio E. Castellvi, MD

11:52 Discussion

Concurrent Session #1B: Early Onset Scoliosis

Hall A2/3
Moderators: Behrooz A. Akbarnia, MD
Hilali Noordeen, FRCS

11:00 Paper # 19: Preliminary Report: Use of a Magnetic Growing Rod In the Treatment of Childhood Spinal Deformity
Ian Torode, MB, BS, FRCS,FRACS

11:04 Paper # 20: Does the Type of Distraction-Based Growing System for Early Onset Scoliosis Affect Post-Operative Sagittal Alignment?
Ron El-Hawary, MD; Peter Sturm, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD; Michael G. Vitale, MD, MPH; Peter G. Gabos, MD; Nathan D. Bodin, MD; Colin Harris; Charles R. d'Amato, MD, FRCSC; John T. Smith, MD

Meeting Agenda

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11:08 Paper # 21: Anterior vs. Posterior Approach of Neurocentral Synchondrosis Hemiepiphysiodesis to Create Experimental Scoliosis
Hong Zhang, MD; Daniel J. Sucato, MD, MS

11:12 Discussion

11:20 Paper # 22: Some Connectors in Growing Rods Fail More than Others
Christopher Lee, BS; Karen S. Myung, MD, PhD; David L. Skaggs, MD

11:24 Paper # 23: Radiation Exposure in Growing Rod Surgery for Early Onset Scoliosis
Michael W. Hennessy, MD; Jeff Pawelek; Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD

11:28 Paper # 24: Modified Lenke Classification System for Infantile and Juvenile Idiopathic Scoliosis
Takuya Mishiro, PhD; Lawrence G. Lenke, MD; Linda Koester, BS; Keith H. Bridwell, MD; Scott J. Luhmann, MD

11:32 Discussion

11:40 Paper # 25: Pulmonary Metal. Non-Invasive Positive Pressure Ventilation (NPPV) for Sleep-Related Breathing Difficulties in Children with Thoracic Insufficiency Syndrome (TIS)
Kit Song, MD, MHA; Greg Redding, MD; Christopher Makris, MD; John H. Waldhausen, MD

11:44 Paper # 26: Growth Guidance Procedures in EOS: Do They Work?
Richard E. McCarthy; Frances McCullough

11:48 Paper # 27: Factors Influencing Proximal Foundation Failure in Growing Rod Constructs
Kasra Ahmadinia, MD; Connie Poe-Kochert, BSN; Jochen P. Son-Hing, MD, FRCSC; George H. Thompson, MD

11:52 Discussion

11:00 – 12:00 Debates
Auditorium 11

11:00 – 11:30 Debate #1 Optimal Treatment for a Slightly Displaced Odontoid Fracture in a 73-Year-Old
Moderator: H. Alan Crockard, FRCS

11:00 – 11:10 Optimal Treatment is Observation or Collar Alone
James Harrop, MD

11:10 – 11:20 Optimal Treatment is an Anterior Odontoid Screw
Brian K. Kwon, MD, PhD, FRCSC

11:20 – 11:30 Optimal Treatment is Posterior C1-2 Instrumentation and Fusion
Praveen V. Mummaneni, MD

11:30 – 12:00 Debate #2: Mild (25-Degree) Degenerative Scoliosis with Spinal Stenosis: Optimal Treatment
Moderator: Frank J. Schwab, MD

11:30 – 11:40 Optimal Treatment is via a Transpsoas Approach
Luiz Pimenta, MD

11:40 – 11:50 Optimal Treatment is via a Posterior Minimally Invasive Approach
D. Greg Anderson, MD

11:50 – 12:00 Optimal treatment is via a posterior open approach
Sigurd H. Berven, MD

12:00 – 13:00 Lunch & Exhibit Viewing
Exhibit Hall, Bella Center

Meeting Agenda

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13:00 – 14:00 Concurrent Sessions #2 A&B and Debates

Concurrent Session #2A: Adolescent Idiopathic Scoliosis

Hall A1

Moderators: Randal R. Betz, MD
Henry Halm, MD

13:00 Paper # 28: The Lonstein-Carlson Progression Factor Does Not Predict Scoliosis Curve Progression in a Replication Study
Kenneth Ward, MD; Lesa M. Nelson, BS; James W. Ogilvie, MD

13:04 Paper # 29: The Influence of Brace Treatment on the Pulmonary Function Test in Adolescent Idiopathic Scoliosis
Bin Yu, MD; Yipeng Wang, MD; Guixing Qiu; Jianguo Zhang; Jianxiong Shen, MD

13:08 Paper # 30: Using the Adolescent Idiopathic Scoliosis Prognostic Test (AIS-PT) to Predict Progression to Moderate Curves in Patients with a Mild Curve
James W. Ogilvie, MD; Lesa M. Nelson, BS; Kenneth Ward, MD

13:12 Discussion

13:20 Paper # 31: Variability of t-EMG Threshold at Concavity and Convexity in Apex Segments of Thoracic Scoliosis. Its Correlation with Pedicle-Dural Sac Distance
Gema De Blas, MD, PhD; Carlos Barrios; Ignacio Regidor, MD, PhD; Elena Montes; Jesús J Burgos Flores, PhD; Gabriel Piza Vallespir, MD, PhD; Eduardo Hevia, MD

13:24 Paper # 32: Single-Pulse vs. Pulse-Train Screw Stimulation Technique: A Comparative Study while Monitoring of Thoracic Pedicle Screws Placement in Scoliosis Surgery
Elena Montes; Gema De Blas, MD, PhD; Carlos Barrios; Jesús J Burgos Flores, PhD; Eduardo Hevia, Dr; Ignacio Regidor, MD, PhD; Maria Soledad del Cura; Alberto Caballero, MD

13:28 Paper # 33: Lower Cortical Bone Mineral Density is Associated with Abnormal Osteopontin Level in Adolescent Idiopathic Scoliosis
Guang-quan Sun; Hiu Yan Yeung, PhD; Annie Po Yee Yim, MSc; Kwong Man Lee; Yong Qiu; Alain Moreau, PhD; Jack C. Cheng, MD

13:32 Discussion

13:40 Paper # 34: Post-Operative Changes in Coronal Balance after Surgical Correction of Adolescent Idiopathic Scoliosis using Pedicle Screw Constructs
Julien Leroux; Jean-Marc Mac-Thiong, MD, PhD; Hubert Labelle, MD; Stefan Parent, MD, PhD

13:44 Paper # 35: Kyphosis Restoration or Maintanence in Patients With Lenke Type I Scoliosis Treated by Pedicle Screw Construct: Is It Really Impossible by Using 5.5 mm Titanium Rods?
Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Emre Karadeniz; Mehmet B. Balioglu, MD; Azmi Hamzaoglu, MD

13:48 Paper # 36: Short Fusion For Lenke Type 1 Thoracic Curve Using Pedicle Screw Fixation
Morio Matsumoto, MD; Kota Watanabe; Naobumi Hosogane; Eijiro Okada; Kazuhiro Chiba, MD, PhD; Yoshiaki Toyama

13:52 Discussion

Meeting Agenda

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Concurrent Session #2B: Cervical Spine

Hall A2/3
Moderators: Alan S. Hilibrand MD
H. Alan Crockard, MD

13:00 Paper # 37: Accuracy and Complications of C1 Instrumentation
Richard J. Bransford, MD; Mark A. Freeborn, MD; Anthony Russo, MD; Quynh T. Nguyen, PA-C, MHS; Michael J.Lee, MD; Jens R. Chapman, MD; Carlo Bellabarba, MD

13:04 Paper # 38: International Variations in the Clinical Presentation and Management of Cervical Spondylotic Myelopathy: One Year Outcomes of the AOSpine Multicenter Prospective CSM-I Study
Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Helton Defino, MD; Shashank S. Kale, MCh; Giuseppe Barbagallo; Ronald H. Bartels, MD,PhD; Qiang Zhou; Paul Arnold; Mehmet Zileli, MD; Gamaliel Tan; Yasutsugu Yukawa, MD; Osmar Moraes; Manuel A. Alvarado, MD; Massimo Scerrati; Tomoaki Toyone, MD

13:08 Paper # 39: Is the Requirement for Inclusion of the Occiput in Surgically Treated Craniocervical Instabilities for Rheumatoid Arthritis a Prognostic Risk for Accelerated Subaxial Degeneration?
Stephan Werle; Hesham ElSaghir; Ali Ezzati; Heinrich Boehm

13:12 Discussion

13:20 Paper # 40: Historical Foundation for Use and Justification of Instrumented Cervicothoracic Osteotomy Correction in Ankylosing Spondylitis - Clinical Rationales Based on Results with Mason-Urist Osteomies C7-T1 and Gradual Halo-Thoracic-Cast Correction
Heiko Koller, Dr; Juliane Zenner, MD; Luis Ferraris, MD; Wolfgang Hitzl, PhD; Oliver Meier

13:24 Paper # 41: Establishment of Parameters for Congenital Stenosis of the Cervical Spine: An Anatomic Study of 410 Postmortem Specimens
Navkirat S. Bajwa; Jason O. Toy, MD; Nicholas U. Ahn, MD

13:28 Paper # 42: Rigid Internal Fixation for Occipito-Cervical Arthrodesis Results in 22 Children
Rony Bou Ghosn, MD; Thierry Odent, MD, PhD; Christophe Glorion; Lotfi Miladi; Vicken Topouchian, MD; Michel Zerah, MD, PhD

13:32 Discussion

13:40 Paper # 43: Cost-Utility Analysis of Anterior Cervical Discectomy and Fusion vs. Cervical Disc Arthroplasty
Daniel T. Warren, MD; Christian M. Hoelscher, BS; Pedro A. Ricart-Hoffiz, MD; John A. Bendo, MD; Jeffrey A. Goldstein, MD

13:44 Paper # 44: Cervical Laminoplasty vs. Laminectomy and Fusion: Differences in Outcomes, Neck Pain, and Cost
Sanjay S. Dhall, MD; Jason M. Highsmith, MD; Regis W. Haid, MD; Gerald E. Rodts, MD; Praveen V. Mummaneni, MD

13:48 Paper # 45: Posterior Cervical Lateral Mass Screw Fixation and Fusion to Treat Pseudarthrosis of Anterior Cervical Fusion
Avraam Ploumis, MD, PhD; Hong Liu; James D. Schwender, MD; Timothy A. Garvey, MD

13:52 Discussion

Meeting Agenda

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13:00 – 14:00 Debates

Auditorium 11

13:00 – 13:30 Debate #3: Optimal Treatment for a 10mm Mobile Degenerative L4-5 Spondylolisthesis in a 75-Year-Old

Moderator: Michael F. O'Brien, MD

13:00 – 13:10 Optimal Treatment is MIS Decompression, Instrumentation and Fusion
Praveen V. Mummaneni, MD

13:10 – 13:20 Optimal Treatment is Decompression and Instrumented Posterolateral Fusion
J. Abbott Byrd, MD

13:20 – 13:30 Optimal Treatment is an Instrumented L4-5 TLIF or PLIF
John R. Dimar, II, MD

13:30 – 14:00 Debate #4: Multilevel Cervical Stenosis in the Straight Spine: Optimal Treatment

Moderator: Alexander R. Vaccaro, MD

13:30 – 13:40 Optimal Treatment is Anterior Decompression, Instrumentation and Fusion
Alan S. Hilibrand, MD

13:40 – 13:50 Optimal Treatment is Posterior Decompression, Instrumentation and Fusion
Todd J. Albert, MD

13: 50 – 14:00 Optimal Treatment is Cervical Laminoplasty
Rick C. Sasso, MD

14:15 – 15:15 Instructional Courses Lectures 2A-D

2A – Options in Cervical Motion

Room: Hall A2/3
Moderator: Rick C. Sasso, MD

14:15 – 14:27 Indications for ACF/ CDR
Todd J. Albert, MD

14:27 – 14:39 Cervical Adjacent Segment Disease – Is it the Fusion?
Alan S. Hilibrand, MD

14:39 – 14:51 Is Disc Regeneration Possible?
Brian K. Kwon, MD, PhD, FRCSC

14:51 – 15:03 Results of IDE Studies
Rick C. Sasso, MD

15:03 – 15:15 Discussion and/or Cases

2B – Adolescent Idiopathic Scoliosis I: Classification and Fusion Level Selection

Room: Auditorium 10
Moderator: Hubert Labelle, MD
Panel: Randal R. Betz, MD
Hubert Labelle, MD
Stephen J. Lewis, MD, MSc FRCSC
Peter O. Newton, MD
B. Stephens Richards, III, MD

This session will be a case-based panel discussion focusing on how to classify Adolescent Idiopathic Scoliosis and to select appropriate fusion levels in order to optimize treatment decisions with respect to surgical instrumentation and fusion. Key topics discussed will include important 2D and 3D features of curves patterns, how they can help decide when to perform a selective fusion and how to select upper and lower instrumentation levels.

Meeting Agenda

† = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper

2C – Adult Deformity II: Use of Osteotomies in Adult Spinal Deformity

Room: Auditorium 11
Moderator: Oheneba Boachie-Adjei, MD

14:15 – 14:18	Introduction and Disclosure Presentation *Oheneba Boachie-Adjei, MD*
14:18 – 14:28	Assessment of Spinal Imbalance. Surgical Considerations for Coronal and Sagittal Deformities *Frank J. Schwab, MD*
14:28 – 14:38	Posterior Osteotomies. The Role and Technique of (SPO, PSO) to Manage Adult Spine Deformity *Henry F. Halm, MD*
14:38 – 14:45	Discussion
14:45 – 14:55	Vertebral Column Resection *Lawrence G. Lenke, MD*
14:55 – 15:05	Complication of Spinal Osteotomies. How to Recognize, How to Avoid and How to Manage Them. *Sigurd H. Berven, MD*
15:05 – 15:15	Discussion

2D – Principles and Practice in the Treatment of Metastatic Spine Disease

Room: Auditorium 12
Moderator: James S. Harrop, MD

14:15 – 14:30	Overview of Epidural Spine Metastasis and Surgical Treatment (GSTSG?) *H. Alan Crockard, FRCS*
14:30 – 14:45	Is MIS an Option? *D. Greg Anderson, MD*
14:45 – 15:00	Spinal Oncology – What is the Best Outcome Measures? *Cody E. Bunger, DMSc*
15:15 – 15:30	Case Presentations *James S. Harrop, MD*

15:15 – 16:45 Hands-On Demonstrations - Cervical and Thoracolumbar Systems

Exhibit Hall, Bella Center

See "Exhibits and Hands-On Sessions" section for more information.

16:45 Adjourn

Meeting Agenda

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Friday, July 15, 2011

7:00 – 16:15 Registration, E-Posters & Exhibits Open

7:00 – 7:45

Hands-On Workshops

Rooms 17, 18, 19, 20
First Floor

See "Exhibits and Hands-On Sessions" section for more information.

Breakfast & Exhibits Viewing

Exhibit Hall, Bella Center

8:00 – 9:00 Concurrent Sessions #3 A&B and Debates

Concurrent Session #3A: Adult Deformity

Hall A1
Moderators: Frank J. Schwab, MD
Sigurd H. Berven, MD

8:00 Paper # 46: Failure of Pelvic Fixation after Long Construct Fusions in Adult Deformity Patients; Clinical and Radiographic Risk Factors
Woojin Cho, MD, PhD; Jonathan R. Mason, MD; Adam Wilson, MD; Christopher I. Shaffrey, MD; Francis H. Shen, MD; Adam L. Shimer, MD; Wendy Novicoff, PhD; Kai-Ming Fu, MD, PhD; Joshua E. Heller, MD; Vincent Arlet

8:04 Paper # 47: rhBMP-2 and Modern Surgical Techniques Significantly Reduce the Pseudarthrosis Rate in Long Fusions to the Sacrum for Complex Adult Spinal Deformity
Lukas P. Zebala, MD; Jacob M. Buchowski, MD, MS; Keith H. Bridwell, MD; Samuel K. Cho, MD; Joshua M. Pahys, MD; Matthew M. Kang, MD; Woojin Cho, MD, PhD

8:08 Paper # 48: Adult Spinal Deformity Fusion to the Sacrum using RhBMP-2 vs. Autogenous Iliac Crest Bone Graft: Minimum Four-Year Follow-Up
Douglas D. Dickson, MD; Jacob M. Buchowski, MD, MS; Lukas P. Zebala, MD; Linda Koester, BS; Keith H. Bridwell, MD

8:12 Discussion

8:20 Paper # 49: The UCSF Experience Evaluating the Effect of One vs. Two Attending Surgeons on Peri-Operative Morbidity for Pedicle Subtraction Osteotomy
Christopher P. Ames, MD; Sassan Keshavarzi; Serena S. Hu, MD; Michael H. Weber, MD, PhD; Shane Burch, MD; Vedat Deviren, MD

8:24 Paper # 50: Vertebral Column Resection (VCR) for the Treatment of Adult Spinal Deformities: Outcome and Complications
Firas Chamas; Mostafa H. El Dafrawy, MD; Hamid Hassanzadeh, MD; Philip Neubauer, MD; Khaled Kebaish

8:28 Paper # 51: Prevalence and Risk Factors for Pseudarthrosis after Lumbar Pedicle Subtraction Osteotomy (PSO) in Adult Spinal Deformity
Douglas D. Dickson, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Brenda A. Sides, MA

8:32 Discussion

8:40 Paper # 52: Outcomes and Complications of Minimally Invasive Correction for Adult Degenerative Scoliosis
Nael Shanti, MD; Rachel Mistur, MS; Rehan Puri, MD; Atiq Durrani, MD

8:44 Paper # 53: Two to Four Year Functional Outcomes of Minimally Invasive Surgery (MIS) for Adult Spinal Deformity
Neel Anand, MD; Sheila Kahwaty, PA-C; Babak Khandehroo, MD; Eli Baron, MD

Meeting Agenda

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8:48 Paper # 54: Surgical Outcome of Adult Idiopathic Scoliosis: Comparison with Adolescent Idiopathic Scoliosis
Se-Il Suk, MD; Jin-Hyok Kim; Sung-Soo Kim, MD; Dong-Ju Lim; Jae-Min Jeon, fellow; Seung-Hyun Choi

8:52 Discussion

Concurrent Session #3B: Congenital/Neuromuscular Deformity

Hall A2/3
Moderators: Azmi Hamzaoglu MD
Suken Shah, MD

8:00 Paper # 55: Type Three Hemivertebra Resection Via Posterior Approach In Young Children
Meric Enercan; Ahmet Alanay; Cagatay Ozturk, MD; Selhan Karadereler; Mercan Sarier; Azmi Hamzaoglu, MD

8:04 Paper # 56: Cervical Spinal Cord Dimensions and Clinical Outcomes in Adults with Klippel-Feil Syndrome: A Comparison with Matched Controls
Woojin Cho, MD, PhD; Dong-Ho Lee, MD, PhD; Joshua D. Auerbach, MD; Jennifer K. Sehn, BS; Colin E. Nabb, BS; K. Daniel Riew, MD

8:08 Paper # 57: Abnormalities Associated with Congenital Scoliosis
Zijia Wang, MD; Jianxiong Shen, MD

8:12 Discussion

8:20 Paper # 58: Single Stage Posterior Vertebral Column Resection of Lumbar Hemivertebrae in Children under the Age of Ten Years
Yasser ElMiligui, MD, FRCS; Wael Koptan, MD; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa

8:24 Paper # 59: Correction of Neglected Congenital Spinal Deformities Associated With Intraspinal Anomalies. Is it Safe?
Yasser ElMiligui, MD, FRCS; Wael Koptan, MD; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa; Mohamed O. Ramadan, MD, MSc

8:28 Paper # 60: The Efficacy and Complications of Posterior Hemivertebra Resection with Monosegmental Fusion for Congenital Scoliosis
Zhang Jianguo, MD; Wang Shengru

8:32 Discussion

8:40 Paper # 61: Differences Between Patients with Cerebral Palsy whose Curves are treated Operatively vs. Non-Operatively
Paul Sponseller; Joseph P. Gjolaj, MD; Unni G. Narayanan, MBBS, MSc, FRCS(C); Suken A. Shah, MD; Peter O. Newton, MD; Amer F. Samdani, MD; Tracey Bastrom, MA; Michelle C. Marks, PT, MA

8:44 Paper # 62: The Effect of Scoliosis Surgery on Upper Gastrointestinal Function in Patients with Neuromuscular Scoliosis - A Prospective Follow-Up Study
Tuomas Jalanko, BM; Antti Koivusalo, MD, PhD; Mikko P. Pakarinen, MD, PhD; Päivi M. Salminen; Jari Peltonen; Risto Rintala; Ilkka Helenius, MD, PhD

8:48 Paper # 63: Larger Curve Magnitude is Associated with Markedly Increased Perioperative Complications after Scoliosis Surgery in Patients with SCI
Amer F. Samdani, MD; Patrick J. Cahill, MD; Steven Hwang, MD; Joseph King, MD; Asher Edwards; Anthony Fine; Joseph Ferguson; Randal R. Betz, MD

8:52 Discussion

Meeting Agenda

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8:00 – 9:00 Debates
Auditorium 11

8:00 – 8:30 Debate #5: Optimal Treatment for a 15-Year-Old, Two-Years Post-Menarche with a 45-Degree Lenke 5C Scoliosis.
Moderator: Lawrence G. Lenke, MD

8:00 – 8:10 Optimal Treatment is Observation
David S. Marks, FRCS

8:10 – 8:20 Optimal Treatment is Anterior Instrumentation and Fusion
Randal R. Betz, MD

8:20 – 8:30 Optimal Treatment is Posterior Instrumentation and Fusion
B. Stephens Richards, III, MD

8:30 – 9:00 Debate #6: Optimal Treatment for 28-Year-Old with a L1 Burst Fracture, 60% Canal Compromise and 25-Degrees of Kyphosis and No Neurological Deficit
Moderator: Kenneth MC Cheung, MD

8:30 – 8:40 Optimal Treatment is Observation with Bracing or Casting
James Harrop, MD

8:40 – 8:50 Optimal Treatment is Anterior Decompression, Instrumentation and Fusion
Jacob M. Buchowski, MD, MS

8:50 – 9:00 Optimal Treatment is Posterior Instrumentation and Fusion
Steven D. Glassman, MD

9:15 – 10:15 Instructional Course Lectures 3A-D

3A – Lumbar Posterior Fusion Options/Instrumentation (Degenerative)
Room: Hall A2/3
Moderator: Steven D. Glassman, MD

9:15 – 9:30 When is Circumferential Fusion Better than Posterolateral Fusion?
Sigurd H. Berven, MD

9:30 – 9:45 Posterior Approaches for Lumbar Degenerative Scoliosis
Serena Hu, MD

9:45 – 10:00 Management of Revision Scenarios and Iatrogenic Instability
Richard Guyer, MD

10:00 – 10:15 Economics of Lumbar Fusion
Steven D. Glassman, MD

3B – Early Onset Scoliosis II
Room: Auditorium 10
Moderator: Richard E. McCarthy, MD

9:15 – 9:20 Introduction
Richard E. McCarthy MD

9:20 – 9:28 Assessment of Maturity and Tether Based Treatment
Suken Shah, MD

9:29 – 9:36 Casting and Magnet Driven Rods
Hilali Noordeen, FRCS

9:36 – 9:44 Growth Rods - Turkish Style
Azmi Hamzaoglu, MD

9:44 – 9:52 Dual Growing Rods
Behrooz A. Akbarnia, MD

Meeting Agenda

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9:52 – 10:00 VEPTR and Shilla
Richard E. McCarthy, MD

10:00 – 10:15 Questions/Case Discussion

3C – Adult Deformity III: Decision Making Relative to Extension to the Sacrum Pelvis

Room: Auditorium 11
Moderator: Khaled Kebaish, MD

9:15 – 9:24 Indications of Extending Fusions to the Sacrum/Pelvis: When Can I Spare it and When do I Include It?
Christopher I. Shaffrey, MD

9:24 – 9:33 Spino-Pelvic Parameters: How do They Affect my Decision Relative to Extension to the Sacrum
Frank J. Schwab, MD

9:33 – 9:42 Fusion Options at the Lumbo-Sacral Junction: Approach, Graft Type, Interbody Support
Oheneba Boachie-Adjei, MD

9:42 – 9:51 Sacro-Pelvic Fixation: Options, Techniques and Complications
Khaled Kebaish, MD

9:51 – 10:00 Mistakes to Avoid and Surgical Strategy in Obtaining Optimum Balance at the Lumbo-Sacral Junction
Lawence G. Lenke, MD

10:00 – 10:15 Case Presentation, Questions and Discussions

3D – Thoracolumbar Trauma

Room: Auditorium 12
Moderator: Alexander R. Vaccaro, MD

915 – 9:27 Update on Thoracolumbar Classification Systems: Do They Impact Treatment and Prognosis?
Alexander R. Vaccaro, MD

9:27 – 9:39 Thoracolumbar Decompressive Techniques: When Anterior, When Posterior, When Combined? Does it Need to be Done?
Praveen V. Mummaneni, MD

9:39 – 9:51 The Surgical Management of Posttraumatic Spinal Deformity and Miscellaneous Complications of TL Fracture Care
Jacob M. Buchowski, MD, MS

9:51 – 10:03 MIS Applications for Thoracolumbar Spine Trauma
Steven C. Ludwig, MD

10:03 – 10:15 Discussion

10:30 – 11:30 Concurrent Sessions #4 A&B and Debates

Concurrent Session #4A: Lumbar Degenerative & Spondylolisthesis

Hall A1
Moderators: Steven C. Ludwig, MD
Praveen V. Mummaneni MD

10:30 Paper # 64: Optimal RhBMP-2 Dose in TLIF: Long-Term Outcomes in 451 Patients
Dennis Crandall, MD; Jason Patterson, MD; Eric Huish, BS; Jan Revella, RN; Jason Datta, MD; Michael S. Chang, MD; Terrence Crowder, MD; Ryan McLemore, PhD

10:34 Paper # 65: Relative Benefit of TLIF vs. PSF Stratified by Diagnostic Indication
Roger K. Owens, MD; Leah Y. Carreon, MD,MSc; Mladen Djurasovic, MD; Steven D. Glassman, MD

10:38 Paper # 66: Adjacent Disc Disease and Revision Surgery after 360-degree Lumbar Fusion. Outcome Comparison of 73 patients at 2.5 and Ten Years Follow-Up
Jose I. Maruenda; Felipe Garibo; Carlos Barrios; Jesús J Burgos Flores, PhD; Eduardo Hevia, MD

10:42 Discussion

Meeting Agenda

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10:50 Paper # 67: Long-Term Work Capability after Spine Surgery: Decompression vs. Fusion
Dennis Crandall, MD; Kenneth Schmidt, MD; Jan Revella, RN; Michael S. Chang, MD; Jason Datta, MD; Terrence Crowder, MD; Ryan McLemore, PhD

10:54 Paper # 68: SF-6D Values Stratified by Specific Diagnostic Indication
Leah Y. Carreon, MD,MSc; Mladen Djurasovic, MD; Chelsea E. Canan, BA; Lauren O. Burke, BS; Steven D. Glassman, MD

10:58 Paper # 69: Changes in the Oswestry Disability Index Domains that Predict Improvement after Lumbar Fusion
Mladen Djurasovic, MD; Steven D. Glassman, MD; John R. Dimar, MD; Charles H. Crawford, MD; Kelly R. Bratcher, RN, CCRP; Leah Y. Carreon, MD,MSc

11:02 Discussion

11:10 Paper # 70: Surgical Correction of Lumbosacral Spondyloptosis by a Posterior-Only Approach
Harry L. Shufflebarger, MD; Dianna C. Morales, BA

11:14 Paper # 71: Spondylolisthesis, Sacro-Pelvic Morphology and Orientation in Young Gymnasts
Charles-William Toueg, MD; Jean-Marc Mac-Thiong, MD, PhD; Guy Grimard, MD; Benoit Poitras, Dr; Stefan Parent, MD, PhD; Hubert Labelle, MD

11:18 Paper # 72: Direct Decompression and Interlaminar Stabilization Compared to Laminectomy and Posterior Spinal Fusion with Pedicle Screw Instrumentation for Spinal Stenosis with Back Pain or Degenerative Spondylolisthesis: Two-Year Results from the Prospective, Randomized, Multicenter FDA IDE Trial
Reginald J. Davis, MD; Thomas Errico; Hyun Bae, MD; Joshua D. Auerbach, MD

11:22 Discussion

Concurrent Session #4B: Innovative Methods

Hall A2/3
Moderators: Khaled Kebaish, MD
D. Greg Anderson, MD

10:30 Paper # 73: Fusionless Scoliosis Management using a Growth Modulating Intravertebral Epiphyseal Device in a Porcine Model
Mark Driscoll, BEng; Carl-Eric Aubin, PhD, PEng; Alain Moreau, PhD; Yaroslav Wakula, MD; Stefan Parent, MD, PhD

10:34 Paper # 74: A Randomized Controlled Trial Assessing the Safety and Efficacy of a Novel Superelastic Rod in Comparison to Conventional Titanium Rod for Scoliosis Curve Correction
Kenneth M. Cheung, MD; Evelyn E. Kuong; Dino Samartzis, DSc, PhD, MSc; Kelvin Yeung, PhD; Keith D. Luk, MD

10:38 Paper # 75: Next Generation of Growth-Sparing Techniques: Preliminary Clinical Results of a Magnetically Controlled Growing Rod in 14 Patients
Behrooz A. Akbarnia, MD; Kenneth M. Cheung, MD; Hilali H. Noordeen, FRCS; Hazem B. Elsebaie, FRCS , MD; Muharrem Yazici, MD; Zaher Dannawi, FRCS (Tr & Orth); Nima Kabirian, MD

10:42 Discussion

10:50 Paper # 76: Pars Interarticularis Repair with Percutaneous Screw Fixation
Lester F Wilson, FRCS(Orth); Farhaan Altaf, MBBS, BSc, MRCS; Philippa A Tyler, FRCR

10:54 Paper # 77: Repair of Spondylolysis using Compression with a Modular Link and Screws
Farhaan Altaf, MBBS, BSc, MRCS; Nana Osei; Enrique Garrido, MBBS, FRCS; Mohannad Al-Mukhtar, MB ChB, MRCS; Colin Natali, FRCS(Orth); A. Sivaraman, MBBS, FRCS(Orth); Hilali H. Noordeen, FRCS

10:58 Paper # 78: Preliminary Experience with Clinical Use of a DNA Prognostic Test for Adolescent Idiopathic Scoliosis in 196 Patients
Suken A. Shah, MD; Petya Yorgova; Geraldine I. Neiss, PhD; E. Patrick Curry, MD; Brain S. Winters, MD; Peter G. Gabos, MD; J. Richard Bowen, MD

11:02 Discussion

Meeting Agenda

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11:10 Paper # 79: The Impact of a Distal Expansion Mechanism Added to a Standard Pedicle Screw on Pullout Resistance: A Biomechanical Study
Heiko Koller, MD; Michael Mayer, MD; Juliane Zenner, MD; Wolfgang Hitzl, PhD; Oliver Meier; Herbert Resch

11:14 Paper # 80: Comparison of Anterior/Posterior to Posterior-Only Correction of Scheuermann's Kyphosis: A Matched Pair Analysis of 166 Patients
Heiko Koller, MD; Lawrence G. Lenke, MD; Yutaka Nakamura, MD, PhD; Keith H. Bridwell, MD; Linda Koester, BS; Axel Hempfing, Consultant; Luis Ferraris, MD; Oliver Meier; Juliane Zenner, MD; Wolfgang Hitzl, PhD

11:18 Paper # 81: Gradual Scoliosis Correction over Time with Shape-Memory Metal: An Experimental Study
José Miguel Sánchez Márquez, MD; Francisco Javier Sánchez Pérez-Grueso; Nicomedes Fernández-Baillo; Alfredo García Fernández

11:22 Discussion

10:30 – 11:30 Debates

Auditorium 11

10:30 – 11:00 Debate #7: Optimal Treatment of Significant (50-Degree) Thoracolumbar Scoliosis in 50-Year-Old

Moderator: Frank Schwab, MD

10:30 – 10:40 Optimal Treatment is MIS
Neel Anand, MD

10:40 – 10:50 Optimal Treatment is Posterior-Only Instrumentation and Fusion
Brian O'Shaugnessy, MD

10:50 – 11:00 Optimal Treatment is a Circumferential Approach
Oheneba Boachie-Adjei, MD

11:00 – 11:30 Debate #8: Optimal Treatment for Progressive 60-Degree Early Onset Scoliosis in 4-Year-Old

Moderator: Ahmet Alanay, MD

11:00 – 11:10 Optimal Treatment is VEPTR
Randal R. Betz, MD

11:10 – 11:20 Optimal Treatment is Shilla Procedure
Richard E. McCarthy, MD

11:20 – 11:30 Optimal Treatment is Growth Rods
George H. Thompson, MD

11:45 – 12:45 Round Table Case Discussions

Cervical Reconstruction

Room: Hall A1
Moderator: Brian K. Kwon, MD, PhD, FRCSC
Panelists: Jacob M. Buchowski, MD, MS
James S. Harrop, MD
Praveen V. Mummaneni, MD

Lumbar Degenerative

Room: Hall A2/3
Moderator: D. Greg Anderson, MD
Panelists: Serena Hu, MD
Isadore H. Lieberman, MD, MBA, FRCSC
Steven D. Glassman, MD
Richard Guyer, MD

Meeting Agenda

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Pediatric Deformity

Room: Auditorium 10
Moderator: Suken Shah, MD
Panelists: Richard E. McCarthy MD
Harry L. Shufflebarger, MD
Hilali Noordeen, FRCS
Randal R. Betz, MD

Adult Deformity

Room: Auditorium 11
Moderator: Sigurd H. Berven, MD
Panelists: Frank J. Schwab, MD
Oheneba Boachie-Adjei, MD
Khaled Kebaish, MD
Se-Il Suk, MD

Tumor / Trauma / Infection

Room: Auditorium 12
Moderator: Michael J. Yaszemski, MD, PhD
Panelists: Kenneth MC Cheung, MD
Azmi Hamzaglou, MD
Steven C. Ludwig, MD
Alexander R. Vaccaro, MD

12:45 – 13:45 Lunch & Exhibit Viewing

Exhibit Hall, Bella Center

Membership Information Session

Hall A2/3

Join us and learn more about the Scoliosis Research Society

- An Overview of the SRS
- How to Apply
- Benefits of Membership
- Leadership Opportunities
- Scholarships
- Networking
- Education
- Open Discussion

Speakers: Kamal N. Ibrahim, MD, Vice President
Serena Hu, MD, Fellowship Chair
Justin Smith, MD, Morbidity and Mortality Committee Member
Benny Dahl, MD, PhD, SRS Candidate Member and Local Host

13:45 – 14:45 Instructional Courses Lectures 4A-D

4A – Infection and Post-Infectious Deformity

Room: Hall A2/3
Moderator: Brian K. Kwon, MD, PhD, FRCSC

13:45 – 13:57 Preventing Postoperative Spinal Wound Infections – What Does the Evidence Show?
James S. Harrop, MD

13:57 – 14:09 Is Instrumentation Removal Necessary in the Face of a Postoperative Wound Infection?
Brian K. Kwon, MD, PhD, FRCSC

14:09 – 14:21 Postinfectious Thoracolumbar Spinal Deformity – Principles of Surgical Management
Kenneth MC Cheung, MD

Meeting Agenda

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14:21 – 14:33 Medical and Surgical Management of Disciitis, Osteomyelitis and Epidural Abcess
Azmi Hamzaoglu, MD

4B – Adolescent Idiopathic Scoliosis II: Correction Techniques for Simple to Severe Curves

Room : Auditorium 10
Moderator: Suken Shah, MD

13:45 – 13:55 Tried and True: Compression, Distraction, Translation, Rod Rotation
Francisco J. Perez-Grueso, MD

13:55 – 14:05 Special Situations: Selective Fusions, Shoulder Balance
Kamal N. Ibrahim, MD

14:05 – 14:15 Vertebral Body Derotation
Suken A. Shah, MD

14:15 – 14:25 Posterior Releases & Sagittal Plane Restoration
Randal R. Betz, MD

14:25 – 14:35 Vertebral Column Resection
Harry L. Shufflebarger, MD

14:35 – 14:45 Panel Discussion with Cases

4C – Adult Deformity IV: Non-Fusion and MIS Alternatives in Adult Scoliosis

Room: Auditorium 11
Moderator: D. Greg Anderson, MD

13: 45 – 13:57 Pre-Operative Planning and Robotic Guidance for Deformity Surgery
Isadore H. Lieberman, MD, MBA, FRCSC

13:57 – 14:09 Minimally Invasive Lateral and Trans-Sacral Techniques for Deformity Correction
Neel Anand, MD

14:09 – 14:21 Pedicle Screw Constructs for Deformity Correction: What are the Limitations
Se-Il Suk, MD

14:21 – 14:33 Mini-Open PSO with Percutaneous Fixation for Kyphosis Correction
D. Greg Anderson, MD

14:33 – 14:45 Case Discussions

4D – The Osteoporotic Spine: Fixation Challenges and Solutions

Room: Auditorium 12
Moderator: Michael J. Yaszemski, MD, PhD

13:45 – 13:57 Fixation Problems in the Osteoporotic Spine
Mark Weidenbaum, MD

13:57 – 14:09 Biomechanical Evaluation and Instrumentation Strategies
Sigurd H. Berven, MD

14:09 – 14:21 New Technologies for Osteoporotic Fixation
Steven C. Ludwig, MD

14:21 – 14:33 The Treatment of Osteoporosis
Michael J. Yaszemski. MD, PhD

14:33 – 14:45 Discussion

14:45 – 16:15 Hands-On Demonstrations - Interbody Devices Biologics, Deformity Systems, Other

Exhibit Hall, Bella Center

See "Exhibits and Hands-On Sessions" section for more information.

Meeting Agenda

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Saturday, July 16, 2011

7:00 – 14:00 Registration, E-Posters Open

7:00 – 7:45 Hands-On Workshops

Rooms 19 & 20
First Floor

See "Exhibits and Hands-On Sessions" section for more information.

Breakfast

Congress Foyer, Bella Center

8:00 – 9:00 Instructional Course Lectures 5A-D

5A – Cervical Degenerative Techniques

Room: Hall A2/3
Moderator: Jacob M. Buchowski, MD, MS

8:00 – 8:05	Introduction	*Jacob M. Buchowski, MD, MS*
8:05 – 8:17	Cervical Spondylosis	*Todd J. Albert, MD*
8:18 – 8:30	Treatment of Cervical Radiculopathy	*Jeffrey A. Goldstein, MD*
8:31 – 8:43	Treatment of Cervical Myelopathy	*Praveen V. Mummaneni, MD*
8:44 – 9:00	Cases/Discussion	*Jacob M. Buchowski, MD, MS*

5B – Lumbar Disc Replacement

Room: Auditorium 10
Moderator: Luiz Pimenta, MD

8:00 – 8:10	Biomechanics	*Serena Hu, MD*
8:10 – 8:20	Meta-Analysis on Lumbar TDR	*John R Dimar, II, MD*
8:20 – 8:30	Long-Term Follow-Up	*J. Abbott Byrd, MD*
8:30 – 8:40	Advanced Options	*Isador H. Lieberman, MD*
8:40 – 8:50	Complications and Revision Options	*Luiz Pimenta, MD*
8:50 – 9:00	Discussion	

5C – Adolescent Idiopathic Scoliosis III

Room : Auditorium 11
Moderator: Daniel J. Sucato, MD, MS

8:00 – 8:06	Preoperative Patient Assessment in AIS	*Richard E. McCarthy, MD*
8:06 – 8:08	Discussion	

Meeting Agenda

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8:08 – 8:14 Anterior vs. Posterior Indications for AIS Surgery
David S. Marks, FRCS

8:14 – 8:16 Discussion

8:16 – 8:22 Surgical Technique for Anterior Surgery in AIS
Henry F. Halm, MD

8:22 – 8:24 Discussion

8:24 – 8:30 Use of Posterior Pedicle Screws and DVR for AIS
Se-Il Suk, MD

8:30 – 8:32 Discussion

8:32 – 8:45 Case Discussions
Daniel J. Sucato, MD, MS

5D - Adult/Pediatric Deformity: My Worst Complication and How I Treated It

Room: Auditorium 12
Moderator: B. Stephens Richards, MD
Panelists: Khaled Kebaish, MD
Brian A. O'Shaughnessy, MD
B. Stephens Richards, MD
Suken A. Shah, MD
Justin S. Smith, MD, PhD

9:00 – 11:00 Concurrent Sessions #5A & B

Concurrent Session #5A: Adolescent Idiopathic Scoliosis and Adult Deformity

Hall A1
Moderators: John R. Dimar, II, MD
Justin S. Smith, MD, PhD

9:00 Paper # 82: Use of Quantitative Ultrasound (QUS) for Predicting Curve Progression in Adolescent Idiopathic Scoliosis - A Prospective Cohort Study of 294 Cases Followed Beyond Skeletal Maturity
Tsz-ping Lam, MB, BS; Vivian WY Hung; Hiu Yan Yeung, PhD; Bobby KW Ng, MD; Kwong-man Lee, PhD; Jack C. Cheng, MD

9:04 Paper # 83: Total En Bloc Spondylectomy: A North American Experience
Addisu Mesfin, MD; Amit Jain; Ahmed S. Mohamed, MD; Hamid Hassanzadeh, MD; Khaled Kebaish

9:08 Paper # 84: Validation of EOS 3D Reconstruction Accuracy Against CT
Diana A. Glaser, PhD; Josh Doan, MEng; Michael Mukhin, BS; Peter O. Newton, MD

9:12 Discussion

9:20 Paper # 85: Effect of Spinal Shortening on Motor-Evoked Potentials and Spinal Cord Blood Flow
Hitesh N. Modi, MS, PhD; Seung-Woo Suh, MD, PhD; Jae Hyuk Yang, MD; Jae-Young Hong, MD
Korea, Republic of

9:24 Paper # 86: Pediatric Pedicle Screw Placement Using 3D Image-Guided Navigation is Safe and Accurate
A. Noelle Larson, MD; Edward Rainier G. Santos, MD; Charles Gerald T. Ledonio, MD; David W. Polly, MD; Jonathan N. Sembrano, MD; Cary H. Mielke, MD; Kenneth J. Guidera, MD

9:28 Paper # 87: Long-Term Functional Results after Anterior Surgery with Screwed / Plate Construct for Treatment of (AIS): Correlation between Results and Sagittal Balance
Guillaume Riouallon; Thierry Odent, MD, PhD; Caroline Elie; Jean-Paul Padovani; Christophe Glorion

9:32 Discussion

Meeting Agenda

† = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper

9:40	Paper # 88: Treatment of Lenke 1 AIS Curves: Where to Stop Proximally and How does it Affect Shoulder Balance? Comparison of Selective vs. Non-Selective Thoracic Fusions *Jaspaul Gogia, MD; Darren R. Lebl, MD; Akilah B. King, BA; Matthew E. Cunningham, MD, PhD; John S. Blanco, MD; Roger F. Widmann, MD; Oheneba Boachie-Adjei, MD; Complex Spine Study Group*
9:44	Paper # 89: Frontal or Sagittal Spinal Imbalance Does Not Affect Quality of Life Two Years after Posterior Spinal Instrumentation and Fusion for Adolescent Idiopathic Scoliosis *Michael G. Vitale, MD, MPH; W.G. Stuart Mackenzie, BS, MS II; Hiroko Matsumoto, MA; Nicholas D. Colacchio, BA; Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; Mark A. Erickson, MD; James O. Sanders, MD; Lawrence G. Lenke, MD; David P. Roye, MD; Brendan A. Williams, AB*
9:48	Paper # 90: Unintended Change in Physiological Lumbar Lordosis and Pelvic Tilt after Posterior Spinal Instrumentation and Fusion: How Much is Too Much? *Frank J. Schwab, MD; Nicholas D. Colacchio, BA; Hiroko Matsumoto, MA; Virginie Lafage, PhD; Evan D. Sheha, BS; David P. Roye, MD; Michael G. Vitale, MD, MPH; Brendan A. Williams, AB*
9:52	Discussion
10:00	Paper # 91: Role of Intervertebral Release and Three-Column Spinal Osteotomy in Corrective Surgery for Degenerative Thoracolumbar/Lumbar Spinal Deformity in Patients over 60 Years of Age *Hiroshi Taneichi, MD; Satoshi Inami; Takashi Namikawa, MD, PhD; Daisaku Takeuchi; Chizuo Iwai; Nakayuki Kato; Yutaka Nohara, MD*
10:04	Paper # 92: Long Adult Spinal Deformity Fusion to Sacrum Using Low Dose rhBMP-2: A Retrospective Evaluation and Comparison to Reported High Dose rhBMP-2 vs. Autogenous Iliac Crest Bone Graft(ICBG) *Joshua E. Heller, MD; Justin S. Smith, MD, PhD; Woojin Cho, MD, PhD; Kai-Ming Fu, MD, PhD; Christopher I. Shaffrey, MD*
10:08	Paper # 93: Factors Influencing the Transition from Non-Operative to Operative Treatment in Elderly Adults with Degenerative Scoliosis *Kai-Ming Fu, MD, PhD; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD*
10:12	Discussion
10:20	Paper # 94: Over Correction by Osteotomy for Sagittal Plane Deformity: It Happens and Here is Why *Benjamin Blondel, MD; Frank Schwab, MD; Shay Bess, MD; Christopher P. Ames, MD; Robert A. Hart, MD; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Oheneba Boachie-Adjei; International Spine Study Group; Virginie Lafage, PhD*
10:24	Paper # 95: Pedicle Subtraction Osteotomy with Extension of Fusion to the Pelvis: Does Anterior Interbody Support at L5-S1 Improve Sagittal and Pelvic Parameters? *Munish C. Gupta, MD; Eric Klineberg, MD; Virginie Lafage, PhD; Shay Bess, MD; Frank Schwab, MD; Oheneba Boachie-Adjei; Khaled Kebaish; Kirkham B. Wood, MD; Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Christopher P. Ames, MD; Michael F. Obrien, MD; Richard Hostin, MD; International Spine Study Group*
10:28	Paper # 96: Validation of the SRS-Schwab Adult Deformity Classification *Benjamin Ungar; Frank Schwab, MD; Virginie Lafage, PhD; Benjamin Blondel, MD; Jacob M. Buchowski, MD, MS; Jeffrey D. Coe, MD; Donald A. Deinlein, MD; Christopher J. DeWald, MD; Hossein Mehdian, MD, MS(Orth) FRCS(Ed); Christopher I. Shaffrey, MD; Clifford B. Tribus, MD*
10:32	Discussion
10:40	Paper # 97: Multiplanar Radiological Assessment and Outcomes of Minimally Invasive Surgical Treatment (XLIF) in Adult Deformity: Follow-Up out to 36 Months *Hazem Nicola; Manuel Da Silva; Luiz Pimenta, MD, PhD*
10:44	Paper # 98: Surgical Outcomes of Long Spinal Fusions for Scoliosis in Patients with Rheumatoid Arthritis *Addisu Mesfin, MD; Amit Jain; Hamid Hassanzadeh, MD; Mostafa H. El Dafrawy, MD; John P. Kostuik, MD; Khaled Kebaish*
10:48	Paper # 99: A Prospective Study to Assess the Utility of MRI Planning in the Use of a Lateral Transpsoas Approach to the Lumbar Spine *Hazem Nicola; Manuel Da Silva*
10:52	Discussion

Meeting Agenda

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Concurrent Session #5B: Trauma, Tumor, Miscellaneous

Hall A2/3

Moderators: Alexander R. Vaccarro, MD
Cody E. Bunger, MD

9:00	Paper # 100: Short Segment Posterior Instrumentation for Unstable Burst Fractures of the Dorsolumbar Spine. Is Fusion Really Necessary? *Wael Koptan, MD; Yasser ElMiligui, MD, FRCS; Mohammad M. El-Sharkawi, MD; Mohamed O. Ramadan, MD, MSc; AbdElMohsen Arafa*
9:04	Paper # 101: Modified Posterior Vertebral Column Resection For The Treatment Of Osteoporotic Fractures With Neurological Deficit In Elderly Patients *Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Mehmet Aydogan; Mehmet Tezer; Azmi Hamzaoglu, MD*
9:08	Paper # 102: Combat vs. Noncombat Spine Injures in Operation Iraqi Freedom and Operation Enduring Freedom *James A. Blair, MD; Jeanne C. Patzkowski, MD; Jessica D. Cross; Eric Grenier, MD; Ronald A. Lehman, MD; Andrew J. Schoenfeld, MD; Daniel G. Kang, MD; Joseph R. Hsu, MD*
9:12	Discussion
9:20	Paper # 103: Pediatric Spine Trauma in the United States - Analysis from the Healthcare Cost and Utilization Project (HCUP) Kid's Inpatient Database (KID) *Sergio A. Mendoza-Lattes, MD; Gnanapragasam Gnanapradeep, MD.; Zachary Ries, B. Sc.; Rachel C. Nash; Yubo Gao; Stuart L. Weinstein, MD*
9:24	Paper # 104: Prevalance of Associated Injuries in Children with Spine Fractures *Jeffrey R. Sawyer, MD; Ben Guevara, MD; William C. Warner, MD; Derek M. Kelly, MD*
9:28	Paper # 105: Pediatric Cervical Spine Injury: A Single Institution Study *James Barnes; Parthak Prodhan, MD; Richard E. McCarthy*
9:32	Discussion
9:40	Paper # 106: Functional and Quality of Life Outcomes in Geriatric Patients with Type II Odontoid Fracture: One Year Results from the AOSpine North America Multi-Center GOF Prospective Study *Alexander R. Vaccaro, MD, PhD; Branko Kopjar; Jens R. Chapman, MD; Christopher I. Shaffrey, MD; Michael Fehlings, MD, PhD, FRCSC; Paul Arnold; Ziya L. Gokaslan, MD; Roger Hartl, MD; Darrel S. Brodke, MD; John C. France, MD; S. Tim Yoon; Mark B. Dekutoski, MD; Rick C. Sasso, MD; Christopher Bono*
9:44	Paper # 107: Corpectomy of the Fifth Lumbar Vertebra: A Challenging Procedure *Mootaz Shousha, MD; Hesham El-Saghir; Heinrich Böhm*
9:48	Paper # 108: Percutaneous Stabilization of Spinal Metastasis *Lars V. Hansen; Martin Gehrchen, MD, PhD; Søren S. Morgen, MD; Benny Dahl, MD*
9:52	Discussion
10:00	Paper # 109: Results of Surgical Management of Metastatic Spinal Tumours Based on an Epidural Spinal Cord Compression Scale *Nasir A. Quraishi, FRCS; Sanjay Purushothamdas, FRCS (Orth), MS (Orth); Kyriakos E. Giannoulis, PhD*
10:04	Paper # 110: Surgical Outcomes of a Posterior Approach for Large Ventral Intradural Extramedullary (IDEM) Spinal Cord Tumors *Chi Heon Kim, MD, PhD; Chun Kee Chung; Soo Eun Lee, MD*
10:08	Paper # 111: Surgical Outcome of Spinal Hepatocellular Carcinoma Metastases *Chi Heon Kim, MD, PhD; Chun Kee Chung; Tae-Ahn Jahng, MD, PhD; Soo Eun Lee, MD*
10:12	Discussion
10:20	Paper # 112: Surgical Treatment of Aneurysmal Bone Cysts of the Spine *Addisu Mesfin, MD; Khaled Kebaish*

Meeting Agenda

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10:24 Paper # 113: A Novel Approach to Upper Lobe Tumors Involving the Spine: Video-Assisted Thoracoscopic Surgery with Posterior Spinal Reconstruction
Geoffrey E. Stoker, BS; Jacob M. Buchowski, MD, MS; Michael P. Kelly, MD; Bryan F. Meyers, MD; G. Alexander Patterson, MD

10:28 Paper # 114: Comparison of Unilateral vs. Bilateral Kyphoplasty in Patients with Multiple Myeloma
Frank D. Vrionis, MD, PhD; Mohammed Eleraky, MD; Kamran Aghayev; Ioannis Papanastassiou, MD

10:32 Discussion

10:40 Paper # 115: A Prospective, Randomized, Controlled Clinical and Radiological Study to Evaluate and Compare the use of Silicated Calcium Phosphate and rh-BMP2 in Interbody Lumbar Spine Fusion. 36-Month Follow-Up
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD

10:44 Paper # 116: Free-Hand Transpedicular Screw Placement in the Process of Applying Posterior Vertebral Column Resection to Treat Severe Spinal Deformity
Jingming Xie; Zhi Zhao; Yingsong Wang, MD; Ying Zhang; Tao Li; Zhendong Yang; Ni Bi; Hong Chen

10:48 Paper # 117: Retrieval Analysis of Lumbar Total Disc Replacements - A Study of in vivo Wear, Surface Properties, and Fixation
Darren R. Lebl, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD; Samantha M. Lee; Fred Mo, MD; Timothy Wright, PhD; Celeste Abjornson, PhD

10:52 Discussion

11:15 – 13:05 General Session & Whitecloud Paper Award Presentation

Hall A1
Moderators: Isadore H. Lieberman, MD, MBA, FRCSC
James S. Harrop, MD

11:15 Presentation of Whitecloud Awards

11:20 Paper # 118: A Prospective, Randomized Clinical Investigation of the Porous Coated Motion (PCM) Artificial Cervical Disc: Two Year Results from the US IDE Study
Frank M. Phillips, MD; Andrew Cappuccino, MD, BES; Fred H. Geisler, MD, PhD; Christopher Chaput, MD; John G. DeVine, MD; Christopher J. Reah, PhD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA

11:24 Paper # 119: Factors Associated with Perioperative Complications in the Treatment of Cervical Spondylotic Myelopathy Based on 302 Patients from the AOSpine North America Cervical Spondylotic Myelopathy Study
Justin S. Smith, Christopher I. Shaffrey, Michael Fehlings, Branko Kopjar, Paul Arnold, S. Tim Yoon, Alexander R. Vaccaro, Darrel S. Brodke, Eric J. Woodard, Robert Banco, Jens R. Chapman, Michael Janssen, Rick C. Sasso, Mark B. Dekutoski, Ziya L. Gokaslan

11:28 Paper # 120: Predictors of Outcomes in Surgical Treatment For Cervical Spondylotic Myelopathy: The AOSpine North America Multi-Center Prospective Study
Michael Fehlings, Branko Kopjar, S. Tim Yoon, Paul Arnold, Alexander R. Vaccaro, Darrel S. Brodke, Christopher I. Shaffrey, Eric J. Woodard, Robert Banco, Jens R. Chapman, Michael Janssen, Rick C. Sasso, Christopher Bono, Mark B. Dekutoski, Ziya L. Gokaslan

11:32 Discussion

11:40 Paper # 121: Cervical Disc Arthroplasty in Patients with Prior Fusions: Results from the PCM US IDE Trial
Fred H. Geisler, MD, PhD; Frank M. Phillips, MD; Christopher Chaput, MD; Andrew Cappuccino, MD, BES; John G. DeVine, MD; Christopher J. Reah, PhD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA

11:44 Paper # 122: Clinical Outcomes after Lumbar Fusion Complicated by Deep Wound Infection: A Case-Control Study
Julio Petilon, MD; Steven D. Glassman, MD; John R. Dimar, MD; Leah Y. Carreon, MD,MSc

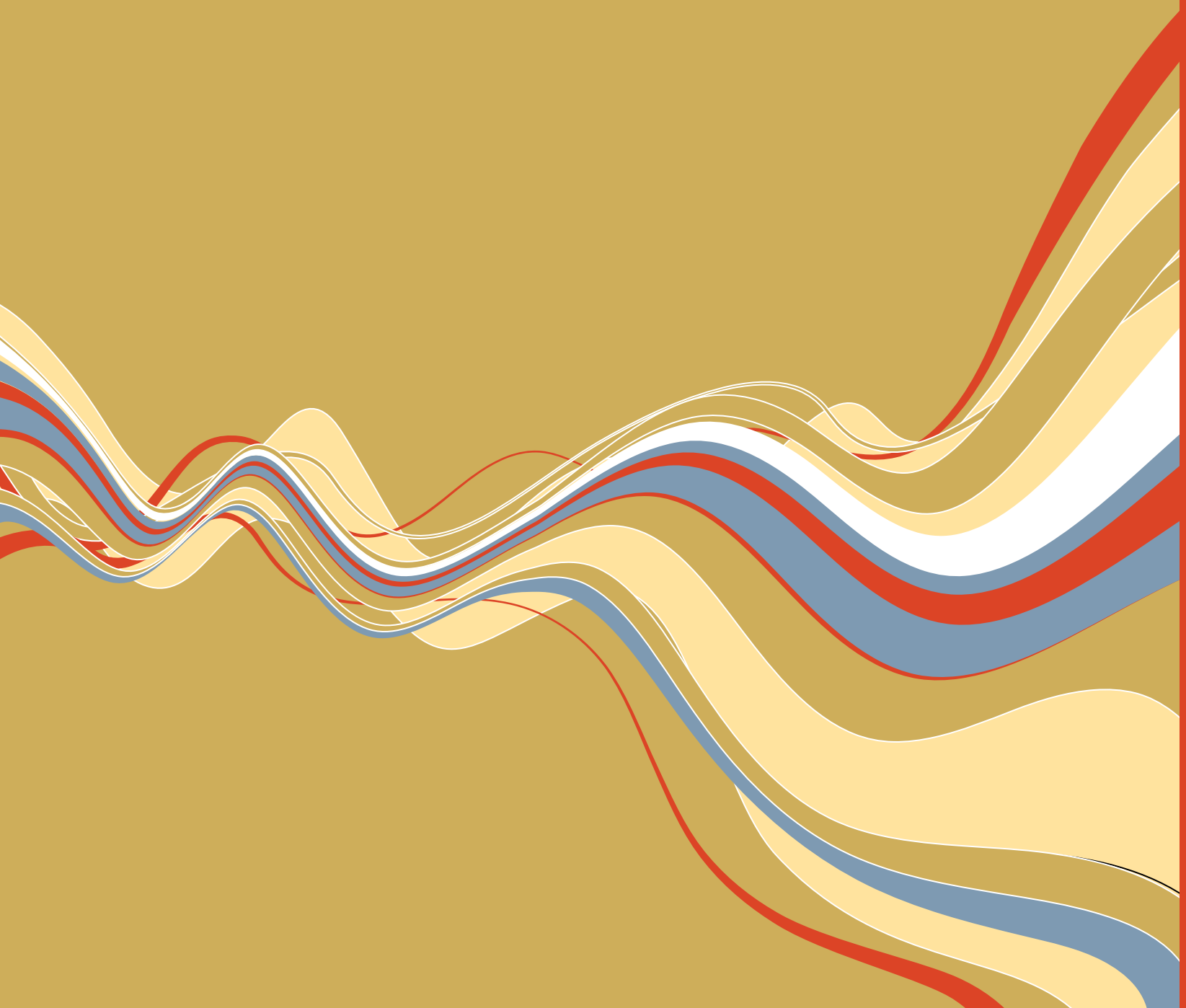
11:48 Paper # 123: Lateral Lumbar Arthroplasty: Clinical and Radiological Evaluation on a New Metal-on-Metal Device
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD

Meeting Agenda

† = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper

11:52	Discussion
12:00	Paper # 124: Readmission Rates after Decompression Surgery for Lumbar Spinal Stenosis among Medicare Beneficiaries *Steven Takemoto, PhD; Urvij M. Modhia, MD; Robyn A. Capobianco, MA; Mary Jo Braid-Forbes, MPH; Sigurd H. Berven, MD*
12:04	Paper # 125: Impact of Peri-Operative Complications in Lumbar Fusion Surgery on Clinical Outcome Measures *Manish Lambat, MD; Leah Y. Carreon, MD,MSc; Mitchell J. Campbell, MD; Steven D. Glassman, MD*
12:08	Paper # 126: Procalcitonin as an Early Marker for Postoperative Infection for Cases of Elective Spine Surgery *Katharine Cronk, MD, PhD; Nikolay Martirosyan; Nicholas Theodore, MD, FACS*
12:12	Discussion
12:20	Paper # 127: Is Subjective Outcome Better and Persistent with Microendoscopic Discectomy (MED) than Open Discectomy? *Bhavuk Garg; Arvind Jayaswal, MS (ortho)*
12:24	Paper # 128: Thoracic Pedicle CT Classification for Free-hand Pedicle Screw Placement in Posterior Vertebral Column Resection Treating Severe Spinal Deformity *Jingming Xie; Ying Zhang; Zhi Zhao; Hong Chen; Yingsong Wang, MD; Ni Bi; Zhendong Yang; Tao Li*
12:28	Paper # 129: Short Segment Anterior Fusion with Interbody Cages for Painful Scheuermann's Disease *Jwalant S. Mehta, FRCS (Orth); Kan Min, MD; Eldin E. Karaikovic, MD, PhD; Suken A. Shah, MD; Daniel Zarzycki, MD, PhD; Robert W. Gaines, MD*
12:32	Discussion
12:40	Paper # 130: The Reliability of X-Ray Based Evaluation of Pedicle Screw Misplacement in Adolescent Spinal Deformity *Paul Haynes, MD; Beverly Thornhill, MD; Gordon E. Sims, BS; Jonathan J. Horn; Adam L. Wollowick, MD; Terry D. Amaral, MD; Preethi M. Kulkarni, MD; Vishal Sarwahi, MD*
12:44	Paper # 131: The Role Closed Reduction under General Anesthesia in the Treatment of C1/C2 Rotatory Subluxation in Children *Lynn J. Letko, MD; Jurgen Harms, MD*
12:48	Paper # 132: MRI is Unnecessary to Clear the Cervical Spine in Pediatric Trauma Patients: Ten-Year Experience of a Level One Pediatric Trauma Center *Jessie Gargas, MD; Burt Yaszay, MD; Peter Kruk, MD; Tracey Bastrom, MA; Sandeep Khanna, MD*
12:52	Discussion
13:00	Paper # 133: Pulmonary Function Changes following Posterior Vertebral Column Resection in Pediatric and Adult Spinal Deformity Patients *David Bumpass, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Jeremy J. Stallbaumer, MD; Yongjung J. Kim, MD; Michael J. Wallendorf, PhD; Woo-Kie Min, MD,PhD; Brenda A. Sides, MA*
13:04	Paper # 134: Bilateral Rib-Based Distraction to the Pelvis for the Management of Congenital Gibbus Deformity in the Growing Child *John T. Smith, MD; Jennie B. Mickelson, BS*
13:08	Paper # 135: A New Technique for Surgical Correction of Severe Kyphosis *Hong Zhang, MD; Daniel J. Sucato, MD, MS; David Ross, MFA; William Pierce, BS; Karen D. Standefer, BS*
13:12	Discussion
13:20	Adjourn

Paper Abstracts



The Scoliosis Research Society gratefully acknowledges DePuy Spine for their overall support of the 18th IMAST.

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Paper Abstracts

1. Are Anti-Fibrinolytics Effective at Reducing Peri-Operative Blood Loss in Adolescent Idiopathic Scoliosis?

Kushagra Verma, MD; Thomas Errico; Christian M. Hoelscher, BS; Joseph W. Dryer, MD; Tessa Huncke, MD; Kirsten Boenigk, MD, PhD; Baron S. Lonner

United States

Summary: The benefit of the routine use of anti-fibrinolytics during spinal fusion surgery for AIS is unclear. We found a significant reduction in blood loss but not transfusion rate with anti-fibrinolytics compared with placebo. Mean arterial pressure during exposure appears to play a crucial role in the efficacy of anti-fibrinolytics.

Introduction: Anti-fibrinolytics have been proven effective in reducing intra-operative blood loss in several settings. However, their value in Adolescent Idiopathic Scoliosis (AIS) remains unclear. No previous study has compared tranexamic acid (TXA), epsilon aminocaproic acid (EACA), and placebo in regards to their ability to limit operative blood loss, post-operative drain output, and transfusion rate.

Methods: This is a prospective, randomized, double-blind comparison of TXA, EACA and placebo used intra-operatively in patients with AIS. 119 AIS patients were randomly assigned to TXA, EACA, or control. TXA was given at 10mg/kg loading dose followed by 1mg/kg-hr, while EACA was given at a 10 fold higher dose. Data recorded included estimated blood loss (EBL), hematocrit, blood product usage, post-operative drain output, and total blood loss (EBL+ drain output).

Results: 119 patients were randomized to TXA (n=35), EACA (n=38), or placebo (n=46). There were 93 females and 26 males, average age 15. Most pre-operative characteristics were similar, however saline patients had significantly greater height, weight, and estimated blood volume vs TXA ($p<0.05$). TXA patients had significantly lower hematocrit at anesthesia start vs saline (33.2 vs 35.7, $p<0.05$). There was no difference in transfusion rate, operative time, levels fused, or anchors placed. When controlling for mean arterial pressure (MAP) during exposure, TXA reduced EBL vs saline ($p<0.05$), and reduced total blood loss, total blood loss per anchor, and total blood loss per degree of curve vs saline ($p<0.05$). EACA reduced EBL per anchor vs saline in patients with reduced mean exposure MAP ($p<0.05$). Neither TXA nor EACA reduced EBL or total blood loss in patients with mean exposure MAP >75. While total drain output was not reduced for TXA or EACA vs saline, TXA showed reduced drain output per anchor and degree curve ($p<0.05$) compared to saline.

Conclusion: Our results suggest that anti-fibrinolytics safely reduce blood loss in patients with AIS. However, transfusion rates were not impacted. Mean arterial pressure during surgical exposure appears to be a critical factor in the efficacy of anti-fibrinolytic action.

2. Preoperative Vitamin D Status in Adults Undergoing Spinal Fusion Surgery

Geoffrey E. Stoker, BS; Jacob M. Buchowski, MD, MS; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; K. Daniel Riew, MD; Lukas P. Zebala, MD

United States

Summary: Serum 25-hydroxyvitamin D levels were measured in 262 consecutive adults undergoing spinal fusion. The prevalence of inadequacy (<32 ng/mL) was 65%. Deficiency (<20) was documented in 27%.

Introduction: Vitamin D plays a pivotal role in mineral homeostasis and bone health. Deficiency in the hormone predisposes to fracture and pseudarthrosis. It can also lead to bone pain and muscle weakness, which may translate into higher VAS, NDI, and ODI scores. To our knowledge, the prevalence of preoperative vitamin D deficiency has yet to be investigated in a dedicated adult spine surgery population.

Methods: Serum 25-hydroxyvitamin D levels were measured prospectively in 262 consecutive adults undergoing spinal fusion at a single institution. There were no initial exclusion criteria.

Results: The mean age and BMI of the population were 55.2±12.9 years and 28.7±5.8 kg/m2, respectively. Of the 262 patients, 55% were female, 94% were white, and 4.6% were black. There were 44% cervical, 38% thoracic, and 53% lumbar fusions. The mean vitamin D level was 28.6±13.0 ng/mL. The overall rates of vitamin D inadequacy (<32) and deficiency (<20) were 65% and 27%, respectively. As expected, there were significantly higher rates of obesity (BMI≥30; $p=0.025$), black race ($p=0.005$), and smoking ($p=0.023$) in the vitamin D-inadequate subset. The mean VAS pain score was higher ($p=0.024$) and neurologic deficits were more prevalent ($p=0.094$) in this group as well. We generated a composite disability measure by pooling NDI and ODI scores of cervical and thoracolumbar patients, respectively. Upon excluding 57 patients with previous vitamin D or multivitamin supplementation, the mean pooled NDI and ODI score was significantly higher in the inadequate cohort ($p=0.003$).

Conclusion: Our investigation revealed an alarming high rate of vitamin D abnormality in the analyzed population. While certain previously identified risk factors were confirmed, validated indices of spine-related disability were higher in the presence of hypovitaminosis D.

Significance: Since augmenting serum vitamin D is easy and inexpensive and vitamin D deficiency may predispose to fracture and pseudarthrosis, we advocate vitamin D supplementation in patients with hypovitaminosis D.

Paper Abstracts

	N	Adequate	N	Inadequate	P*
Total population					
Male	93	40.9%	169	46.7%	0.367
Age (years)	93	56.3 ± 14.3	169	54.7 ± 12.1	0.256
Obesity (BMI ≥30)	93	30.1%	169	45.0%	0.025
BMI (kg/m²)	93	27.1 ± 5.1	169	29.6 ± 5.9	0.001
Black race	93	0.0%	168	7.1%	0.005
Smoking†	91	12.1%	169	24.3%	0.023
Prior spine surgery	93	51.6%	169	46.2%	0.439
Nonunion	93	15.1%	169	14.2%	0.856
Fracture	93	2.2%	169	7.1%	0.148
BMD (g/cm²)	24	1.1 ± 0.3	26	1.0 ± 0.3	0.032
Neurologic abnormality	93	39.8%	169	50.9%	0.094
VAS (0-10)	90	6.7 ± 2.4	158	7.4 ± 2.1	0.024
NDI/ODI (0-100)	80	41.7 ± 17.1	138	45.3 ± 18.3	0.201
Modified population‡					
Age (years)	56	53.4 ± 15.5	149	54.2 ± 12.2	0.996
BMI (kg/m²)	56	26.7 ± 4.6	149	29.5 ± 5.7	0.001
BMD (g/cm²)	12	1.2 ± 0.3	21	1.0 ± 0.2	0.007
VAS (0-10)	54	6.4 ± 2.7	138	7.5 ± 2.0	0.014
NDI/ODI (0-100)	44	36.9 ± 16.5	122	46.1 ± 17.3	0.003

*Fisher's exact and Mann-Whitney U tests.
†Habitual smoking within 6 months prior to surgery.
‡After excluding 57 patients with prior vitamin supplementation.

Characteristics of Patients with Adequate and Inadequate Vitamin D Levels

3. Clinical Outcomes and Complications of Posterior Vertebral Column Resection (PVCR) for Severe Adult Spinal Deformity

Woo-Kie Min, MD, PhD; Lawrence G. Lenke, MD; Yutaka Nakamura, MD, PhD; Dong-Ho Lee, MD, PhD; Moon Soo Park, PhD; Brenda A. Sides, MA

Korea, Republic of

Summary: 44 consecutive PVCRs were reviewed in the treatment of severe adult spinal deformity. Patients had overall favorable radiographic and clinical outcomes with only one (2.3%) major neurologic deficit. Patients with no obtainable SCM data appear to be at higher neurologic risk.

Introduction: The safety and efficacy of a posterior vertebral column resection (PVCR) procedure in severe pediatric spinal deformity has been recently reported, but less is known regarding the outcomes of PVCR in the adult population. We performed a retrospective review of radiographic and clinical outcomes and complications of PVCR in the treatment of severe adult spinal deformity.

Methods: 44 consecutive adult pts (mean age, 36.4 years; range, 18-73) who underwent PVCR between 2005 and 2009 by 1 surgeon were reviewed. There were 23 primary/21 revision surgeries. There were 34 one-level, 7 two-level and 3 three-level resections. Pts were divided into 4 diagnostic categories: (1) severe scoliosis (SS) (n=5; mean 108°; range 78-150°; avg flexibility 19%); (2) global kyphosis (GK) (n=14; mean,102°; range 70-125°; avg flexibility 23%); (3) angular kyphosis (AK) (n=12; mean 84°; range 40-150°; avg flexibility 24%); (4) kyphoscoliosis (KS) (n=13; mean kyphosis 105°/ scoliosis 89°; mean combined 193°; range 98-305°). 37 pts had a min 1-yr follow-up (FU) and 24 a min 2yr FU.

Results: The avg major curve correction: Group SS=62°/59%, Group GK=51°/51%, Group AK=52°/67% and Group KS=108°/56%. The avg OR time was 620min (range, 304-1100), with an avg EBL of 2228mL (range, 650-8200). 2 pts (4.5%) lost spinal cord monitoring (SCM) data, which returned to baseline following prompt surgical intervention. 1 pt (2.3%) had severe preop myelopathy with no obtainable SCM data, and awoke with a motor paraplegia with slow improvement. 5 pts (11.37%) had revision surgery: implant failure/pseudarthrosis (n=3), deep infection (n=1) and spinal imbalance (n=1). There were no deaths but 1 pt had thoracic aorta injury intraoperatively, immediately treated with an endovascular graft, and aborted VCR. SRS scores were significantly improved at the final FU: self-image ($p<0.001$), satisfaction ($p<0.001$), mental health ($p=0.02$), avg subscore ($p<0.001$) and normalized total score ($p<0.001$).

Conclusion: A PVCR is a technically demanding procedure, effective in the treatment of severe adult spinal deformities with favorable clinical and radiographic results. However, ancillary staff, including intraop SCM expertise is essential. Pts with no obtainable SCM appear to be at higher neurologic risk.

4. Can Less Invasive Lateral Interbody Fusion with Transpsoas ALL Release (LIFTAR) Replace Three Column Osteotomy for Correction of Adult Focal Sagittal Plane Deformity?

Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Payam Moazzaz, MD; Nima Kabirian, MD; Ramin Bagheri, MD; Robert K. Eastlack, MD; Jeff Pawelek

United States

Summary: Eight consecutive patients with focal sagittal malalignment underwent ALL release in addition to less invasive LIF. The mean segmental correction achieved in one level was 31° resulting in 26° mean correction of lumbar lordosis. Less invasive LIF with ALL release (LIFTAR) can be a safe technique achieving radiographic correction similar to a 3-column osteotomy.

Introduction: Restoration of sagittal alignment is essential to obtain and preserve desirable outcomes in adult spinal deformity surgery. Perioperative morbidity of traditional osteotomies was the main trigger to explore less invasive sagittal realignment surgery. A technique was developed which included a safe and reproducible method to resect the anterior longitudinal ligament from a lateral transpsoas approach through the disc space for focal sagittal deformity (FSD) correction.

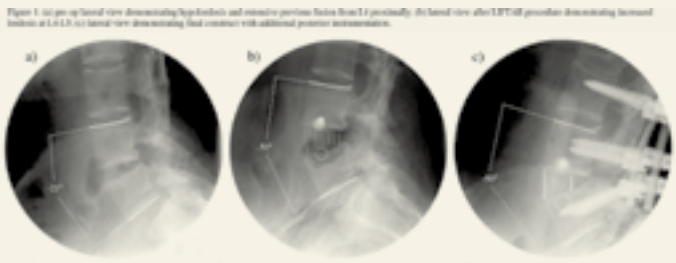
Methods: Adults (F=6, M=2) who underwent LIFTAR for FSD between 2005 and 2010 were retrospectively reviewed. Eight patients were identified. Demographic and radiographic data collected including pre-op, post-op, final FU and segmental and global radiographic parameters. All patients had posterior supplemental fixation in addition to LIFTAR. Complications were recorded.

Results: Mean age at surgery was 53 yrs (35-70) with mean FU of 17.5 months. Pre-op segmental Cobb averaged 6.4° (-21° to 37°) and corrected to -26.7° post-op and -25° at final F/U with a 31.4 degree improvement. Pre-op lumbar lordosis (LL) was -21° correcting to -47° immediate post-op and maintained -47° at final FU, a mean improvement of 26°. The mean final SVA improved from 90 to 66 mm. No perioperative vascular or neurologic injuries were observed. EBL averaged 21 cc. One infection, 1 upper instrumented

Paper Abstracts

vertebrae fracture and 1 anterior cage migration after a fall (all unrelated) were observed.

Conclusion: Single level ALL release via LIFTAR is a safe and effective technique averaging 31° of FSD correction. Our results compare favorably with historic radiographic correction obtained with a 3 column osteotomy. This approach, though technically demanding, has the potential to lower perioperative morbidities and blood loss associated with posteriorly based osteotomies such as PSO. Adherence to details of surgical technique is of paramount importance to avoid complications, especially neurovascular injuries.



5. The Effect of Surgery on Health Related Quality of Life and Functional Outcome in Patients with Metastatic Epidural Spinal Cord Compression- Initial Results of the AOSpine North America Prospective Multicenter Study

Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Alexander R. Vaccaro, MD, PhD; Paul Arnold; Charles G. Fisher, MD, MHSc, FRCSC; Ziya L. Gokaslan, MD; James Schuster, MD, PhD; Mark B. Dekutoski, MD; Joel Finkelstein, MD FRCSC; Laurence Rhines

Canada

Summary: This prospective study shows that surgery improves pain and functional outcomes in patients with MESCC.

Introduction: Studies suggested that combined surgery and radiotherapy provides optimal neurological recovery in patients with epidural spinal cord compression (MESCC). The impact of surgery on functional and quality of life outcomes is less clear.

Methods: To date, 84 patients with solitary symptomatic MESCC were enrolled in a prospective multi-center, ongoing cohort study. Patients were followed for 12 months.

Results: The average age was 58 years (SD 11, range 31 – 82) with 60% males. Common primary sites were lung (29%), breast (12%), prostate (10%), kidney (8%), other genitourinary (7%) and, unknown (13%). Baseline Visual Analog Pain (VAS) level was 6.1 (SD 2.4); the ODI was 62 (SD 22); the SF36v2 Physical Component Score (PCS) was 32 (SD 7.6) and, the EQ-5D was .37 (SD .27). Only 38% of the subjects had normal ASIA motor impairment grade "E"; 39% had grade "D"; 18% "C", 3% "B" and, 3% "A".

Median survival was 200 days (95% CI 118—381 days). 39% survived 12 months. Survival was strongly associated with the site of the primary neoplastic disease ($P < .05$). About 66% of patients with breast cancer and only 14% of patients with lung cancer survived 12 months. Median survivals were 569 and 120 days in the breast and lung cancer groups, respectively.

Patients who survived 3 months experienced significant improvement in pain, function and health utility. At 3 months, Pain VAS improved for 2.7 (SD 3.3, $P < .05$) and, ODI for 26 (SD 24; $P < .01$) and EQ5D .27 (SD .24. $P < .01$), The improvement in SF36v2 PCS was 3.5 (SD 10.7) but not statistically significant ($P = .09$). The gains in EQ5D, ODI and VAS Pain were maintained in patients who survived 6 months.

Conclusion: Surgically treated patients with MESCC are a diverse group of patients with different prognoses. Survival prognosis is associated with type of primary cancer with lung cancer being associated with the poorest prognosis and breast cancer with the best. The surviving patients experience clinically relevant symptoms improvement and gains in function and utility. Our analysis supports use of surgery in patients with survival expectancy of 3 months or more.

6. Balloon Kyphoplasty Improves Quality of Life, Bodily Pain and Vertebral Body Height Among Cancer Patients with Vertebral Compression Fractures Compared to Non-Surgical Management: Results from a Multicenter, Randomized Trial

Frank D. Vrionis, MD, PhD; Ioannis Papanastassiou, MD; Robert Pflugmacher; James R. Berenson, MD; Jeffrey Zonder; John Tillman, PhD; Kenneth Schechtman, PhD; Leonard Bastian, MD; Talat Ashraf, .MD, MS; Peter Jarzem, MD

United States

Summary: Whereas RCTs suggest the superiority of BKP over conservative management in osteoporotic fractures, no randomized trials exist in cancer patients. This RCT shows that patients with cancer-related VCFs treated with BKP show marked, statistically significant improvement in QOL at one month compared to NSM. BKP vertebral body height restoration was also statistically significant in the transition zone. Subsequent fracture rate was similar between groups and no serious complications were related with the procedure.

Introduction: Balloon kyphoplasty (BKP) has been successfully employed in the treatment of vertebral compression fractures (VCFs). Here we present data from the first randomized trial evaluating BKP in a cancer population.

Methods: Adult patients with multiple myeloma or cancer and < 3 painful VCFs (VAS ≥ 4) were randomly assigned to BKP (N=70) or non surgical management (NSM) (N=64) at 21 international centers. Patients had an average age of 64 years, 58% were female and 62% had cancer or multiple myeloma (38%). Patients were excluded if they had primary bone or osteoblastic tumors, solitary plasmacytoma or spinal cord compression. Randomized 1-month results are modified intent-to-treat. Patients were followed for 12-months but NSM patients

Paper Abstracts

were allowed to cross-over after the first 1 month; thus, 12-month data are reported as treated. The 8 subscales of the SF-36 quality of life questionnaire and height restoration were analyzed; procedure-related serious adverse events (SAE) are also described.

Results: BKP patients showed statistically significant improvement in all SF-36 subscales at 1-month whereas the NSM group did not improve in any subscale ($p<0.0001$). After the 1-month evaluation, 59% of NSM patients crossed over and underwent BKP; those continuing NSM did not have improvement in any SF-36 subscale. For the original BKP group and BKP crossovers, the 1- and 12-month post-procedure improvement for all SF-36 subscales were statistically significant ($p<0.0001$). At 1-month, as randomized, BKP resulted in statistically significant mid-vertebral body height restoration in transition zone fractures (2.4mm; $p<0.0001$) while NSM resulted in vertebral body height loss (-0.7mm; $p=0.028$); the BKP treatment effect was 3.1 mm (95% CI, 2.1-4.1; $p<0.0001$). BKP vertebral body height gain was 1.8mm ($p=0.03$) at 12 months. There was no difference in subsequent radiographic VCF rates between BKP and NSM at 1 month, as randomized.

Conclusion: This randomized study shows that patients with cancer-related VCFs treated with BKP show marked, statistically significant improvement in QOL at one month compared to NSM. BKP vertebral body height restoration was also statistically significant in the transition zone.

7. The AOSpine North America Cervical Spondylotic Myelopathy Study: Perioperative Complication Rates Associated with Surgical Treatment Based on a Prospective Multicenter Study of 302 Patients

Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Paul Arnold; S. Tim Yoon; Alexander R. Vaccaro, MD, PhD; Darrel S. Brodke, MD; Michael Janssen, DO; Jens R. Chapman, MD; Rick C. Sasso, MD; Eric J. Woodard, MD; Robert Banco; Mark B. Dekutoski, MD; Ziya L. Gokaslan, MD

United States

Summary: The AOSpine North America cervical spondylotic myelopathy (CSM) study is a recently completed prospective multicenter study of 302 patients surgically treated for CSM. The overall perioperative complication rate was 24% (8% major, 16% minor). The most common complications included: cardiopulmonary (3.3%), infection (3.0%), dysphagia (3.0%), C5 radiculopathy/palsy (1.7%), worsened myelopathy (1.3%), and new radiculopathy other than C5 (1.0%). These data demonstrate a remarkably low rate of neurological complications, with the vast majority of complications being treatable and without long-term impact.

Introduction: Cervical spondylotic myelopathy (CSM) often warrants surgical treatment. Our objective was to assess complication rates associated with the surgical treatment of CSM based on a prospective multicenter study.

Methods: The AOSpine North America CSM study is a recently completed prospective multicenter study of patients surgically treated for CSM. Standardized forms were used to collect clinical and surgical data. Perioperative complication rates (within 30 days of surgery) were assessed.

Results: A total of 302 patients (178 men/124 women) were enrolled, with a mean age of 57 years (range: 29-86). Surgical approaches included anterior-only (n=176, 58%), posterior-only (n=107, 35%), and combined anterior-posterior (n=19, 6%). Fusion, laminoplasty, and corpectomy were performed in 85%, 13%, and 18% of cases, respectively. Of 332 reported adverse events, 73 were adjudicated to be complications, including 25 major (8%) and 48 minor (16%). The most common complications included: cardiopulmonary events (3.3%), infection (7 superficial/2 deep, overall 3.0%), dysphagia (3.0%), C5 radiculopathy/palsy (1.7%), worsened myelopathy (1.3%), new radiculopathy other than C5 (1.0%), epidural/wound hematoma (1.0%), instrumentation malposition/migration (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%). Single cases of death, stroke, re-operation (not otherwise specified), thromboembolism, wound dehiscence, worsened neck pain, and pneumonia were reported. Ten miscellaneous complications were documented.

Conclusion: These data provide benchmark rates for perioperative complications associated with the treatment of CSM and demonstrate a remarkably low rate of neurological complications, with the vast majority complications being treatable and without long-term impact.

8. Lessons Learned on Cervical Total Disc Replacement after Seven Years Follow-Up

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Brazil

Summary: Here we point out to the success and the complications after our 7 years experience with PCM total disc replacement. Besides occurrence of facet degeneration, bone formation and prosthesis overhang, the data in CTDR has reveled valuable clinical and radiological data when compared to ACDF.

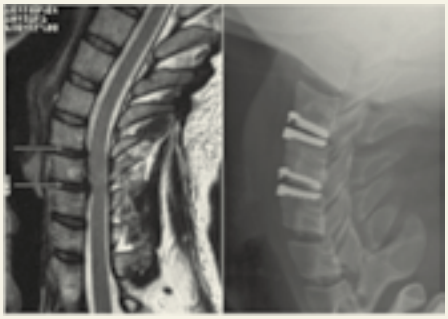
Introduction: Cervical spine fusion was well adopted since the 1950s to stabilize, treat degenerative changes and reduce deformity. Various studies demonstrate that single-level ACDF do alter spinal kinematics and compromise global spinal motion. Along with critical clinical and scientific overview, arthroplasty technology was developed to maintain movement and reduce adjacent segment stress and degeneration.

Methods: We studied radiographs of 270 levels in 158 patients (mean age 45.4 y/o) treated in cervical levels between C3-4 and C7-T1. 74 patients were operated at one disc level, 62 at two, 16 at three, and 6 at four levels. Radiological and clinical outcomes were collected preoperatively, 1 week and 1, 3 and 6 months and annually. The NDI and VAS questionnaires were used to assess pain and functional outcomes. The McAfee scale for heterotopic bone formation evaluation was applied. For facet degeneration analysis, was used a four grade scale based on CT Scans.

Paper Abstracts

Results: The clinical outcomes significantly improved in all postoperative. Using the four grade facet degeneration classification, the majority of patients evolved with grade I and II, and for these cases there wasn't clinical worsening, differently for cases with grade III and IV. Among studied levels, 21(7.7%) revealed some level of HO: 10 grade I levels (47.6%), 7 grade II (33.3%), 3 grade III (14.28%) and 1 grade IV (4.76%). In 92% of patients that developed HO, preoperative radiographs showed incipient osteophytes. Adjacent level disease occurred in 5.7% of patients, lower than the 20.3% described by Hilibrand et al for ACDF (2.9% a year).

Conclusion: Motion preservation allowed a better biomechanical restoration of the spine, unloading the facets and preserving the adjacent discs. The good clinical results also corroborate with the superiority of CTDR in comparison to ACDF results described on the literature.



9. Technique of Cervicothoracic Junction Pedicle Subtraction Osteotomy for Cervical Sagittal Imbalance: Report of 11 Cases

Vedat Deviren, MD; Justin K. Scheer, BS; Christopher P. Ames, MD

United States

Summary: 11 patients underwent a modified cevicothoracic pedicle subtraction osteotomy (PSO) for sagittal imbalance. Excellent correction was achieved with improved patient HRQOL scores and no neurological complications.

Introduction: Historically, the Smith-Peterson osteotomy has been used to restore sagittal balance. Cervicothoracic junction (PSO) offers more controlled closure and greater biomechanical stability but is infrequently reported in literature. This study details the cervicothoracic PSO technique in 11 cases with modifications from the current literature.

Methods: From 2/08 to 9/10, 11 patients underwent PSO (10 at C7, 1 at T1) for sagittal imbalance. Pre- and postoperative sagittal plane radiographic measurements were made. Chin-brow-vertical angle (CBVA) was measured on clinical photographs. Operative technique and perioperative correction was reported for all 11 patients and 9/11 patients were reported for long term follow up. Outcomes used for 9/11 patients were Neck Disability Index (NDI), SF36, Visual Analogue Pain Scale (VAS) and CT at min 1yr follow up.

Technique: Following instrumentation, facet release and C6-C7 and C7-T1 facet removal were performed. The C7 and C8 nerve roots were identified and traced out the foramen. The osteotomy was carried out laterally and the C7 pedicle was isolated. The lateral wall of the C7 vertebral body was then dissected out with a with a Penfield 1 retractor and visualized to the anterior vertebral body margin. The C7 pedicle was skeletonized and removed with a Lempert-Leksell. Sequential lumbar taps were used to decancellate the C7 vertebral body; osteotomes and down-pushing curettes were used to attempt a 30° wedge as a starting point. The C7 lateral wall, then medial column, were removed. The head was loosened from the table and the Mayfield was then used to lift the head and close the osteotomy.

Results: Results are averages (n=11): age-70yrs, estimated blood loss-1100cc, surgical time-4.3hrs, hospital stay-9.9 days, follow-up time for 9/11 patients-23mo, preop cervical sagittal imbalance-7.9±1.4cm, immediate post-op-3.4±1.7cm, overall correction-4.5±1.5cm (42.8%), PSO correction-19.0deg, CBVA correction-36.7deg. NDI (51.1 to 38.6, p=0.03) and VAS (8.1 to 3.9, p=0.0021) decreased significantly. PCS increased by 18.4% (30.2 to 35.8) with no neurological complications.

Conclusion: The cervicothoracic junction PSO is a safe and effective procedure for the management of cervicothoracic kyphotic deformity.

10. Would CoCr Rods Provide Better Correctional Forces than Stainless Steel or Titanium for Rigid Scoliosis Curves?

Devdatt Mhatre; Peter O. Newton, MD; Paul A. Giorgio; Peter Sturm, MD; Hassan Serhan, PhD

United States

Summary: While rigid rods have the ability to exert high forces on the spine, they also have the highest potential of plastic deformation. Ti may continue to apply correction forces on the spine after the construct is in place, however, the speed of fusion will overcome these forces and render the rods ineffective. CoCr rods have the ability to achieve the best intraoperative correction otherwise anterior releases might be required.

Introduction: The ability of the rod to achieve and hold the correction is a key factor while selecting rod material in the scoliosis surgery. In this study we've attempted to determine 1) if rods retain their shape after implantation into rigid spine, 2) loads that different rod materials (SS, Ti and CoCr) can produce on the spine.

Methods: In the 1st experiment, rods were pre-contoured to various tangential angles and reduced sequentially onto unilateral rigid block simulating 11 segmental spinal construct. Set screws were tightened until rod is fully seated, then loosened and the residual rod contour angle was measured, compared with original & analyzed for each material.

In the 2nd experiment pre-contoured rods were used to reduce onto the synthetic-rigid spine with load cell attached to the most apical screw. Load was measured and compared among the different materials.

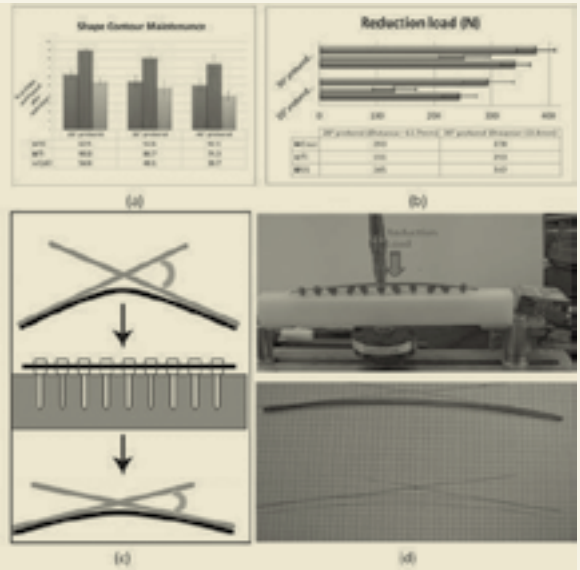
Results: All the rods deformed plastically, at 20°, only Ti rods were able to maintain almost 90% of their original curve. SS and CoCr rods deformed significantly at 20° and their % plastic deformation correlated to the degree of

Paper Abstracts

bend. For the 30° pre-bend CoCr rods, the intraoperative reduction force was 42% higher than the Ti and 10% than SS rods which significantly reduced by adding the screws in between the proximal end & reducing those screw first.

Conclusion: While rods with high rigidity have the ability to exert high forces on the spine, they also have the highest potential of plastic deformation in a highly rigid spine. Ti will continue to apply correction forces on the spine after the construct is in place, however, the speed of fusion will soon overcome these forces and render the Ti rods ineffective postoperatively. Hence CoCr rods, have the ability to achieve the best intraoperative correction and if correction with CoCr rods is not achieved, then anterior releases might be required. Therefore, determining curve flexibility and selecting of appropriate rod size & stiffness and or surgical releases should be considered in highly rigid curves.

Significance: This study quantifies the difference in the force generated by the three rod materials used in scoliosis surgery and shape retention of rods used for the correction of extremely rigid curves.



Figures (a) Shape contour maintenance comparison with different material rods at various pre-bend. (b) Rod reduction load comparison with different material and pre bend (c) Testing sequence for shape contour experiment (d) Reduction load determination set up and contour tracing.

11. Biomechanical Effectiveness of Three Types of Pedicle Screws for the Spinal Instrumentation of Adolescent Idiopathic Scoliosis

Xiaoyu Wang, PhD; Carl-Eric Aubin, PhD, PEng; Hubert Labelle, MD; Dennis Crandall, MD; Stefan Parent, MD, PhD

Canada

Summary: The biomechanical effectiveness of spinal instrumentation using Monoaxial (M), Polyaxial (P), and Six Degree Of Freedom post loading (6DOF) pedicle screws was assessed using patient-specific computer models of the same six AIS cases. Similar correction was obtained using the three screw types, however the resulting stresses on the constructs were influenced by the different kinematics of the vertebra-screw-rod connections. The loads exerted on the vertebrae were higher for the M, than the P, and the 6DOF screws. The 6DOF screws better distributed the loads and "forgave" imperfectly aligned/oriented screws, while M screws more likely caused over constraints and resulted in higher non-corrective loads.

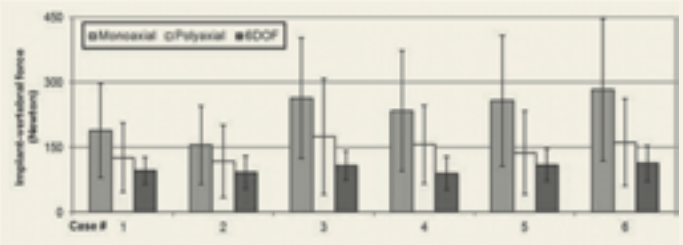
Introduction: Different pedicle screws are used in spinal instrumentation but their relative biomechanical effectiveness is questioned when considering recent correction techniques. The objectives were to biomechanically assess on the same cases three types of pedicle screws in terms of deformity correction, resulting loads, and sensitivity to screw placement variations.

Methods: Patient-specific biomechanical models were built using the 3D geometry and spine stiffness of 6 AIS patients who undergone a spinal instrumentation. The same instrumentation steps (attachment of the concave side rod; rod derotation; attachment of the second rod; vertebral derotation) were computationally simulated, each time using a different type of screw (M, P, or MDOF). For each case and screw type, 15 additional simulations were conducted while varying the screw tilt (±5°), insertion points (±1.5 mm) and screw height (±1.5 mm).

Results: Similar correction was obtained using the three screw types (average differences of 2.1° and 1.3° respectively for the main thoracic Cobb angle and the thoracic apical vertebral rotation), however the average loads exerted on the vertebrae were 227±129N, 140±94N, and 103±38N, respectively for the M, P, and 6DOF screws (Figure 1). Load variations due to screw placement modification were smaller and more equilibrated for the 6DOF screws, followed by the P screws, and ending with the M screws (Table 1).

Conclusion: Although the three tested screw types allow performing similar correction, the resulting stresses on the construct are influenced by the different kinematics of the vertebra-screw-rod connections. The 6DOF screws better distribute the loads and "forgive" imperfectly aligned/oriented screws, while M screws more likely cause over constraints and result in higher non-corrective loads.

Significance: Articulated (6DOF and P) screws are better suited to lower loads on the construct, and are more likely to reduce damage on the bone-screw interface or instrumentation failure.



Average loads applied by the three screw types on the vertebrae (6 AIS cases).

Paper Abstracts

12. Does Pedicule Screw Fixation Under Age Five Disrupt Vertebral Growth? A Computerized Tomography Study

Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Mehmet Tezer; Emre Karadeniz; Azmi Hamzaoglu, MD

Turkey

Summary: Pedicle screw instrumentation before age 5 does not cause spinal canal narrowing.

Introduction: The influence of pedicle crew fixation below age 5 on canal diameter is controversial. Animal studies consistently demonstrated development of canal stenosis after pedicle screw fixation. However 2 clinical studies from the same center reported normal canal development after pedicle screw fixation in small kids. In both clinical studies analysis were done by indirect x-ray findings or MRI studies which were not the optimum methods to determine the canal area. The aim of this retrospective study was to evaluate the growth of several anatomic landmarks of vertebrae in patients who had pedicle screw instrumentation under age 5 by using Computerized Tomography.

Methods: Thirteen patients (8 female, 5 male) who had been operated due to spinal deformity under age 5 and had preoperative and more than 2 years follow-up CT of operated and adjacent vertebral segments, were included. All patients had congenital scoliosis and underwent hemivertebrectomy and transpedicular fixation one above and one below at an average age of 3 (range; 2 to 4). Measurements were done on CT scans at the instrumented upper (UIV) and lower (LIV) vertebrae as well as the uninstrumented upper (UAV) and lower (LAV) vertebrae. Measurements included; anterior vertebral body height (AVBH), posterior vertebral body height (PVBH), cranial end plate length (CrEPL), caudal end plate length (CaEPL), spinal canal area (SCA), anteroposterior diameter of vertebral body (APD) and lateral diameter of vertebral body (LD). Growth ratio for each parameter was calculated as percentage of change between the preoperative and final follow-up measurements. Statistical analysis was done by using repeated measures of ANOVA to compare the growth ratios in each parameter for each level. A p value of less than 0.05 was set for significance.

Results: The average follow-up was 3.6 (range; 2 to 8) years. Eleven of the patients were over age 5 during the final CT examination while 2 were at age 4. Female to male ratio was 8 to 5. There was no significant differences in growth ratios of all parameters (Table).

Conclusion: This CT study showed that pedicle screw instrumentation before age 5 does not cause spinal canal narrowing.

Significance: -

13. Retrieval Analysis of Cervical Total Disc Replacements - A Study of In Vivo Wear, Surface Properties, and Fixation

Darren R. Lebl, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD; Samantha M. Lee; Timothy Wright, PhD; Celeste Abjornson, PhD

United States

Summary: Cervical total disc replacements(c-TDRs) have shown promising results compared to anterior cervical diskectomy and fusion(ACDF) procedures in prospective clinical studies. In this retrieval study of c-TDRs, pain and loosening were the predominant indications for explantation. Backside wear was not seen in explanted devices. Posterior metal-on-metal impingement may indicate anterior placement of the c-TDR center of rotation. Precise matching of the c-TDR center of rotation to the physiologic center of rotation may minimize impingement and optimize clinical outcomes.

Introduction: To determine the mechanical performance of c-TDRs in vivo, we performed a prospective analysis of retrieved devices to examine for evidence of wear, surface damage, and bony fixation.

Methods: Explanted ProDisc-C® TDRs were cleaned and catalogued according to an IRB-approved retrieval program. Polyethylene(PE) and metallic(CoCrMo) components were examined using light stereo-microscopy(6X-31X) and areas of interest by SEM.

Results: 29 c-TDR's from 28 patients of age 44.7±1.7yrs(range 31-57) were studied after a mean implantation time of 378±66days(range 2-1,295). The operative level was C4-C5 in 20.5%(n=6),C5-C6 in 45%(n=13),C6-7 in 20.5%(n=6), and not reported in 14%(n=4). Indications for revision were axial pain(n=8), radicular symptoms(n=6), atraumatic loosening(n=6), traumatic loosening(n=5), unknown(n=1), hypermobile spinal segment(n=1), metal allergy(n=1), and myelopathy(n=1).

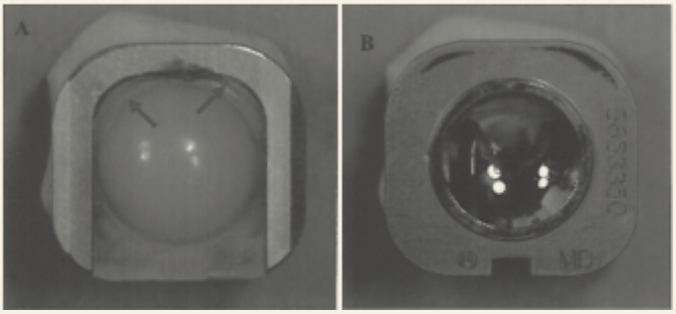
Bone ongrowth was present on the Ti plasma-sprayed coating of the superior component in 69%(n=20) and the inferior component in 55%(n=16). Ongrowth was seen on both components in 41% (n=12), 1 component in 41% (n=12), and neither component in 17% (n=5).

Evidence of impingement was seen in 96% of implants(n=28); impingement of the CoCrMo endplates was seen in 86%(n=25) and on the polyethylene insert in 17%(n=5). Impingement was on the posterior aspect in 48%(n=14), the anterior aspect in 31%(n=9), and circumferential in 24%(n=7). Backside wear was not observed on any of the disassembled implants(n=16). Wear consistent with 3rd body wear was observed in 21%(n=6).

Conclusion: Motion was maintained in vivo by c-TDRs and endplate impingement occurred in the majority of patients that required revision surgery. Posterior metal-on-metal impingement was the most common pattern. Backside wear was not a common pattern. Pain and loosening were the predominant indications for explantation.

Paper Abstracts

Significance: Anterior placement of the c-TDR center of rotation may result in posterior impingement in extension during a physiologic range of motion. Long-term follow-up studies will determine the clinical significance of metal-on-metal impingement in c-TDR's.



14. Biocompatibility of CFR-PEEK Particle Debris in Epidural Space

Koroush Kabir, MD

Germany

Summary: CFR-PEEK particles shows a greater biocompatibility compared to PEK and UHMWPE in the cervical epidural space in a model to simulate the biological consequences of wear debris after Total Disc Arthroplasty.

Introduction: One of the goals in designing new implants in Total disc arthroplasty (TDA) is to use materials with low wear rate-behaviour, which produces wear debris with low biological activities. Our goal was to compare the biological response of carbon fibre reinforced PEEK(CFR-PEEK), Polyetherketone (PEK) and Ultra High Molecular Weight Polyethylene (UHMWPE) wear debris in epidural space.

Methods: Forty eight female rabbits were randomly allocated to 4 groups: CFR-PEEK, PEK, UHMWPE-particles and sham. The particles were implanted into the epidural space of the cervical region by percutaneous technique (fluoroscopic guidance). Neurobehavioral observations were conducted at pretreatment, on day 1-14 postinjection, then weekly. Blood sample were collected and evaluated pretreatment and at 3 and 6 months postintervention. The rabbits were sacrificed at 3 and 6 months. Histologic sections from the regional lymph nodes, organs, from remote and implantation sites, were analyzed for any abnormalities and inflammation.

Results: Expect of five animals, non of the animals showed any neurological or musculo-skeletal abnormality. The neurological deficits presented immediately after injection and did not progress. Blood results from predeath samples were consistent with preoperative blood work values. There was no evidence of systemic toxicity. Regardless of the implantation time, all particles remained at the implantation site. The inflammation was limited to the epidural space around the particles. PEEK and UHMWPE showed similar biological reactivity. CFR-PEEK demonstrated less biological reactivity compare to PEEK and UHMWPE.

Conclusion: The biological response to PEK and UHMWPE were comparable. CFR-PEEK particles showed a greater biocompatibility than UHMWPE with reduced inflammatory response in cervical epidural space. In past studies, CFR-PEEK demonstrated an excellent wear behaviour with a wear rate reduction in comparison to UHMWPE in in vitro studies. Therefore CFR-PEEK based articulations provide an viable alternative to UHMWPE on metal and have a high potential for next generation disc replacements.

15. Cartilage Biomarkers in Degenerative Lumbar Scoliosis

Naobumi Hosogane, MD; Kota Watanabe; Takashi Tsuji; Takeshi Miyamoto; Ken Ishii, MD, PhD; Yasuo Niki, MD; Masaya Nakamura; Yoshiaki Toyama; Kazuhiro Chiba, MD, PhD; Morio Matsumoto, MD

Japan

Summary: Serum levels of keratan sulfate, cartilage oligomeric matrix protein (COMP) and procollagen type II C-propeptide (CPII) were significantly higher in degenerative lumbar scoliosis (DLS) patients. There was a significant positive correlation between Cobb angle and CPII in DLS group. This study suggests that synthesis and degradation of type II collagen are promoted in DLS patients which may be related to development and progression of DLS.

Introduction: Degenerative lumbar scoliosis (DLS) develops following degeneration of intervertebral discs and facet joints. Several biomarkers have been used for the evaluation of osteoarthritis of limb joints.

In this study, we assessed the serum cartilage metabolites to evaluate whether they can serve as biomarkers for DLS.

Methods: Thirty DLS patients over 40 years of age (mean 66.0 yrs) with Cobb angle > 10° were included in this study. Mean Cobb angle was 26.5° (11.7 to 62.3°). Fifteen patients with spinal diseases other than deformity (Cobb angle <10°, mean 63.4 yrs) served as controls. Blood samples were collected after obtaining their informed consent.

Serum level of hyaluronic acid (HA) was measured by enzyme-linked binding protein assay, keratan sulfate (KS) by HPLC and cartilage oligomeric matrix protein (COMP), collagen type II cleavage (C2C) and procollagen type II C-propeptide (CPII) with ELISA.

The degree of osteoarthritis change of the lumbar spine was assessed using Kellgren Lawrence grade. The statistical analysis was conducted using unpaired-T test and Mann-Whitney test.

Results: Serum levels of KS (DLS 1.24 ± 0.39 vs. control 0.85 ± 0.35 μg/ml), COMP (DLS 715.2 ± 321.2 vs. control 435.5 ± 158.7 ng/ml) and CPII (DLS 2215.2 ± 822.9 vs. control 1662.3 ± 703.2 ng/ml) were significantly higher in DLS group than the control group. There were no significant differences in serum levels of HA (DLS 59.5 ± 30.2 vs. control 50.5 ± 26.3 ng/ml) or C2C (DLS 223.6 ± 40.8 vs. control 216.0 ± 54.8 ng/ml). There was a significant positive correlation between Cobb angle and CPII in DLS group (R=0.62). Kellgren Lawrence grade of the lumbar spine was significantly higher in DLS group than the control group (DLS 3.5 ± 0.6 vs. control 1.9 ± 0.8), and had significant positive correlation between CPII (R=0.40) and COMP (R=0.32).

Paper Abstracts

Conclusion: This is the first study that evaluated the cartilage biomarkers in DLS patients. This study suggests that synthesis and degradation of type II collagen are promoted in DLS patients as indicated by the increase in serum CPII and COMP, respectively. As type II collagen is a major component of collagens in nucleus polposus and facet joint cartilages, its enhanced turnover may be related to development and progression of DLS.

16. Can Monitoring Spinal Cord Blood Flow (SCBF) Identify Pre-Injury State During Surgery? A Porcine Study Correlating MEP's with LASER Doppler Measurements

Vishal Sarwahi, MD; Adam L. Wollowick, MD; Seth A. Grossman, MD; Terry D. Amaral, MD; Farzin Kabaei, MD; Etan P. Sugarman, MSIV; Christian Keller, MD; Alan Legatt, MD, PhD

United States

Summary: This study is the first to demonstrate the existence of a pre-injury state. LASER Doppler blood flow measurements are a reliable and reproducible method to document evolving spinal cord injury.

Introduction: Spinal cord injuries during spinal surgery most commonly occur during cord manipulation or from iatrogenic compression due to misplaced hardware. Ischemia and reperfusion of the spinal cord play a significant role in both pathogenesis and functional outcome. Measuring spinal cord blood flow in real time may detect impending spinal cord injury. The objective of this study was to determine the effect of compressive spinal cord injury on spinal cord blood flow and to correlate circulatory disturbances with trans-cranial motor evoked potential signals.

Methods: Seven farm-raised pigs were studied. An inflatable, balloon catheter with pressure monitor was used in the mid-thoracic spine to apply gradual compression to the spinal cord. Dual channel LASER doppler leads were placed posteriorly and laterally on the dura, immediately caudal to the level of compression. The balloon was inflated in 0.55 cc increments at 5 minute intervals until MEP's decreased to less than 90%. Continuous TcMEP, SCBF, and ABP monitoring was carried out. Thirty minutes after the MEP changes were seen, a wake-up test was performed, the animal was sacrificed, and a spinal cord biopsy was obtained.

Results: Two animals died during intubation. Between 6 to 9 psi, a 30% increase in the spinal cord blood flow was seen on the posterior leads while MEP remained at baseline. Significant decrease in MEP's occurred around 11 psi and corresponded to a 50% decrease in spinal cord blood flow on both posterior and lateral leads. MEPs did not return and the wake-up test was unsuccessful in all five pigs. Spinal cord histopathology showed eosinophillic infiltrates and microhemorrhages consistent with acute ischemia.

Conclusion: Real time SCBF measurement corresponds well with changes in MEPs. In the presence of cord compression, the LASER Doppler can detect spinal cord injury earlier than MEPs. This pre-injury, hyperemic state can provide the operating surgeon with an opportunity to intervene before complete spinal cord injury occurs.

Significance: Real time SCBF monitoring with LASER doppler allows for detection of a pre-injury state. Awareness of this time period has the potential to significantly impact the safety of complex spine surgery.

17. Capacitive Coupling Reduces Instrumentation Infection in a Rabbit Spine Model

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United States

Summary: The bioelectric effect is explored in an in vivo rabbit spine infection model. A low current helps detach biofilm making bacteria more susceptible to antibiotics. A capacitive coupling device delivered an alternating current to the infection bed. Results showed decrease hardware infection rate but no effect on the soft tissues.

Introduction: Postoperative spine infections are a taxing complication and cause significant morbidity. Patients are subjected to long-term antibiotics and often revision surgery with instrumentation removal. Electrical current through hardware detaches biofilm allowing antibiotic penetration. Capacitive coupling delivers a safe dose of alternating current through non-invasive electrodes. We hypothesized that capacitive coupling in addition to antibiotics would decrease infection rate compared to antibiotics alone.

Methods: Thirty rabbits were subjected to a well established spine infection model with systemic ceftriaxone prophylaxis. Two noncontiguous titanium rods were implanted inside dead space defects at L3 and L6. All sites were challenged with 10e6 colony forming units of Staphylococcus aureus. Rabbits were then randomly treated with either a capacitive coupling or control device. The capacitive coupling field encompassed both of the noncontiguous sites. Both instrumentation and soft tissue bacterial growth was assessed after 7 days using a standardized quantification techniques

Results: Capacitive coupling treated sites showed a statistically significant decrease in titanium rod infection. The incidence of capacitive coupling treated hardware infection was 36% compared with 81% in the control group ($p=0.0011$). However, there was no statistical difference in soft tissue infection rates. In addition, soft tissue bacterial load was not decreased with capacitive coupling use.

Conclusion: Capacitive coupling non-invasively delivers an alternating current that detaches biofilm from instrumentation. Long term, capacitive coupling may aid in treatment of biomaterial-centered spine infections.

Significance: Clinical Significance: Bacterial eradication may be successful without removal of instrumentation with the use of electricity. Retention of hardware would allow for improved stability.

Paper Abstracts

18. Cadaveric Radiographic Analysis of Indirect Spine Decompression: Comparison of Lateral Plating vs. Pedicle Screws

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United States

Summary: This study reports on a cadaveric model of XLIF and quantifies the volumetric changes. A comparison of lateral plates and pedicle screws for instrumentation will be made.

Introduction: Few reports examine the anatomical changes in spine fusion through an extreme lateral approach with inter-body cages (XLIF). No data exists of the use of lateral plates vs. pedicle screws with this technique.

Methods: Eighteen L1 to S1 cadaveric specimens were instrumented. CT scans were obtained of each intact specimen and after instrumentation. Variables included disc height, foraminal and canal area. The L3-L4 and L4-L5 levels were then instrumented after lateral discectomy with placement of two interbody cages and augmentation with two lateral plates (n=8) and pedicle screws with rods (n=10). A radiologist, a senior orthopaedic resident and a spine surgeon performed the radiographic measurements in a standardized radiology station.

Results: Pre- and post-implantation changes in the lateral plating group at L3-L4 showed a 45% increase in area of the right foramen (137mm2 to 200mm2), 50% increase in area of the left foramen (144mm2 vs 216mm2), and 53% increase in the canal area (106.5mm2 vs. 163.7mm2, p=0.044). At L4-L5, there was a 38% increase in area of the right foramen (135mm2 vs. 187.5mm2), 50% increase in area of the left foramen (130mm2 vs. 195.2mm2), and 31% increase in the canal area (115mm2 vs. 151.2mm2). The group with pedicle screw instrumentation at L3-L4 showed 73% increase in area of the right foramen, 70% increase in area of the left foramen (p=0.0001), and 40% increase in the canal area (p=0.0006). At L4-L5, there was a 67% increase in area of the right foramen (p=0.0037), 65% increase in area of the left foramen (p=0.0002), and 48% increase in the canal area (p=0.006).

Conclusion: Both groups showed statistically significant changes in pre- and post-operative measurements. The quantitative change in foramen and canal area was significantly larger using posterior instrumentation compared to the group using lateral plating (p<0.005).

Significance: This is the first study to evaluate radiographic changes after indirect spinal decompression using the XLIF technique. The authors believe that the results of this study support the use of pedicle screws to augment the placement of interbody cages. The XLIF technique in this cadaveric model showed statistically significant increase in foraminal and canal areas at the instrumented levels.

19. Preliminary Report: Use of a Magnetic Growing Rod In the Treatment of Childhood Spinal Deformity

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Australia

Summary: 12 patients who have undergone implantation of a magnetic growing rod for control of early onset scoliosis are reported. Preliminary results suggest this is a major step forward in the management of this problem.

Introduction: Early onset scoliosis remains an unsolved problem of spinal deformity during the early years of growth. Growth rods demand repeated operations which combined with soft bone and hard implants commonly result in infections, wound breakdown, hook or screw dislodgement. Stepwise lengthening leads to peak loading on the implants and then increasingly less distraction force until the next assault.

The magnetic growing rod addresses some of these issues. The rod is lengthened via a changing magnetic field being applied to the mechanism within the body of the implant through the skin. The amount of lengthening can be titrated to the patients' needs and growth. Peak loading on implants and bone is avoided. The parents perform the lengthening.

Methods: Prior to commencing this study, a business plan and clinical program was presented to the hospital New Technology Committee. These are the preliminary results of this prospective study.

12 patients of varying diagnoses have been instrumented with a magnetic growing rod over the past 30 months. Three versions of this rod have been used. All patients underwent primary surgery by the author and all patients remain under clinical review.

Results: One patient the procedure was aborted due to cardiovascular compression when positioned prone. Two other patients have had re-implantation of fixation and one of these patients has a deep infection detected 12 months after the index procedure. Two patients have had fractures of the rod. Four patients have now gained in excess of 40mm. Three patients have had a variable axis connector incorporated into the construct.

Conclusion: The results from the first and third generations show that this device can deliver the goal of curve control and partial correction with less surgical intervention than standard growth rods.

Significance: A device that can grow with patients and lessen their spinal deformity without repeated surgical insults is a major advance in the treatment of early onset spinal deformity

Paper Abstracts

20. Does the Type of Distraction-Based Growing System for Early Onset Scoliosis Affect Post-Operative Sagittal Alignment?

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Canada

Summary: A multi-center, retrospective, IRB-approved radiographic comparison was performed. Pre-operative and minimum 2-year follow-up radiographs were analyzed for a group of 79 children with EOS who were treated with posterior distraction-based implants. Although longer follow-up for the rib-based group was a potential confounding variable; at final follow-up, subjects treated with rib-based implants had greater cervical lordosis, greater thoracic kyphosis, less lumbar lordosis, less sacral slope, greater pelvic tilt, and less pelvic radius angle as compared to those treated with spine-based implants.

Introduction: Rib-based (RB) and spine-based (SB) posterior distraction growing systems are commonly used for the treatment of early onset scoliosis (EOS). The purpose of this study was to determine if the type of growing system affects post-operative sagittal-plane alignment.

Methods: A multi-center, retrospective, IRB-approved radiographic comparison was performed. Pre-operative and minimum 2-year follow-up radiographs were analyzed for a group of 79 children with EOS who were treated with posterior distraction-based implants.

Results: There were 56 subjects treated with rib-based and 23 subjects treated with spine-based systems. Mean pre-operative values for rib vs spine-based systems were: Age (4.4 vs 6.3 yr)*, Thoracic scoliosis (70.4° vs 74.8°), lumbar scoliosis (34.6° vs 40.1°), thoracic kyphosis (36.6° vs 40.0°), and lumbar lordosis (45.7° vs 54.9°)*. Other than sacral slope (34.9° vs 39.7°)*, sagittal spinal and pelvic parameters were similar between groups.

At minimum 2 yr follow-up (3.5 yr RB vs 2.1 yr SB)*, curve correction was less for the rib-based group: 20.9% vs 47.5% thoracic* and 19.3% vs 48.9°% lumbar*. The rib-based group had greater cervical lordosis (36.4° vs 21.4°)*, greater thoracic kyphosis (46.2 vs 26.0°)*, less lumbar lordosis (46.4 vs 53.5°), less sacral slope (34.8 vs 40.0°)*, greater pelvic tilt (18.0° vs 11.1°)*, and less pelvic radius angle (49.8° vs 66.4°)*. Pelvic incidence was not different between groups. (* denotes $p<0.05$).

Conclusion: Although longer follow-up for the rib-based group is a potential confounding variable; at final follow-up, subjects treated with rib-based implants had greater cervical lordosis, greater thoracic kyphosis, less lumbar lordosis, less sacral slope, greater pelvic tilt, and less pelvic radius angle as compared to those treated with spine-based implants.

Significance: Rib-based and spine-based implants result in different post-operative sagittal profiles. The patient's pre-operative sagittal alignment should be considered when deciding upon which type of distraction-based growing system to use for an individual patient with EOS.

21. Anterior vs. Posterior Approach of Neurocentral Synchondrosis Hemiepiphysiodesis to Create Experimental Scoliosis

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United States

Summary: The posterior pedicle neurocentral synchondrosis (NCS) screws produced 13% shortening of the pedicle and 45% narrowing of the hemicanal on the screw-insertion side to create scoliosis with an average of 42° at 2-weeks and 36° at 17-weeks postoperatively. The anterior NCS screws produced 6% shortening of the pedicle and 25% narrowing of the hemicanal but did not create scoliosis. The posterior pedicle NCS screws usually (75%) violated the intervertebral foramina and damaged the nerve roots. The initial curve appeared soon after the posterior NCS screw epiphysiodesis suggesting a neuropathic mechanism, however, growth modulation by the NCS posterior screw epiphyseodesis maintained the curve over time.

Introduction: The purpose of this study was to investigate creation of scoliosis via 1) posterior pedicle NCS screw and 2) anterior thoracotomy NCS screw hemiepiphyseodesis in an immature pig model.

Methods: 14 one-month-old pigs were randomly assigned to 4 groups based on screw length (short: not crossing the NCS or long: crossing the NCS) and approach (posterior vs. anterior via thoracotomy): Posterior short NCS screw (posterior sham, n=3); Posterior long NCS screw (n=4); Anterior short NCS screw (anterior sham, n=3); and Anterior long NCS screw (n=4). All animals were followed for 17 weeks and the plain radiographs and axial CT images were obtained. An evaluation of the pathological anatomy of the neuroaxis and the histological analysis were performed.

Results: Scoliosis was seen: posterior short NCS screw: 3 of 3 animals, average of 40.1 ± 7.8° at 2 weeks and 11.6 ± 8.2° at 17 weeks postoperatively; posterior long NCS screw: 4 of 4 animals, average of 42.1 ± 5.8° at 2 weeks and 35.6 ± 9.3° at 17 weeks postoperatively. No scoliosis developed in the anterior short or long NCS screw group. The posterior long NCS screws produced 13% shortening of the pedicle and 45% narrowing of the spinal hemi-canal on the screw-insertion side and vertebral rotation averaging 25°. The anterior long NCS screws produce 6% shortening of the pedicle and 25% narrowing of the hemicanal without vertebral rotation. The posterior pedicle NCS screws violated the intervertebral foramina in 75% of the instrumented levels with evidence of nerve root damage by the screw.

Conclusion: The posterior pedicle NCS screw placement creates scoliosis in an immature pig model due to a combined mechanism of initial neural element disruption followed by inhibition of the neurocentral synchondrosis. Inhibition of the neurocentral synchondrosis with the anterior screw produced a shorter pedicle and a narrow hemicanal but did not create scoliosis.

Significance: This model suggests that a neuropathic mechanism may be necessary to initiate the development of scoliosis which can be maintained by inhibition of the neurocentral synchondrosis.

Paper Abstracts

22. Some Connectors in Growing Rods Fail More than Others

Christopher Lee, BS; Karen S. Myung, MD, PhD; David L. Skaggs, MD

United States

Summary: This retrospective study examines the rate of failure of various types of spinal rod connectors in growing rod constructs for early onset scoliosis. This data shows that some distraction-based growing rod connectors fail more than others. In fact, simple side-to-side closed "Wedding Band" connectors had an unacceptable slippage rate of 41%. Side-to-side connectors with a tapered teardrop lock and longitudinal "Growing Rod" connectors had fewer failures, 3% and 4% of cases respectively.

Introduction: This study examines the rate of failure of various types of spinal rod connectors in growing rod constructs for early onset scoliosis. This data shows that some distraction-based growing rod connectors fail more than others.

Methods: A retrospective review of a single surgeon's consecutive cases with growing rod constructs for early onset scoliosis was performed. 30 patients with an average age of 5 years (1-10 years) with diagnoses of congenital scoliosis (15), neuromuscular (10), idiopathic (4), and other (1) were included. Minimum follow up was 2 years, with a mean follow-up of 49 months (24-83 months).

Results: Of 139 connectors, there were 14 connector failures (10%) in 10 patients. In 13 failures, the set screw loosened, resulting in rod slippage; in 1 case a transverse connector broke. On average, failures occurred 29 months after the index procedure, and after the 3rd lengthening. Simple side-to-side closed "Wedding Band" connectors had the highest rate of slippage, 41% (7/17). Side-to-side connectors with a tapered teardrop lock that mechanically locks the rod had 10 times fewer failures, 4% (1/27) (p=0.006). Only one longitudinal "Growing Rod" connector failed, 3% (1/34) (p=0.002). There were no unplanned operations as a result of the failures. The average T1-S1 gain during growth was 6.5 mm/year for patients who had a connector failure, as opposed to 9.0 mm/year for those who did not (p=0.25). We were surprised to find connectors failed in dual rods 44% (8/18) and single rods 40% (6/15) at similar rates (p=0.92).

Conclusion: Simple side-to-side closed "Wedding Band" connectors had an unacceptable slippage rate of 41%. Side-to-side connectors with a tapered teardrop lock and longitudinal "Growing Rod" connectors had fewer failures, 3% and 4% of cases respectively.

Significance: Choice of specific type of rod connectors in distraction-based growing rods is critical to minimize implant failure.

23. Radiation Exposure in Growing Rod Surgery for Early Onset Scoliosis

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United States

Summary: Growing rod (GR) surgery for early onset scoliosis (EOS) requires repetitive surgeries and serial radiographic imaging. This type of imaging emits ionizing radiation (IR), a well-known known health hazard in high doses. IR exposure in four GR patients with idiopathic EOS was quantified. The average IR exposure per year of spine treatment and per spine surgery was 4.5 times and 4.6 times the average annual exposure to background radiation, respectively.

Introduction: Health hazards related to ionizing radiation (IR) exposure have been well studied; however, no longitudinal studies have monitored IR exposure in growing rod surgery (GR) for treatment of early onset scoliosis (EOS). GR surgery with subsequent periodic surgical spinal distractions require multiple radiographic studies during the course of treatment. The purpose of this study was to quantify IR exposure in this group of patients.

Methods: Idiopathic EOS patients under age 11 who underwent GR surgery at a single center between 1997 and 2010 were retrospectively reviewed. Out of 5 patients who met the inclusion criteria, 4 pts had complete surgical and radiographic history available for analysis. All imaging studies using IR were recorded for each patient. Estimated IR was measured in millisieverts (mSv). IR was calculated based on historic controls: spine x-ray (1.5 mSv); extremity x-ray (0.001 mSv); chest x-ray (0.1 mSv); CT c-spine (2 mSv); CT T-spine (2 mSv); CT L-spine (2 mSv); CT chest (7 mSv); yearly background radiation (BR) (2.4 mSv).

Results: There were a total of 254.8 mSv of IR and 23 surgeries recorded among all 4 patients. Average follow-up from initial spine evaluation was 5.9 years (range 2.2 to 14.8 years). Avg IR exposure per surgical event was 11.08 mSv, 4.6 times the average annual IR from BR. Average IR exposure per year of treatment was 10.7mSv, 4.5 times the average annual IR from BR (Table 1).

Conclusion: This small series of EOS patients received at least 4 times the average annual IR from BR for each year of treatment. IR is grossly underestimated as the average mSv values used for this study were based on the "average sized" adult, multiple x-rays are often taken to obtain one satisfactory film, and patients frequently have other co-morbidities requiring additional IR studies unrelated to the spinal deformity. This study demonstrates the need for a large prospective study to address this understudied risk to patients.

Significance: This study is the first to quantify IR in EOS. Stronger conclusions can then be made with prospectively collected data in regards to lifetime risk of exposure for these patients and possible ways to decrease exposure needed for treatment.

Paper Abstracts

24. Modified Lenke Classification System for Infantile and Juvenile Idiopathic Scoliosis

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Japan

Summary: There is no universally acceptable system for the classification of IIS and JIS. We developed a new system by modifying the current Lenke Classification System for adolescent idiopathic scoliosis (AIS). The frequency of curve patterns is remarkably similar to the AIS population. The ultimate goal of this modified system is to allow the inclusion and organization of IIS and JIS curve patterns and objectively evaluate various treatment methods.

Introduction: There is no universally acceptable system for the classification of infantile (IIS: age 0 to 2+11) and juvenile (JIS: age 2+11 to 9+11) idiopathic scoliosis. We developed a new system for the classification of IIS & JIS by modifying the Lenke Classification System for adolescent idiopathic scoliosis (AIS).

Methods: 115 IIS/JIS patients (67 operative/48 nonoperative; 86 females/29 males) were included. The proximal thoracic (PT), main thoracic (MT), and thoracolumbar/lumbar (TL/L) regions were designated as either the major curve (largest Cobb measurement, always structural) or minor curves which are determined to be either structural or nonstructural. Minor curve criterion for the MT curve-the apex is completely off the plumbline; and for the TL/L curve-the apex is completely off the center sacral vertical line (CSVL). Structural characteristics of the PT curve are designated by a Cobb angle of ≥35° and the height of the bilateral 1st ribs (1st rib opposite the MT curve ≥3mm elevation for PT Cobb angle between 10-35°). If the PT Cobb angle is <10°, the curve is always nonstructural regardless of the 1st rib height.

Results: This produced the triad classification of curve types (1-6) combined with a coronal lumbar modifier (A, B, C) and a sagittal thoracic modifier (-, N, +) similar to the AIS classification system. Type 1 MT curves were found in 43.5% of cases (n=50), type 2 DT in 23.5% (n=28), type 3 DM in 2.6% (n=3), type 4 TM in 4.4% (n=5), type 5 TL/L in 20.9% (n=24) type 6 TL/L-MT in 4.3% (n=5). Lumbar modifier A was found in 64.3% of cases, B modifier in 17.4 C modifier in 18.3%. Sagittal modifier "-" was found in 11.3% of cases, "N" in 82.6% "+" in 6.1%. The 5 most common classifications include: 1AN (27.0%), 2AN (16.5%), 5AN (7.8%), 5CN (7.8%) 1A- (7.0%).

Conclusion: The classification system of IIS & JIS is based on a modified Lenke Classification System allowing for the classification from only upright AP and lateral x-rays, side-bending x-rays are not needed. The frequency of curve patterns is remarkably similar to the AIS population. The ultimate goal of this modified system is to allow the inclusion and organization of IIS & JIS curve patterns and objectively evaluate various treatment methods.

25. Pulmonary Metal. Non-Invasive Positive Pressure Ventilation (NPPV) for Sleep-Related Breathing Difficulties in Children with Thoracic Insufficiency Syndrome (TIS)

Kit Song, MD, MHA; Greg Redding, MD; Christopher Makris, MD; John H. Waldhausen, MD

United States

Summary: Of 20 children who had sleep studies with thoracic insufficiency syndrome, 11 had no recommendation for NPPV with 4/11 worsening to need NPPV after surgery. 6/9 who were recommended to have NPPV had already had surgical treatment. Surgical treatment alone does not resolve TIS. NPPV is a vital adjunct.

Introduction: TIS treatment has focused on implants to change anatomy to improve pulmonary function. Prior studies suggest that up to half of children with TIS have abnormal sleep studies that may benefit from NPPV. Our aim was to assess the impact of NPPV for sleep related breathing difficulties in children with EOS before and after surgical treatment.

Methods: We reviewed sleep study results for 20 children with TIS who began treatment with NPPV devices long-term at home and for the impact of NPPV on breathing during sleep in this group.

Results: 11/20 patients received no night time therapy based on their initial sleep study (column 1). All subsequently had surgery . Three developed worsening sleep studies leading to recommendations for NPPV and 1 clinically worsened leading to NPPV. 9/20 (45%) of the children received nighttime NPPV therapy (7 on Bilevel Positive Airway Pressure (BIPAP) and 2 on Continuous Positive Airway Pressure (CPAP.)]. Of those treated with NPPV, 6 of 9 were first studied after initial spine or chest wall surgery with a growing construct had occurred. Mean (+/- Standard deviation) Apnea-Hypopnea Index (AHI), Arousal Index (AI), lowest SaO2 during sleep (SaO2), and highest end-tidal CO2 value (PCO2) for those not treated with NPPV (column 1) and for those prior to receiving BIPAP/CPAP in column 2 below. The changes in sleep indices after BIPAP or CPAP was instituted are listed in column 3. Children with EOS requiring NPPV at night had worse gas exchange, hypopneic events, and arousals than those not treated. NPPV effectively improved all indices in all treated patients except CO2 retention during sleep.

Conclusion: Children with TIS have sleep abnormalities. Treatment with growth constructs does not resolve these in a high percentage of patients. Improvement in respiratory function using NPPV after surgery can improve these children to the level of those not requiring night time treatment.

Significance: NPPV is an increasingly common form of therapy both before and after spine surgery which provides better sleep quality and breathing during sleep. NPPV represents an important adjunct to surgical intervention and provides benefit after initial surgical therapy for children with EOS.

Paper Abstracts

26. Growth Guidance Procedures in EOS: Do They Work?

Richard E. McCarthy; Frances McCullough

United States

Summary: From a cohort of 40 EOS pts. treated with a growth guidance system, we are reporting on 35 with 2 to 6 ½ yr. follow-up. In this group, there have been a total of 53 procedures beyond the index compared to an estimated 250 procedures had a distraction growing system been utilized. All pts. have demonstrated increased truncal height

Introduction: Growth guidance systems have been used to treat spinal deformities in children without repeated operative lengthenings. Dual stainless steel rods are fixed to the corrected fused apex of the curve via pedicle screws with extraperiosteally placed sliding pedicle screws above and below to permit vertebral growth. We are reporting on 35 pts with > 2 yr. follow-up.

Methods: 35 pts with a mean age of 6+2 yrs. with progressive scoliosis (avg. 67 degrees) underwent the this procedure. Diagnoses were: infantile idiopathic scoliosis (3), juvenile idiopathic scoliosis (4), congenital scoliosis (2), neuromuscular scoliosis (14), and syndromic scoliosis (11). Spinal cord monitoring was accomplished where appropriate.

Results: 35 pts with a mean age of 6+2 yrs. with progressive scoliosis (avg. 67 degrees) underwent this procedure. Diagnoses were: infantile idiopathic scoliosis (3), juvenile idiopathic scoliosis (4), congenital scoliosis (2), neuromuscular scoliosis (14), and syndromic scoliosis (11). Spinal cord monitoring was accomplished where appropriate.

Conclusion: At >2 yr follow-up, the growth guidance procedure has allowed children correction of their spinal deformity without repeated trips to the operating room for lengthenings or a brace. They participate in normal childhood activities. The complication rate has been acceptable with only 18 pts. requiring return to the OR. Had these patients used distraction techniques, it is estimated they would have had 250 procedures. We feel the growth guidence procedure is a safe and valuable procedure.

27. Factors Influencing Proximal Foundation Failure in Growing Rod Constructs

Kasra Ahmadinia, MD; Connie Poe-Kochert, BSN; Jochen P. Son-Hing, MD, FRCSC; George H. Thompson, MD

United States

Summary: Proximal foundation failure (PFF) occurred in 8 of 66 (12%) patients with early onset scoliosis (EOS) treated with growing rod instrumentation. Young age, increased kyphosis and apical fusions were risk factors for PFF.

Introduction: Surgery is indicated when orthotics and casting fail in EOS. Growing rod instrumentation has been effective in controlling the deformity while allowing spinal growth. However, there are known complications, including, PFF. We analyzed our patients who underwent growing rod instrumentation and identified factors that were correlated with PFF.

Methods: Our Pediatric Orthopaedic Spine Database (1992-2008) identified 72 patients who underwent growing rod instrumentation for EOS. These were divided into two groups: group 1- PFF and group 2 - no PFF. The two groups were evaluated for differences in age, sex, weight, upper vertebral level in construct, presence of apical fusion, and pre-operative radiographic measurements. Sixty-six patients had a minimum of 2 years follow-up.

Results: Eight of 66 patients (12%) had PFF. Only age, pre-operative kyphosis, and presence of apical fusion were significant differences between the two groups. The mean age of group 1 patients was 4.9 years (range, 2.6-9.2 years) compared to 7.5 years (range, 2.4-11.6 years) group 2 ($p < 0.006$). The mean pre-operative kyphosis in group 1 was 71 degrees compared to 50 degrees in group 2 ($p=0.049$). Among the 12 patients with apical fusion, 4 (33%) had PFF. The presence of apical fusion was a statistically significant risk factor ($p=0.003$). Linear regression demonstrated a significant correlation between kyphosis and failure ($k=0.005$, p-value 0.016) as well as age and pullout ($k=-0.005$, p-value <0.01).

Conclusion: Our data indicates that younger patients with a previous apical fusion and increased pre-operative kyphosis are at a higher risk for PFF. This results in increased unplanned surgeries.

28. The Lonstein-Carlson Progression Factor Does Not Predict Scoliosis Curve Progression in a Replication Study

Kenneth Ward, MD; Lesa M. Nelson, BS; James W. Ogilvie, MD

United States

Summary: The Lonstein-Carlson Progression Factor does not predict scoliosis curve progression in an independent replication study.

Introduction: A risk of progression model for adolescent idiopathic scoliosis (AIS) was created in pivotal research by Lonstein and Carlson (L-C) in 1984. This study suggested a formula and nomogram for risk of progression in AIS curves 20-29o in those who were skeletally immature using Risser sign, chronologic age and Cobb angle as inputs. To our knowledge, the formula and nomogram have not been formally evaluated in a second cohort of AIS patients. Our objective was to test the performance of the L-C model in an independent population.

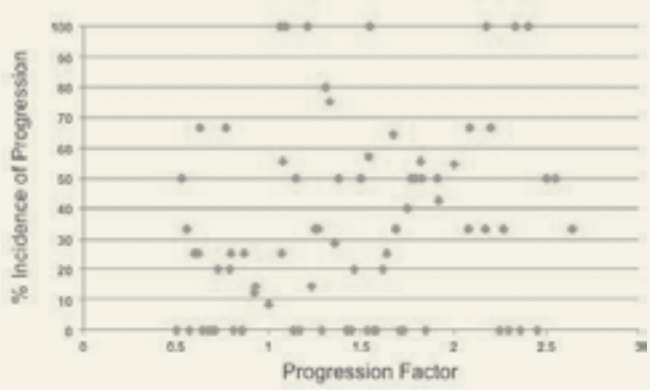
Methods: Using the same methods as the original study, we compared the L-C study of 268 patients with 315 similar AIS patients drawn from a wide distribution in North America. We calculated the progression factor versus the incidence of progression as defined in the original L-C study.

Results: The demographic and clinical features of the L-C cohort and the present study cohort were not statistically different. As shown in the plot below, there was little correlation between the progression score and the observed risk of progression ($R=0.24$).

Conclusion: This replication study shows that the L-C Progression Factor model is not generalizable. Furthermore, any algorithm that relies so heavily on the Cobb angle is not truly predicting the risk of progression, rather it is an observation of how much progression has already occurred.

Paper Abstracts

Significance: The L-C study used rigorous and state-of-the-art methods, but widespread use (and some misuse) of the data have occurred prior to any validation and replication studies. It is clear that biomarkers other than Risser sign, age and Cobb angle are necessary to provide more accurate parameters for calculating a risk of progression.



29. The Influence of Brace Treatment on the Pulmonary Function Test in Adolescent Idiopathic Scoliosis

Bin Yu, MD; Yipeng Wang, MD; Guixing Qiu; Jianguo Zhang; Jianxiong Shen, MD

China

Summary: A retrospective study on the influence of brace treatment on the pulmonary function tests (PFTs) in adolescent idiopathic scoliosis (AIS) showed preoperative brace treatment can reduce the actual values and the percentage of actual value and predicted value of FVC and FEV1 in thoracic AIS. The total length of brace treatment and sagittal Cobb angle of the thoracic curve may be the influential factors of the FVC and FEV1.

Introduction: To analyze the influence of brace treatment on the PFTs in AIS, a retrospective study was performed.

Methods: Preoperative PFTs were evaluated in 349 patients. The predicted value, the actual value and the ratio of actual and predicted value of FVC and FEV1 were recorded. The patients were classified into two groups: group A-with preoperative brace treatment, 90 cases; group B-no preoperative brace treatment, 259 cases. Compare the differences of the PFTs between the 2 groups.

Results: The predicted values of FVC and FEV1 in group A and group B were 3.30L and 3.34L, 2.81L and 2.83L, respectively. There was no significant difference between the 2 groups (all P>0.05). The actual values of FVC and FEV1 in group A and group B were 2.64L and 2.90L, 2.39L and 2.62L, respectively. The percentage of actual value and predicted value of FVC and FEV1 in group A and group B were 80.4% and 86.9%, 85.5% and 92.7%, respectively. The patients with preoperative brace treatment had significant lower values (all P<0.05). This difference was significant in patients with a primary thoracic curve (P<0.05), while not in patients without a primary thoracic curve (P>0.05). In the 61 patients with a primary thoracic curve and preoperative brace treatment, there were negative correlation between the total length of brace treatment and the percentage of actual value and predicted value of FVC and FEV1 (r=-0.424, P=0.017; r=-0.385,P=0.032) and positive correlation between the sagittal Cobb angle of the thoracic curve and the percentage of actual value and predicted value of FVC and FEV1 (r=0.593, P=0.000; r=0.597,P=0.000).

Conclusion: Preoperative brace treatment can reduce the actual values and the percentage of actual value and predicted value of FVC and FEV1 in thoracic AIS. The total length of brace treatment and sagittal Cobb angle of the thoracic curve may be the influential factors of the FVC and FEV1.

Significance: This study showed that preoperative brace treatment can reduce the actual values and the percentage of actual value and predicted value of FVC and FEV1 in thoracic AIS. The total length of brace treatment and sagittal Cobb angle of the thoracic curve may be the influential factors of the FVC and FEV1.

30. Using the Adolescent Idiopathic Scoliosis Prognostic Test (AIS-PT) to Predict Progression to Moderate Curves in Patients with a Mild Curve

James W. Ogilvie, MD; Lesa M. Nelson, BS; Kenneth Ward, MD

United States

Summary: In mild AIS with a low risk AIS-PT score the risk progression to a Cobb >30 degrees correlates with the score.

Introduction: We recently validated a panel of DNA markers to predict a low risk of progression to severe (surgical) Cobb angles in adolescent idiopathic scoliosis (AIS). Roughly 75% of patients with mild AIS are identified as "low risk" by the AIS prognostic test (AIS-PT). As a group, low risk patients have a less than 1% probability of progressing to a severe curve. The purpose of this study was to determine whether the same AIS-PT can also predict the risk of progression to a significant moderate curve (>30o) in low risk patients (score <50 on a scale of 1-200).

Methods: We combined data from four recent AIS-PT validation trials and examined Cobb angles at skeletal maturity in patients with an AIS-PT score of 1 to 50. Skeletal maturity was defined as being 16 years of age or being two years post menarche and Risser 4-5. AIS-PT scores are based on genotypes for 53 genetic markers and the patient's presenting Cobb angle.

Results: Data for 628 Caucasian subjects are expressed in the Table below by score quintiles. 20% of patients had risk scores of 1-6. None of these patients progressed to a severe curve, while 1.5% did progress to a Cobb angle greater than 30 degrees. The risk of progressing to a curve over 30 degree increased with increasing AIS-PT scores.

Conclusion: Although the current algorithm was not designed for this purpose, a clear gradation of risk is seen with increasing scores.

Paper Abstracts

Significance: The need for surgical fusion is only one of several important outcomes in scoliosis management; most patients are concerned about the cosmetic and potential functional implication of moderate curves. Future enhancements to the AIS-PT predictive makers and algorithms might allow more precise predictions and further improve the clinical usefulness of the genetic testing.

31. Variability of t-EMG Threshold at Concavity and Convexity in Apex Segments of Thoracic Scoliosis. Its Correlation with Pedicle-Dural Sac Distance

Gema De Blas, MD, PhD; Carlos Barrios; Ignacio Regidor, MD, PhD; Elena Montes; Jesús J Burgos Flores, PhD; Gabriel Piza Vallespir, MD, PhD; Eduardo Hevia, MD

Spain

Summary: Stimulation EMG threshold variability at concavity and convexity in apex segments was studied in 23scoliotic patients who underwent posterior fusions using pedicle thoracic screws. At CC, t-EMG threshold values from 8 to 14 mA could not discriminate screw malposition. At CV, this range was wider (11-19 mA). At the three apex vertebrae, the average pedicle-cord distance was significantly lower at CC than at CV. There was a correlation between pedicle-cord distance and t-EMG values only at the CC side.

Introduction: Whether the t-EMG stimulation threshold depends on pedicle bony integrity or on the distance to neural tissue remains elusive. Studying pedicle screws at the concavity (CC) and the convexity (CV) at the apex segments of scoliotic curves is a good model to address this issue since the spinal cord is displaced to the CC in these patients.

Methods: A total of 23 patients who underwent posterior fusions using 358 pedicle thoracic screws were reviewed. All patients presented main thoracic scoliosis (average: 58.3°). Every patient underwent a preoperative MRI exam, where the distances from the spinal cord to the pedicles of the concave and convex sides at three apex vertebrae were measured. The accuracy of the screw placement was tested at surgery by the t-EMG technique. Screws with t-EMG threshold values below 12 mA were by intra-operative fluoroscopy. Twenty-three screws were removed because of clear signs of malposition. Postoperative CT scans were used in all patients to detect screw malpositioning of the final 335 screws.

Results: According to post-op CT scans, 44 screws (13.1%) showed different malpositions, but only 11 (3.2%) were completely inside the spinal canal. In well-positioned screws, EMG thresholds from the CC showed statistically significantly lower values than those registered at the CV (21.1±8.2 vs. 23.9±7.7 mA, $p<0.01$). At CC, t-EMG threshold values from 8 to 14 mA could not discriminate screw malposition. At CV, the range for uncertain screw malposition was wider, 11-19 mA. At the three apex vertebrae, the average pedicle-spinal cord distance was 2.2±0.7 mm at CC side and 9.8±4.3 mm at CV ($p<0.001$). There was a correlation between pedicle-dural sac distance and t-EMG threshold values only at the CC side.

Conclusion: Independent of the screw position, average t-EMG thresholds were always higher at the convexity in the apex and above the apex regions, presuming that the distance from the pedicle to the spinal cord plays an important role in electrical transmission.

Significance: The t-EMG technique has low sensitivity to predict screw malpositioning and cannot discriminate between medial cortex breakages and complete invasion of the spinal canal.

32. Single-Pulse vs. Pulse-Train Screw Stimulation Technique. A Comparative Study while Monitoring of Thoracic Pedicle Screws Placement in Scoliosis Surgery

Elena Montes; Gema De Blas, MD, PhD; Carlos Barrios; Jesús J Burgos Flores, PhD; Eduardo Hevia, Dr; Ignacio Regidor, MD, PhD; Maria Soledad del Cura; Alberto Caballero, MD

Spain

Summary: Two different techniques of EMG-thresholds were compared during scoliosis surgery. Both single-pulse screw stimulation (SPS) recording EMG-response in the corresponding myotome, and high frequency pulse-train stimulation (PTS) technique with EMG recording in the lower limbs were assessed. Invasion of the spinal canal was confirmed by postoperative CT scan in 29 of the 244 screws. PTS technique with high-frequency stimuli (30 mA) was found to be more accurate than the SPS technique for detecting screws invading the canal (86.2% versus 10.3%).

Introduction: The classic technique of intraoperative neurophysiologic monitoring to detect malposition of thoracic pedicle screws uses single-pulse stimulation (SPS), recording EMG-response in the corresponding myotome. Recently, it has been hypothesized that its reliability in detecting screws located inside the spinal canal could increase using a pulse-train stimulation (PTS) technique with a high frequency stimuli and EMG recording in the lower limbs.

Methods: Thirteen patients undergoing scoliosis surgery with thoracic pedicle screws were monitored using first evoked potentials obtained by electrical SPS screw stimulation and thereafter with PTS. The position of the screws within the pedicles was postoeraptively assessed by CT scan.

Results: Invasion of the spinal canal was confirmed in 29 of the 244 placed screws. The classic SPS technique detected only 3 (10.3%) of these screws using a previously established threshold limit of 12 mA. The PTS technique detected 25 of 29 (86.2%) malpositioned screws when the proposed threshold of 30 mA was attended, with a negative predictive value of 97.7% but with a high rate of false positive results. When setting a threshold of 15 mA, the positive predictive value decreased to 64.2%. Both techniques detected slightly better those screws encroaching the canal at levels far away from the apex of the scoliotic curve.

Conclusion: Intraoperative monitoring of thoracic pedicle screws with high-frequency stimuli trains was found to be more accurate than the SPS technique for detecting screws invading the canal. We recommend using both techniques

since the PTS cannot detect root injuries. We propose a stimulation threshold for the PTS technique of 15 mA to identify screws invading the canal, and an uncertainty range of 15-30 mA to be complemented with intraoperative imaging techniques.

Significance: PTS technique marks a step further in the improvement of neurophysiologic monitoring during spine surgery when using pedicles screws. Although PTS seems to be more accurate in detecting misplaced screws than classic SPS, both techniques in combination should be recommended since the PTS is unable to detect root injuries.

33. Lower Cortical Bone Mineral Density is Associated with Abnormal Osteopontin Level in Adolescent Idiopathic Scoliosis

Guang-quan Sun; Hiu Yan Yeung, PhD; Annie Po Yee Yim, MSc; Kwong Man Lee; Yong Qiu; Alain Moreau, PhD; Jack C. Cheng, MD

China

Summary: Recent reports showed lower BMD and higher osteopontin level separately. In this paper, osteopentin level was significant correlated with year since menarche. AIS girls had significant higher osteopontin level than healthy girls. With retarded increase of cortical BMD, osteopontin level was associated with cortical BMD in AIS but not with healthy girls. The association of osteopontin with abnormal cortical BMD suggested that OPN might play a significant role in affecting the cortical bone mineral acquisition in AIS girls.

Introduction: Many studies have shown the presence of low bone mineral density in girls with adolescent idiopathic scoliosis (AIS). Recent reports have also found higher plasma osteopontin level in AIS. As osteopontin (OPN) was known to play important role in bone mineralization, it was speculated that abnormal OPN level may be related to the low bone mass found in AIS. The present pilot study aimed to study the association between bone mineral density (BMD) and OPN level in AIS girls.

Methods: Clinical and anthropometric parameters of 45 AIS girls at their first presentation and 20 healthy sex, age and maturity matched controls were recorded. Plasma OPN level was quantified with ELISA. The non-dominant distal radius BMD (trabecular and cortical) was measured with high resolution peripheral quantitative computed tomography. Comparison between AIS and healthy girls and correlation of different parameters were conducted with multivariate regression analysis.

Results: AIS and healthy girls were similar in age and sexual maturity. OPN level was significant correlated with year since menarche (YSM). AIS girls had significantly higher OPN level than healthy girls by 99ng/mL after adjusted for YSM (p=.047). In healthy girls, cortical BMD was significantly increased 81.3mgHA/year following the increase in YSM. However, the increase of BMD in AIS girls is significantly slower at 54.0mgHA/year (p=.004). The cortical BMD of AIS was also lower than that of healthy girls. OPN level was found to be associated with cortical BMD in AIS but not with healthy girls.

Conclusion: OPN is one of the major non-collagen proteins for bone mineralization. At puberty, bone mineralization continues after the cessation of longitudinal growth especially in cortical bone. The retarded cortical bone mineral acquisition of AIS girls is likely to be resulting from abnormal regulation of bone metabolism. The association of OPN with abnormal cortical BMD suggested that OPN might play a significant role in affecting the cortical bone mineral acquisition in AIS girls. Further investigation on the mechanism of enhanced OPN expression in circulation and lower cortical BMD could help to shed further understanding on the etiopathogenesis of AIS.

34. Post-Operative Changes in Coronal Balance after Surgical Correction of Adolescent Idiopathic Scoliosis using Pedicle Screw Constructs

Julien Leroux; Jean-Marc Mac-Thiong, MD, PhD; Hubert Labelle, MD; Stefan Parent, MD, PhD

France

Summary: We reviewed the coronal balance of 102 children who had posterior spinal fusion for adolescent idiopathic scoliosis (AIS) using pedicle screw constructs. Spontaneous correction in coronal balance was observed after surgery within the first 3 postoperative months. Therefore after 3 months, revision surgery can be contemplated if major coronal imbalance is still present.

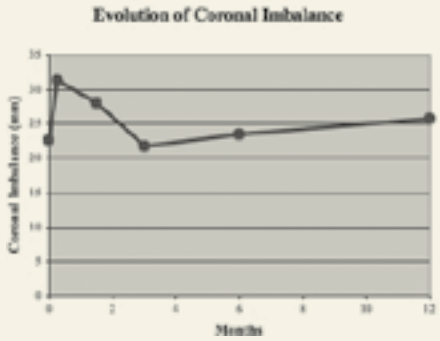
Introduction: Achieving adequate spinal balance is very important after posterior spinal fusion for adolescent idiopathic scoliosis (AIS). Spinal balance can potentially change after surgery but this has not been studied extensively. Revision surgery may be required to correct postoperative coronal imbalance. The aim of the current study is to investigate the changes in coronal balance after posterior spinal fusion for AIS using pedicle screw constructs.

Methods: We reviewed the X-Rays of all patients who had posterior spinal fusion for AIS using pedicle screw constructs between January 2006 and October 2009, with a 1-year minimal follow-up. Coronal balance was measured from postero-anterior X-Rays at 1 week, 6 weeks, 3 months, 6 months, and 1 year after surgery. Paired Student t tests were used to compare the coronal balance between postoperative visits.

Results: A total of 102 patients were included. There was a significant improvement in mean coronal balance between 1 week (31,3mm) and 1 year (25,9mm) (p<0,01), and between 6 weeks (28mm) and 1 year (p<0,05) after surgery. There was no difference between 3 or 6 months and 1 year after surgery.

Paper Abstracts

Conclusion: This study suggests that spontaneous improvement in coronal balance tends to stabilize 3 months after a posterior spinal fusion for AIS using pedicle screws. Clinicians can expect most of the spontaneous correction of coronal balance during the first 3 post-operative months. Therefore 3 months after surgery, major coronal imbalance is not likely to correct spontaneously, and revision surgery can be contemplated.



35. Kyphosis Restoration or Maintanence in Patients With Lenke Type I Scoliosis Treated by Pedicle Screw Construct: Is It Really Impossible by Using 5.5 mm Titanium Rods?

Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Emre Karadeniz; Mehmet B. Balioglu, MD; Azmi Hamzaoglu, MD

Turkey

Summary: Correction of scoliosis by cantilever technique followed by segmental derotation and insitu bending by using 5.5 mm rods provided a significant correction and restoration in thoracic kyphosis.

Introduction: Many studies have shown excellent coronal plane correction by using all pedicle screw constructs. However, same papers have shown difficulty in restoration of kyphosis when pedicle screws were used with 5.5 mm titanium rods. The aim of this study is to evaluate the radiographic results in sagittal plane in Lenke type 1 curves treated by pedicle screw construct and 5.5 mm titanium rods.

Methods: One hundred thirty one patients (14M:117F) with a diagnosis of thoracic idiopathic scoliosis of Lenke type I corrected by polyaxial pedicle screw fixation with 5.5 mm titanium rod were retrospectively analyzed for deformity correction and sagittal plane restoration. Mean age at the time of procedure was 14.9 (10-19) years. Correction of the curve was performed either by cantilever correction, or rod rotation followed by segmental derotation and in situ bending maneuvers. BAVD has not been used as a correction method in any of the patients. Radiographic measurements included coronal thoracic curve Cobb angle, T2-T12 kyphosis, T12-S1 lordosis and CSVL to S1 distance. Proximal junctional kyphosis (PJK) was determined by measuring the kyphosis between upper instrumented vertebrae and the one above. More than 10 degrees kyphosis was accepted as PJK.

Results: Average follow-up was 64 (range; 24 to 148) months. Preoperative thoracic kyphosis of 20° and the lumbar lordosis of 32° were improved to 33° and 47°, respectively, at the most recent follow-up ($p<0.05$). The preoperative thoracic curve of 50° was corrected to 10° (79% correction, 2% loss of correction) at the most recent follow-up ($p<0.05$). The noninstrumented lumbar curve of 32° was corrected to 9° (70% correction, 4% loss of correction) at the most recent follow-up. There was no junctional kyphosis at the most recent follow-up. Forty-five percent of patients had preop sagittal plane decompensation (more than 2cm) preoperatively while 14% had at the final follow-up.

Conclusion: Correction of scoliosis by cantilever technique followed by segmental derotation and insitu bending by using 5.5 mm rods provided a significant correction and restoration in thoracic kyphosis. We conclude that the amount of correction in kyphosis depends more on the technique rather than the rod diameter or type.

Significance: -

36. Short Fusion For Lenke Type 1 Thoracic Curve Using Pedicle Screw Fixation

Morio Matsumoto, MD; Kota Watanabe; Naobumi Hosogane; Eijiro Okada; Kazuhiro Chiba, MD, PhD; Yoshiaki Toyama

Japan

Summary: Short fusion strategy using pedicle screw constructs for Lenke type 1 curve can produce equivalent correction of the main curve to conventional fusion strategy with less surgical time and blood loss, while avoiding elevation of the left shoulder.

Introduction: Maximum correction of a main thoracic curve obtained by pedicle screw constructs(PS) can result in elevation of the left shoulder. To prevent this phenomenon, short fusion with an attempt of maximum correction of the main thoracic curve was conducted for patients with Lenke type 1 curve.

Methods: 38 patients (3 males, 35 females, mean age 16.2, mean follow-up 24 months) with Lenke type 1 curve underwent posterior corrective surgery using PS. The upper instrumented vertebra was one level below the end vertebra in 14 patients (S group) and it was at the end vertebra in 24 patients (C group). There was no difference in mean age(16.9 vs. 15.9), preoperative Cobb angle(51.8 vs 58.0) or curve flexibility(49.7 vs 46.1) between the two groups. In S group, maximum coronal correction was attempted using L benders placed on both rods. Radiographic results and perioperative data were compared between the two groups.

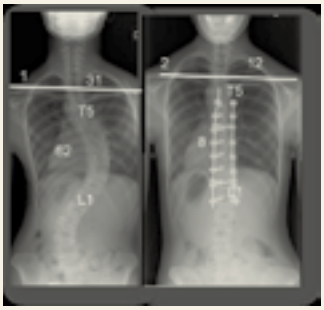
Results: Postoperative Cobb angle of the main curve and correction rate were 13.2±5.7°(74.6±11.1%) in S group and 10.6±7.3 °(82.0±11.4%) in C group, respectively (N.S.).

Cobb angle of the proximal thoracic curve was 28.3±5.3°vs. 28.2±7.2 before surgery, and 16.3±6.4 vs. 13.6±6.1 at follow-up, respectively(N.S.) Clavicle angle was -2.1±2.8°vs. -2.7±2.6 before surgery (N.S.), and 0.8±2.3 vs. 3.8±2.4 at follow-up ($p<0.05$).The number of fused vertebrae, mean surgical time and estimated blood loss were 7.0±0.7 vs. 8.2±1.0, 147.4±25.0 minutes vs. 200.6±54.4, and 305.0 ±98.7ml vs. 446.7±209.6, respectively, all of which were significantly less in S group than in C group.

Paper Abstracts

Conclusion: Short fusion strategy for Lenke type 1 curve can produce equivalent correction of the main curve to conventional fusion strategy with less surgical time and blood loss, while maintaining better shoulder balance.

Significance: Short fusion strategy can avoid left shoulder elevation in Lenke type 1 curve



23 year-old female with the main thoracic curve between T5 and L1 undergoing short fusion between T6 and L1.

37. Accuracy and Complications of C1 Instrumentation

Richard J. Bransford, MD; Mark A. Freeborn, MD; Anthony Russo, MD; Quynh T. Nguyen, PA-C, MHS; Michael J. Lee, MD; Jens R. Chapman, MD; Carlo Bellabarba, MD

United States

Summary: A retrospective review of 344 consecutive C1 screws with post-operative CT scans demonstrated that 96% of screws were acceptably placed within bone. Despite 14 (4%)errantly placed screws, there were no vertebral artery (VA) or neurological injuries.

Introduction: Inaccurate instrumentation placement in the upper posterior cervical spine can lead to VA and neurologic injury with catastrophic consequences. We aim to evaluate a large series of posterior C1 screws to determine accuracy as assessed by post operative computed tomography (CT) scan and to assess the peri-operative complication rate related to screw placement.

Methods: A retrospective review of a single tertiary care referral center spine database was assessed to identify all patients with C1 instrumentation from December 2002 to September 2008. Clinical data was obtained from the electronic medical record. Radiographic analysis included evaluation of pre and post operative CT scans to quantify the patients' bony anatomy as well as to classify the accuracy of C1 screw placement. All C1 screws were graded using the following definitions:

Type I - screw threads completely within the bony cortex.

Type II - less than ½ the diameter of the screw violates the surrounding cortex.

Type III - clear violation of the transverse foramen or spinal canal.

Results: 176 patients underwent posterior C1 screw (lateral mass (LM)or transarticular (TA)) fixation for multiple conditions of the spine. A total of 216 LM screws and 128 TA screws were placed. Overall 96% of screws were rated as "safe" and 86% of screws were rated as being in the ideal location. Fourteen screws (4%) were unacceptably placed (grade III). The accuracy rate of TA screws was greater than that of LM screws (99% vs 94% p<0.01).

Per clinical records, there were no cases of known neurologic or vertebral artery injury at the time of surgery. One patient had a suspected VA injury intra-operatively, however post op CT angiogram showed that the VA was patent. One patient underwent revision surgery for a medial placed screw without neurologic consequence.

Conclusion: Our findings demonstrate a lower than previously reported incidence of complications associated with posterior C1 screw placement. In the management of 176 patients with 344 screws, we found no incidence of iatrogenic vascular or neurologic injury.

Significance: LM and TA into C1 can be safely placed with a high accuracy rate and with a very low rate of vascular or neurological complications.

38. International Variations in the Clinical Presentation and Management of Cervical Spondylotic Myelopathy: One Year Outcomes of the AOSpine Multicenter Prospective CSM-I Study

Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Helton Defino, MD; Shashank S. Kale, MCh; Giuseppe Barbagallo; Ronald H. Bartels, MD,PhD; Qiang Zhou; Paul Arnold; Mehmet Zileli, MD; Gamaliel Tan; Yasutsugu Yukawa, MD; Osmar Moraes; Manuel A. Alvarado, MD; Massimo Scerrati; Tomoaki Toyone, MD

Canada

Summary: One year follow-up data for 247 patients with clinically symptomatic cervical spondylotic myelopathy (CSM) who underwent anterior, posterior or circumferential surgery were analyzed using a variety of instruments (modified Japanese Orthopaedic Assessment scale (mJOA), Nurick Score, Neck Disability Index (NDI), short form 36v2, and complications).

A significant ($P < 0.001$) improvement from baseline values to 12 months was recorded in all outcome parameters.

Regional variations in age and outcomes were also observed and these are being investigated further.

Introduction: Little information is available with respect to differences in global approaches to the treatment of cervical spondylotic myelopathy (CSM).

Methods: A total of 472 patients with clinically symptomatic CSM were enrolled in a prospective multicenter, cohort study which is currently being conducted at 16 sites in Europe, Asia, North and South America. One year follow up data of 247 patients was analyzed for modified Japanese Orthopaedic Assessment scale (mJOA), Nurick Score, Neck Disability Index (NDI), short form 36v2, and complications. Data were analyzed using multivariate techniques (SAS 9.2 PROC MIXED) adjusting for baseline differences in patient populations (age, gender, surgical approach, number of spinal levels and baseline outcome parameter value).

Paper Abstracts

Results: A total of 247 patients have completed the 1 year follow-up. There were 36% females with an average age of 56.04 yrs (SD 12.77). Patients underwent anterior (59%), posterior (39%) or circumferential (2%) surgery. There were significant differences in the age at presentation and baseline neurological status among the regions, with Asian and Latin American patients being noticeably younger. There has been a significant ($P < 0.001$) improvement from baseline values to 12 months in all outcome parameters. The mJOA improved from 12.6±2.9 at baseline to 15.0±2.7 at 12 months. The NDI improved from 38.88±21.06 at baseline to 26.88±19.84 at 12 months. The Nurick improved from 4.3±1.2 at baseline to 3.0±1.5 at 12 months. The SF36 PCS improved from 35.4±8.7 at baseline to 43.2±10.0 at 12 months. The SF36 MCS improved from 38.9±10.0at baseline to 46.0±10.6 at 12 months. Of note, the amount of improvement varied across the regions with patients from Asia-Pacific and Latin America having generally better outcomes than those from North America and Europe (Table 1).

Conclusion: This large prospective global clinical study shows that surgical treatment for CSM is associated with significant improvements in generic and patient-specific outcome measures at one year. However, there are significant variations in clinical presentation and in patient perceptions of improvement that require further investigation.

39. Is the Requirement for Inclusion of the Occiput in Surgically Treated Craniocervical Instabilities for Rheumatoid Arthritis a Prognostic Risk for Accelerated Subaxial Degeneration?

Stephan Werle; Hesham ElSaghir; Ali Ezzati; Heinrich Boehm

Germany

Summary: This retrospective follow up study tries to answer the question: is there an increased risk for accelerated decompensation of the subaxial cervical spine if destruction of C0-C1 requires inclusion of the occiput in surgical treatment?

Introduction: Involvement of the cervical spine in Rheumatoid Arthritis (RA) with maximum at C1-C2 leads to osseous and ligamentous destructions of variable extend. Degeneration of the subaxial cervical spine usually is present at time of surgery for atlantoaxial instability but seems to be only slightly progressive after monosegmental fusion C1-C2. In addition extension of fusion to the occiput bears a considerably higher risk for perioperative complications.

Methods: A total of 121 surgical patients with RA-destructions involving the cranio-cervical junction could be retrieved. Of those 99 were operated just at the atlantoaxial level, while 22 received fusion of C0-C2. Clinical and morphological characteristics of both group's patients were compared retrospectively. Above those the results of a clinical and radiological follow up of 44 retrieved patients of the C1-C2 group were related to those of 9 of the C0-C2 patients at an outpatient visit.

Follow up for the C0-C2 and C1-C2 group averaged 8.2 years (3.8 to 15.8) and 9,4 years (4,9 to 14,7) respectively.

Results: Although changes in the subaxial cervical spine after atlantoaxial fusion often are substantial, surgical intervention caudally to C2 was necessary in only 2 of these patients till current follow up. In contrast, RA-patients with craniocervical changes that required inclusion of the occiput needed subaxial surgical intervention later on more frequently. The rate of perioperative complications was increased considerably in the C0-C2 group.

Conclusion: Extending the fusion to the occiput should be restricted to patients with marked destructions of the C0-C1 level. Surgical treatment including the occiput bears a considerably higher risk for perioperative and late complications.

Subaxial instability C3-C7 10 years after Fusion C0-C2

40. Historical Foundation for Use and Justification of Instrumented Cervicothoracic Osteotomy Correction in Ankylosing Spondylitis - Clinical Rationales Based on Results with Mason-Urist Osteomies C7-T1 and Gradual Halo-Thoracic-Cast Correction

Heiko Koller, Dr; Juliane Zenner, MD; Luis Ferraris, MD; Wolfgang Hitzl, PhD; Oliver Meier

Germany

Summary: There is increasing interest in outcomes of instrumented correction of cervicothoracic kyphosis (CTK) in ankylosing spondylitis due to evolving modern techniques. In the past, non-instrumented correction was an accepted standardized technique.To compare future studies,we analyzed the results of 18 ankylosing spondylitis(AS)-patients with CTK subjected to posterior osteotomy and Halo-Thoracic-Cast based gradual correction. The final correction averaged 25°, but there was a loss of correction until follow-up and other drawbacks. Our study indicates that instrumentation-based corrections are preferable to HTC-based corrections.

Paper Abstracts

Introduction: W/ progression of cervicothoracic kyphosis(CTK) in ankylosing spondylitis(AS) pat suffer functional disability.Cases series are scant & surgical correction poses neurologic risks.There is no ideal osteotomy techn or instrument preventing neurologic lesions at best.We add results w/ non-instrumented correction,as w/ increasing instrumentation use for CTK-corrections a historical control is beneficial.

Methods: We identified 18 AS pat w/ CTK: After application of Halo-Thoracic-Cast(HTC) pat had posterior non-instrumented osteotomy-C7/T1 & approximation of osteotomy by threaded HTC-rod adjustments.Postop gradual HTC-correction was continued w/HTC for 4.5±2mo.Medical charts were reviewed for demographics, surgical details,complications & outcomes.Preop, before HTC-removal and at follow-up patients' photographs were analyzed for Chin-Brow-Vertical-Angle/(CBVA) & radiographs for CTK-angle.To capture postop CTK-correction by HTC we will report time dependent interrelations.

41. Establishment of Parameters for Congenital Stenosis of the Cervical Spine: An Anatomic Study of 410 Postmortem Specimens

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United States

Summary: A cross sectional study of postmortem specimens was performed to provide a working definition for congenital cervical stenosis, based on objective measurements on a large sample of skeletal specimens, and to establish parameters that will accurately predict if CCS is present.

Introduction: Congenital cervical stenosis (CCS) occurs when the bony anatomy of the cervical canal is smaller than expected in the general population. This may predispose an individual to symptomatic neural compression. However, no studies have defined congenital cervical stenosis based on the normal population. The diagnosis is currently made based on clinical impression from radiographic studies which is subjective at best. Exact measurements are needed which define this condition, as are simple parameters that will accurately predict if CCS is present.

Methods: 410 adult skeletal specimens from the Hamann Todd Collection in the Cleveland Museum of Natural History were selected. Digital calipers were used to measure the following (C3-T1): sagittal canal diameter (SD), interpedicular distance (IPD), and pedicle length (PL). Canal area at each level was also calculated using a formula that was verfied by computerized measurements. A standard distribution for each level was created, and values that were -2SD below mean were considered as being congenitally stenotic. Once defined, an analysis of deviance was performed to identify parameters that were predictive of CCS. Logistic regression analysis was used to determine odds ratios for CCS using these parameters, correcting for age, race, and sex.

Results: CCS was defined at each level as: C3/4=1.82cm2; C4/5=1.80cm2; C5/6=1.84cm2; C6/7=1.89cm2. The sagittal diameter (SD) and interpedicular distance (IPD) were found to be predictive of CCS at each level with high sensitivity and specificity. Predictive values were SD<13mm and IPD<22.5mm, which yielded sensitivities and specificities of 88-100% at each level. Logistic regression demonstrated a significant association between these parameters and presence of CCS with OR>40 at each level. Interestingly, pedicle length (PL) was not a good predictor of CCS.

Conclusion: Based on our study of a large population of adult skeletal specimens, we have defined CCS at each level. Values of SD<13mm or IPD<22.5mm strongly predict the presence of CCS at all levels C3/4- C7/T1.

Significance: Providing a definition of CCS will allow for the clinician to better identify patients at risk for neural compression, and will also aid in future studies regarding this condition.

Results: Index age:50±11y, radiographic follow-up:37±47mo.Preop-CBVA was 43.1±16.3° and before HTC-removal 18.3±12.7°(p<.001),correction was 25±9°.Preop CTK-angle was 2.0±17.5°, postop -9±19.6° and follow-up -18.3±16°.Difference betw/ postop & follow-up CTK-angle was not sign. (p=.07).During gradual HTC-correction max.CTK-angle before HTC-removal was -21±16.2° resembling a loss betw/ max and follow-up correction.Differences betw/ clinical-CBVA & max.radiographic correction were not sign. At radiographic follow-up 3 judged their outcome as excellent, 9 good, 3 moderate and 1 poor. Upon invitation at 86.7mo NDPI in 7 pat was 8.4±13.5%, 2 pat had died, 3 were lost, 1 had revision elsewhere & 5 had recent follow-ups.6 pat had minor, 10 major complications.Revisions were done in 5, merely for infection, C8-radiculopathy, neurologic events, translation at osteotomy.3 pat had revision posterior decompression & instrumentation for sagittal translation.2 pat showed intraop-instability at osteotomy causing primary fusion.

Conclusion: W/ the HTC-technique sufficient correction & pat satisfaction was achieved.But, in perspective of a literature review results regarding loss of correction, HTC-morbidity & lack of control at the osteotomy indicates instrumentation-based correction are preferable.

42. Rigid Internal Fixation for Occipito-Cervical Arthrodesis Results in 22 Children

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France

Summary: Occipito-cervical arthrodesis is difficult to obtain particularly in children with constitutional bone disease, genetic disorders and important bone defect. We reported a retrospective study in 22 children with various pathologies, presenting either for instability or medullar compression at the occipito-cervical level, operated on with posterior internal fixation using a system dedicated for adults. Nineteen patients (91%) had a complete fusion. Radiological fusion was obtained in 5 months (3-18m). We had four major complications, none of them related to the implant.

Introduction: Traditional occipito-cervical arthrodesis techniques are associated with an important rate of non fusion and loss of reduction particularly in children having constitutional bone diseases, genetic disorders (e.g; Down syndrome) or

Paper Abstracts

important bone defects. The aims of the study were to evaluate the efficacy and safety of an internal fixation in children.

Methods: This is a retrospective study including 22 patients of mean age 10 years 10 months (1y 10m-17y 9m). Eight children were less than 8 years old. Nine patients had instability, 9 had medullar compression, and 5 had both. A titanium plate rod system using occipital hooks was used for posterior instrumentation. Fourteen patients had a posterior medullar decompression. Ten patients had C2 pedicle screws. The posterior iliac crest or the calvaria were used for bone graft in 18 and 4 patients respectively. Mean number of fused levels was 4.27 (3-7). The postoperative immobilization evolved from a halo-cast to a rigid cervical collar with experience. Mean follow-up was 50 months (27-85 months).

Results: Nineteen patients (91%) had a complete fusion. Radiological fusion was obtained in 5 months (3-18months). Two patients had a radiological nonunion without implant failure. No complications were associated with the use of C2 pedicle screws. We had four complications: one deep infection, one meningitis, one hematoma, and one loss of reduction.

Conclusion: The use of an internal fixation is safe and significantly increases the union rate of occipito-cervical arthrodesis in children. The use of C2 pedicle is safe in young children and limits the extension of the fusion when a spinal cord decompression is associated.

43. Cost-Utility Analysis of Anterior Cervical Discectomy and Fusion vs. Cervical Disc Arthroplasty

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United States

Summary: Anterior cervical discectomy and fusion and cervical arthroplasty have been shown to be effective treatments for cervical disc disease. Fusion provided a slight benefit in terms of QALYs gained at two years over arthroplasty, but at an increased cost. Both treatments were within accepted standards of cost-effectiveness.

Introduction: Patients with cervical disc herniations resulting in radiculopathy or myelopathy from single level disease have traditionally been treated with Anterior Cervical Discectomy and Fusion (ACDF) with excellent results. Cervical Disc Arthroplasty (CDA) has been shown to result in similar clinical outcomes. Expert suggestion of reduced adjacent segment degeneration is a promising future result. A Cost-Utility Analysis of these procedures with long-term follow-up has not been previously reported.

Methods: We reviewed single institution prospective data from a randomized trial comparing single-level ACDF and CDA in cervical disc disease. Data collected included demographics, outcome scores (NDI and SF-36), and utility scores. Procedural cost was estimated via medicare reimbursement based on DRG and physician CPT codes. QALYs were calculated at 1 and 2 years after surgery, allowing for cost/QALY assessments.

Results: Patients included ACDF (n=10) and CDA (n=18) with no significant difference in demographic data. Both groups showed improvement in NDI. Both groups showed improvement in all domains of SF-36 except general health (GH), which remained stable. ACDF patients recorded significantly higher scores in the mental health (MH) domain at 1 and 2 years ($p<0.05$). At two years, total QALYs gained were 0.42 and 0.26 for ACDF and CDA respectively. The average cost of ACDF was $16,162, while CDA averaged $13,187. Cost/QALY was $38,480 and $50,719 for ACDF and CDA at 2 years. The incremental cost effectiveness ratio (ICER) of ACDF vs CDA was $18,593.

Conclusion: We confirm the efficacy of ACDF and CDA in the treatment of cervical disc disease. Our results suggest similar clinical outcomes at one and two year follow-up. Both modalities demonstrate cost-effectiveness. However, the additional QALYs gained by ACDF in this study demonstrate a potentially more cost-effective profile at two years. The ICER suggests that the added benefit via ACDF comes at a reasonable cost. Long term follow-up may illustrate greater cost effectiveness via CDA due to reduced cost and potential economic treatment dominance over ACDF.

44. Cervical Laminoplasty vs. Laminectomy and Fusion: Differences in Outcomes, Neck Pain, and Cost

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United States

Summary: This is a retrospective comparison of cervical laminoplasty versus laminectomy and fusion. Both operations effectively treat cervical stenosis. However, we found that cervical fusion more effectively decreases postoperative neck pain but has higher healthcare costs compared to laminoplasty.

Introduction: A cohort of patients undergoing laminoplasty was compared with a similar cohort of patients treated with cervical laminectomy with fusion to evaluate outcomes, radiographic results, complications, and implant costs.

Methods: The records of 56 adult patients with cervical stenosis were analyzed. 30 had undergone laminoplasty and 26 underwent laminectomy with fusion. Patients who were kyphotic or had spondylolisthesis were excluded. An average of four levels were instrumented in the laminoplasty group while five levels were instrumented in the fusion group ($p<0.01$). Outcomes were assessed with Nurick Scores, mJOA Scores, Neck VAS scores, and Odom's criteria. Post-operative length of stay, complications and implant costs were calculated.

Results: Mean follow up(41 months) and hospital length of stay were similar for both groups. Nurick scores were also similar and improved statistically ($p<0.01$) an average of 1.4 points in both groups. Modified JOA scores improved 2.7 points in laminoplasty patients and 2.8 points in fusion patients ($p<0.01$). Neck pain VAS scores did not change significantly in the laminoplasty group from 3.2 pre-op to 3.4 post-op ($p=0.50$). Fusion patients' neck pain VAS scores improved from 5.8 pre-op to 3.0 post-op ($p<0.01$). In the fusion group, complications were twice as common while implant costs were nearly three times higher. With

subgroup analysis excluding fusions crossing the cervico-thoracic junction, the complication rates were similar between the groups.

Conclusion: Conclusion: Both laminoplasty and laminectomy with fusion patients had similar improvements in Nurick scores, mJOA scores, and Odom outcomes. Patients who underwent fusion typically had higher neck pain pre-op, but their neck pain improved significantly after surgery. Laminoplasty patients' neck pain scores did not change after surgery. Our series suggests cervical fusion significantly reduces neck pain in patients with stenotic myelopathy but at a greater cost than laminoplasty.

Significance: Patients with cervical stenosis and significant preoperative neck pain may benefit from a cervical fusion, but the cost of fusion is higher than that of laminoplasty.

Sagittal T2 MRI of a patient with cervical stenotic myelopathy.

45. Posterior Cervical Lateral Mass Screw Fixation and Fusion to Treat Pseudarthrosis of Anterior Cervical Fusion

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Greece

Summary: This is retrospective clinical cohort study of thirty-eight consecutive patients with symptomatic anterior cervical pseudarthrosis. They were treated by posterior lateral mass screw/rod fixation and fusion. Clinically good and excellent results were achived in thirty-two patients while radiographic fusion was evident in all patients.

Introduction: Both anterior revision and posterior repair of cervical pseudarthrosis have been reported. To date, there is still debate in the literature as how the patient with symptomatic cervical pseudarthrosis should be addressed.

Methods: Thirty-eight consecutive patients with symptomatic anterior cervical pseudarthrosis were treated with posterior lateral mass screw/rod fixation and fusion. The average follow-up was 28 months (24-60 months) and patients were assessed with clinical examination, questionnaires, flexion-extension lateral radiographs and/or CT scans. The clinical results were classified as excellent, good, fair, or poor, according to Zdeblick criteria.

Results: All patients achieved a solid radiographic fusion at the final follow-up. The result was excellent in 10 patients, good in 22, fair in 6, and poor in none.

Conclusion: Patients with symptomatic cervical pseudarthrosis that develops following anterior cervical discectomy and fusion may be managed successfully with posterior lateral mass screw fixation and fusion.

Significance: Symptomatic pseudarthrosis following anterior discectomy and fusion need surgical treatment. Posterior lateral mass screw fixation and fusion is an effective and viable solution avoiding anterior approach-related complications.

46. Failure of Pelvic Fixation after Long Construct Fusions in Adult Deformity Patients; Clinical and Radiographic Risk Factors

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United States

Summary: This study of long construct for adult deformity identified the incidence of pelvic fixation failures and its risk factors. Major failures required revision surgery (rod breakage between L4-S1, failure of S1 screws, and prominence of iliac screws requiring removal). Minor failures included rod breakage between S1-iliac screws and failure of iliac screws. Overall failure occurred 34.3%. The major failure occurred 11.9%, and risk factors were revision surgery, greater pelvic incidence, and failure to adequately restore lumbar lordosis and sagittal balance.

Introduction: Pelvic fixation provides biomechanical support to the base of the long constructs used for adult deformity. However, the failure rate of the pelvic fixation and its risk factors are not well known.

Methods: The retrospective review included 190 adult deformity Pts who had long construct instrumentation (> 6 levels) with iliac screws. Pts' clinical and radiographic data were analyzed. Pts were divided into 2 groups: Failure (F) and Non-Failure (N-F). A minimum 2 year follow up was required for inclusion in N-F. In F, regardless of the failure occurred before or after 2 years, all Pts were included. In both groups, the Pts who needed revisions due to causes other than pelvic fixation failure before 2 yrs were also excluded (e.g. PJK). Failures were defined as Major(M) and minor(m). Major F(M-F) included rod breakage between L4-S1, failure of S1 screws (breakage, halo formation, or pullout), and prominent iliac screws requiring removal. Minor F(m-F) included rod breakage between S1-iliac screws and failure of iliac screws. Minor failures did not require revision surgery. Multiple clinical and radiographic values were compared between M-F and N-F.

Results: Out of 190 Pts, 67 Pts met inclusion criteria and were enrolled. Overall failure rate was 34.3%: 8 Pts in M-F (11.9%) and 15 Pts in m-F (22.4%). M-F occurred at a statistically significant greater rate in those Pts who had revision surgery, greater pelvic incidence (PI), and poor restoration of lumbar lordosis and/or sagittal balance. Pts with a higher number of co-morbidities and preop

Paper Abstracts

coronal imbalance showed trends toward an increase in M-F although these trends did not reach statistical significance. Age, sex, body mass index, smoking history, number of fusion segments, fusion grade, and several other radiographic values were not shown to be associated with increased risk of M-F. 87.5% of Pts in M-F and 84.1% of N-F had ant column support (ALIF or TLIF).

Conclusion: The incidence of overall failure was 34.3%, but the clinically significant major failure after pelvic fixation in adult deformity surgery was 11.9%. Risk factors for Major failures are a larger PI, revision surgery, and failure to restore lumbar lordosis and sagittal balance.

47. rhBMP-2 and Modern Surgical Techniques Significantly Reduce the Pseudarthrosis Rate in Long Fusions to the Sacrum for Complex Adult Spinal Deformity

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United States

Summary: A surgical technique of aggressive local bone graft harvesting combined with an average of 10 mg BMP/posterior level and pedicle screw fixation resulted in only 1 pseudarthrosis in upper thoracic to sacrum adult deformity fusions. This rate is much lower than prior published rates for these difficult adult deformity fusions. No local or systemic complications were attributed to BMP use and Health Related Quality of Life scores improved significantly for this patient cohort.

Introduction: Pseudarthrosis (PA) rates up to 30% have been reported in adult spinal deformity fusion to the sacrum. This study assessed outcomes of upper thoracic (T2-T5) to sacrum spinal fusion (UT SF) with BMP and modern surgical techniques in adult deformity surgery.

Methods: We analyzed a single-center prospective cohort of 48 patients (47 F) with primary UT SF from 2002-2008 at mean f/u of 2.7 years (2-5.1 yrs). Study inclusion criteria were minimum mean 5 mg BMP/ level and mean 1.7 fixation points/level. The study had a return rate of 84% (8 pts < 2-yr f/u, 1 pt died from cancer). Fusion was done with autograft/local bone (no iliac crest harvest), allograft and BMP. PA was diagnosed as implant failure. 40 patients had additional oblique x-rays or CT scan for fusion assessment. SRS scores, ODI and complications were recorded.

Results: The cohort averaged 61.7 years (43.1-80.9 yrs) with a BMI of 26.4 (18.7-46.1). SF averaged 15.2 posterior (mean 1.9 fixation points/level) and 1.5 anterior (71% of patients; 79% TLIF) levels. BMP averaged 12.1 mg/ posterior and 9.7 mg/anterior level. Major coronal curve correction averaged 59%. Mean surgical time was 493 minutes (330-660 min) with a mean EBL of 1.7 liters (0.3-4.7 L). Mean hospital stay was 9.9 days (6-36 days). 1 patient (2.1%) developed a pseudarthrosis. This patient had a T2-sacrum PSF (5 mg BMP/posterior level) with L5-S1 TLIF (12 mg BMP) and presented with pain/broken rods at L3-L4 at 1.6 year f/u. Revision surgery confirmed L2-L5 PA treated with BMP/allograft. 8 patients had intraoperative complications (6 minor, 2 major). 23% had a major acute perioperative and 10% had a long-term complication. There were no local or systemic complications due to BMP. Mean improvements in SRS self-image (1.6), satisfaction (1.5), pain (0.8), subscore (0.7), mental health (0.5) and ODI (-14.2) were significant.

Conclusion: BMP, aggressive local bone graft harvest and pedicle screw fixation may be a competitive alternative to PSF with ICBG. This technique resulted in a 2.1% pseudarthrosis rate in 48 adult deformity fusions. No complications were directly attributable to BMP use. HRQOL scores significantly improved and overall complication rate was consistent with established norms.

48. Adult Spinal Deformity Fusion to the Sacrum using RhBMP-2 vs. Autogenous Iliac Crest Bone Graft: Minimum Four-Year Follow-Up

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United States

Summary: Summary: Rate of Pseudoarthrosis in patients adult scoliosis patients undergoing primary spinal fusion from the thoracic spine to the sacrum with BMP-2 only was 6.4 %(2/31) compared to 28.1 %(9/32) in the autogenous iliac crest group (P=0.04).

Introduction: Introduction: The purpose of this study was to compare the radiographic and clinical outcomes of patients undergoing adult spinal deformity surgery to the sacrum/Ilium, using either rhBMP-2 only or iliac crest bone graft (ICBG) only

Methods: Methods: Prospectively collected data of 63 consecutive patients consisting of 31 patients in BMP group and 32 patients in the ICBG operated on at a single institution, with a minimum 4 yr follow up (4-11.5 yrs). Outcome analysis was conducted using SRS and ODI scores.

Results: Results: The two groups were similar with respect to age, gender, smoking history, co morbidities and BMI. Average number of vertebrae fused was 11.1 in both groups. Average major Cobb angle in the BMP group was 51.3 Vs 58.3 in the ICBG group.SRS outcomes scores and ODI did not demonstrate significant differences between the two groups. 8 patients in the BMP group had a posterior only surgery and all patients in the ICBG had anterior and posterior fusion. Average anterior levels fused were 2.6 in the BMP group and 6.5 in the ICBG group. Average BMP per level was 11.1(3-36). Pseudoarthrosis rate was 6.4% (2/31 patients) in the BMP group 28.1 %(9/32 patients) in the ICBG group (P=0.0433) using Fisher exact test and odds ratio= 5.67. BMP per level of the nonunion patients was 4mg/level. There were no BMP related complications.

Conclusion: Conclusion: Rate of pseudoarthrosis was significantly higher in the ICBG group than BMP group although under dosing (<5mg/level) can also lead

to pseudoarthrosis. Use of BMP may obviate the need for anterior surgery, iliac crest harvesting and additional morbidity.

Significance: Significance: Use of BMP can decrease pseudoarthrosis and revision rate in Adult Spinal Deformity patients

49. The UCSF Experience Evaluating the Effect of One vs. Two Attending Surgeons on Peri-Operative Morbidity for Pedicle Subtraction Osteotomy

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United States

Summary: In cases involving PSO two experienced surgeons working simultaneously reduce the operative time, estimated blood loss and post operative length of hospital stay.

Introduction: Pedicle subtraction osteotomies (PSO) are challenging cases with high rates of complications and a substantial physiological burden to the patient. The literature supports the benefits of two surgeon strategies in complex cases in other surgical specialties. In this report we evaluate the peri-operative morbidity based on the presence of a one versus two attending surgeon in PSO.

Methods: Retrospective study design. A single institution database of all PSO's (75 cases) since 2005was reviewed and the cohort was divided into single vs. two surgeons. Patients with staged anterior and posterior procedures were excluded. Review included analysis of cases for EBL, length of surgery, length of stay, radiographic analysis, and complications.

Results: 46 patients (24 single surgeon and 22 two surgeon) underwent PSO without a staged anterior approach. The average age of the single surgeon and two surgeon groups were 55.9 and 66.4 years, respectively. Radiographic correction was comparable between groups ($p>0.05$). The mean number of levels of posterior spinal fusion (8.8 vs. 8.7) and spinal decompression (2.8 vs. 3.3) and degree of preoperative sagittal imbalance were comparable (12 vs. 14cm). The mean EBL for the one vs. two surgeon was 4837 vs. 1961 ml ($p=0.00587$). The average surgical time for the one surgeon vs. two surgeon was 7.5 vs. 4.9 hrs ($p=0.00036$). The average post operative length of stay for the one surgeon vs. two surgeon was 8.2 vs. 7.7 days ($p>0.05$). The average neurological complication of one surgeon vs. two surgeons was 8.3% vs. 4.5%. In the single surgeon group 6 patients had additional unplanned surgery within 30 days. In the single surgeon group, 3 of 24 cases were terminated secondary for intra-operative coagulopathy or length of surgery. No two surgeon cases were prematurely terminated.

Conclusion: Higher intra-operative EBL and case length have been previously linked to higher rates of peri-operative complications in complex surgery. The use of two surgeons at an experienced spine deformity center decreases the operative time and EBL and may decrease the rate of neurological injury, premature case termination and return to operating room in 30 days.

50. Vertebral Column Resection (VCR) for the Treatment of Adult Spinal Deformities: Outcome and Complications

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United States

Summary: We analyzed the results of VCR in the treatment of rigid adult spinal deformities. We report on the patients' radiographic parameters, functional outcomes and complications.

Introduction: Correction of severe rigid spinal deformities has been traditionally accomplished via a combined anterior/posterior approach. Single incision, all posterior VCR offers a potentially superior alternative. There are few published studies on VCR with the largest series reporting on the pediatric population.

Methods: Retrospective review of 50 consecutive adult patients (17 men and 33 women), average age 50 yrs (21-81), who underwent posterior VCR by a single surgeon between 2004 and 2010. The deformities were divided into three main groups: Coronal (10), sagittal (29) and combined (coronal and sagittal, 11). The average follow-up was 26 months.

Results: There were 28 lumbar and 26 thoracic VCRs (28 revision & 22 primary). 47 patients had a single level and three patients had two nonadjacent levels VCRs. The average number of levels fused was 8.5 (3-17), average EBL 3039cc (550-9000) and average operative time 415 min (220-660). All patients were ASA class 2 (28) and 3 (22) (see table for radiographic parameters and functional outcomes). Major complication were: 6 single nerve root deficits (5 in lumbar and one in a thoracic VCR), 4 completely resolved within three months and 2 had partial recovery. There were 2 deep wound infections treated with I&D, 2 patients had pleural effusions requiring chest tube insertion and one patient suffered respiratory failure requiring re-intubation. One patient developed a PE, one had pneumonia and one asymptomatic MI. Minor complications were: 8 incidental durotomies (6 in revision surgeries and two in primary cases), one superficial wound infection and two wound dehiscences.

Conclusion: VCR is a valuable technique in treating rigid adult spinal deformities. We encountered 15 major and 11 minor complications, which is comparable to other published spinal deformity series in adults without the use of VCR. All neurologic deficits occurred in the lumbar spine except one, all involved a single nerve root and most achieved complete recovery.

Significance: VCR can be a valuable additional tool in managing severe rigid spinal deformities in adults with comparable complication rate to other deformity correction techniques

Paper Abstracts

51. Prevalence and Risk Factors for Pseudarthrosis after Lumbar Pedicle Subtraction Osteotomy (PSO) in Adult Spinal Deformity

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United States

Summary: The prevalence of pseudarthrosis after adult lumbar PSO was 10.5 % (18/171). Prior pseudarthrosis from previous surgery, including at the PSO site, prior decompression in the lumbar spine, prior radiation to the lumbar spine and presence of inflammatory disease/neurologic disorders were identified as risk factors. SRS and ODI scores improved after pseudarthrosis repair.

Introduction: We assessed the prevalence, risk factors, and clinical outcomes for pseudarthrosis after a lumbar pedicle subtraction osteotomy (PSO). To our knowledge, this is the largest PSO series ever evaluated for pseudarthrosis.

Methods: A retrospective review of prospectively collected data on 171 consecutive adult deformity patients undergoing a lumbar PSO by 2 surgeons at a single institution was analyzed with a minimum 2yr F/U. Pseudarthrosis was confirmed by radiographic instrumentation failure, loss of sagittal alignment and intraoperative confirmation.

Results: 18 (10.5%) out of 171 pts developed pseudarthrosis after a PSO. 11 of the 18 pts (6.4% all pts/61.1% of all 18 pseudos) had pseudarthrosis at the PSO site, L3 being the most common site, other locations: L-S junction (4/18), TL junction (2/18) and upper thoracic spine (1/18). Preop pseudarthrosis level was a predictor of postop level of pseudarthrosis (93%). 15 of 18 pts (83%) had no interbody fusion directly above and/or below the PSO site. 16 of 18 (88%) pts had a history of pseudarthrosis at the time of PSO surgery; 2/3 pts who had prior radiation to the lumbar spine developed pseudarthrosis. Most pseudarthroses occurred within the first 2 years (n=13/18), between 2-5yrs (n=3/18) and >5yrs (n=2/18) postop. Prior pseudarthrosis ($P<0.0001$), pseudarthrosis at the PSO site ($P<0.0001$), prior decompression in the lumbar spine ($P=0.0037$), prior radiation to the lumbar spine ($P<0.0001$) and presence of inflammatory/neurologic disorders ($P<0.0036$) were identified as risk factors. All 18 pts with pseudarthroses required revision surgery (posterior-only n=12, A/P n=6) due to loss of sagittal alignment/pain. The mean pre-revision SRS score was 85, post-revision was 95 ($P=0.0166$), and the mean pre-revision ODI score of 42.5 improved at post-revision to 34.5 ($P=0.0203$).

Conclusion: The overall prevalence of pseudarthrosis after lumbar PSO was 10.5% with 11/18 (61%) occurring at the actual PSO site. Prior pseudarthrosis at the PSO site or other regions of the lumbar spine, prior laminectomy in the lumbar spine, prior radiation to the lumbar spine and preop inflammatory/neurologic disorders were all risk factors. SRS and ODI scores improved significantly following pseudarthrosis repair.

52. Outcomes and Complications of Minimally Invasive Correction for Adult Degenerative Scoliosis

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United States

Summary: Adults with minimally invasive correction of spinal deformity show positive outcomes.

Introduction: Minimally invasive surgery has been increasingly used for the correction of spinal deformity. The object for this study is to analyze complication rates and outcomes in 45 patients with degenerative scoliosis treated with minimal invasive correction and fusion.

Methods: We performed a retrospective chart review of 45 patients who received minimally invasive surgical correction for adult degenerative scoliosis at 3+ levels. All patients had two-stage reconstruction surgeries separated by a 4-6 weeks. Stage 1 involved a lateral lumbar interbody fusion and stage 2 required percutaneous spinal fusion and AxiaLIF at L5-S1. VAS pain scores as well as Oswestry Disability Index (ODI) were collected pre- and post-op. Pre-op and post-op Cobb angles as well as sagittal profile with the C7 plumb line were also measured. Perioperative complications were also analyzed.

Results: The present study included 12 males and 37 females with an average age of 53.4 years. Average levels of fusion were T10-S1 in 80% cases and L2-S1 in the residual cases. Estimated blood loss for the stage I was 52 (±15) ml and 213 (±112) ml for stage II. The mean operative time for stage I was 160 (±100) min and stage II was 269 (±130) min. The mean length of hospital stay for stage I was 2.0 (±1.0) days and stage II was 3.2 (±1.4) days. The preoperative Cobb angle was 36°, which corrected to 9° post-op. The C7 plumb line sagittal profile averaged 6.2 cm pre-op and corrected to 1.7 cm after surgery. The mean pre-op VAS=8.20 and post-op=3.01. The mean ODI score at pre-op was 50.3% and 8.5% at post-op. There was a significant decrease in VAS and ODI post-op ($p<0.001$). Superficial wound complications were identified in 6 patients (13%). There were no documented vascular or rectal bowel complications.

Conclusion: Our analysis of 45 patients receiving minimally invasive correction for degenerative scoliosis show very low complication rates overall. Patients also demonstrate excellent correction of coronal and sagittal plane deformity post-op. VAS and ODI scores also show significant decrease postoperatively, providing support for the positive outcomes of this minimally invasive approach.

Paper Abstracts

53. Two to Four Year Functional Outcomes of Minimally Invasive Surgery (MIS) for Adult Spinal Deformity

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United States

Summary: MIS deformity correction using a combination of 3 techniques affords excellent outcomes with reduced morbidity

Introduction: Traditional surgery for adult deformity is associated with significant blood loss & morbidity.

Methods: Consecutive series of patients with > 2 year f/u who underwent MIS Correction of adult deformity including degenerative (25), idiopathic (6), and post laminectomy scoliosis (6). All underwent this using all/combination of 3 MIS techniques: Lateral Transpsoas discectomy/interbody fusion(37), AxiaLIF L5-S1 interbody fusion(18) and segmental multilevel percutaneous pedicle screw fixation(35). 35 patients were staged: lateral fusion first 1st followed by posterior instrumentation/fusion including AxiaLIF done 3 days later. 2 patients had stand-alone lateral fusions. Fusion was augmented with local bone, rh-BMP2 & DBM at each interbody space and in facets. Radiographs, VAS, treatment intensity scores, ODI & SF-36 were assessed preop & at each postop visit.

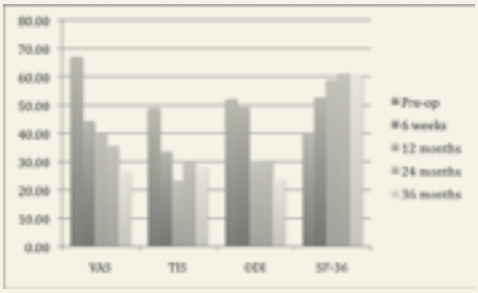
Results: Mean age was 67. Mean f/u was 34 months with > 3 yrs f/u in 18 patients. Mean Blood loss & surgical time was 366 cc & 225 min for the lateral fusion with 247 cc and 239 mins respectively for the posterior fusion including AxiaLIF.

21 patients had transient thigh dysaesthesias for 2 to 6 weeks; 2 patients had quadriceps palsy that resolved within 6 months. 1 patient required removal of a proximal screw at 12 months after fusion was confirmed; 1 had a proximal screw fracture with solid fusion. 1 patient needed decompression for heterotopic ossification; 2 for persistent stenosis. 1 patient is since deceased of Renal failure; 1 patient developed an unrelated cerebellar hemorrhage that was evacuated with no residual effect. 2 patients with stand-alone lateral fusions developed nonunions and were posteriorly instrumented at 9 months and 1 year postop.

Mean pre-op Cobb was 22 degrees; postop was 7 deg. Global coronal & sagittal balance were maintained at final f/u. All patients had solid arthrodesis on plain films. This was was confirmed on CT in 26 patients. No patient had iliac fixation. No failures of sacral screws or sacral fractures were noted.

Conclusion: 3 MIS techniques allow correction of Adult Scoliosis, with low pseudarthrosis rates & improved functional outcomes

Significance: MIS techniques may afford surgical options & improved quality of life for the treatment of adult scoliosis



54. Surgical Outcome of Adult Idiopathic Scoliosis: Comparison with Adolescent Idiopathic Scoliosis

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Summary: Adult idiopathic scoliosis patients who underwent deformity correction were compared to adolescent idiopathic patients with similar correction. The radiologic and clinical outcomes were analyzed. Coronal and sagittal correction were similar in two groups, but the adult group had poor clinical outcomes and more complications.

Introduction: Treatment of idiopathic scoliosis with pedicle screw instrumentation is safe and effective in adolescence. However, there have been few reports in adult idiopathic scoliotic patients. The purpose was to compare the surgical outcome of adult idiopathic scoliosis patients and adolescent patients.

Methods: Eighty five idiopathic scoliosis patients (41 adults and 44 adolescents) treated by segmental pedicle screw instrumentation were analyzed retrospectively with a minimum two year follow-up. In a radiologic study, flexion rate, correction rate, sagittal correction and coronal imbalance were analyzed. In the clinical study, blood loss, operative time, hospital stay, and complications were analyzed.

Results: Mean ages were 28.3 years (18~34) in adult and 13.4 years (12~16) in adolescents. The coronal curves were 55.2±9.9° in adults and 51.6±10.3° in adolescents, and corrected to 28.4±11.2° and 21.6±9.1° respectively in passive bending X-rays. As for correction rates, the average coronal curve was corrected to 16.9±7° in adults and 13.6±7.8° in adolescents. The curve correction in passive bending X-ray was higher in adolescents (p=0.05). The surgical curve correction was not different in the two groups (p=0.174). There was moderate negative correlation between age and curve correctability in a passive bending X-ray (p=0.006, r=-0.345). There was no significant correlation between age and correction rate (p=0.793). Thoracic hypokyphosis was improved in both groups. Coronal imbalance was improved more significantly in adolescents (p=0.013). Operative time and hospital stay were shorter and blood loss was less in adolescents. As for complications, hemothorax occurred in 14 cases in adults, and 3 cases in adolescent (p=0.126).

Conclusion: Idiopathic scoliosis of adults was corrected effectively with pedicle screws. There was more blood loss, more hemothoraces, longer operative times and hospitalization in the adult group. We conclude that early surgical intervention in idiopathic Scoliosis is important to prevent the need for surgery in adult scoliosis patients.

Paper Abstracts

55. Type Three Hemivertebra Resection Via Posterior Approach In Young Children

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Turkey

Summary: Type 3 hemivertebrectomy and strut grafting via posterior approach and transpedicular instrumentation is safe and effective in young children.

Introduction: Hemivertebrectomy via posterior approach can be done by removing only osseous hemivertebrae (HV) with the eggshell technique (type 1), both osseous HV and endplates leaving the adjacent discs intact (type 2) and whole structures between two vertebral bodies adjacent to HV and endplates of adjacent vertebrae (type-3). Type 1 is less complex to perform via posterior approach however with a risk of regrowth of HV. Type 2 creates a gap filled with fibrous scar and stability is doubtful. Type 3 is a technically challenging procedure with no risk of regrowth. The aim of this study is to analyse the results of type 3 hemivertebrectomy.

Methods: 33 patients having 39 posterior hemivertebrectomy and transpedicular fixation were reviewed. Radiological and clinical charts were retrospectively evaluated.

Results: Average age (15 male and 18 female) was 4.2 years (2-10). 17 patients had scoliosis with 34° (18° - 52°), 3 had kyphosis with 53.3° (43° - 68°) and 13 had kyphoscoliosis [mean scoliosis 38° (20° - 62°)], kyphosis 32°(11° - 78°)]. Twenty HV were located in thoracic spine (T3-T11), 9 in thoracolumbar spine (T12-L1) and 10 in lumbar spine (L2-L5). In 6 patients, two-level hemivertebrectomy was done. The mean level of instrumentation was 2.2, operation time was 4.2 h and blood loss was 412 ml. Mesh cages were placed at resected area in all patients Mean follow-up was 48m (24-120). Coronal plane deformity improved to 6° (82%) and was 6.2° at final follow-up. Sagittal plane deformity improved to 3° (94%) and it was 4°at final follow-up.. None of the patients exhibited neurological problems associated with surgery. One patient had dural tear and 2 had superficial infection. Pseudoarthrosis and early or late implant failure was not detected.

Conclusion: Type 3 hemivertebrectomy and strut grafting via posterior approach and transpedicular instrumentation is safe and effective in young children. Several advantages are; immediate correction with no reliance on concave growth, no risk of regrowth of HV, immediate stability and reconstruction of anterior column with successful restoration of sagittal plane alignment.

Significance: -

56. Cervical Spinal Cord Dimensions and Clinical Outcomes in Adults with Klippel-Feil Syndrome: A Comparison with Matched Controls

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United States

Summary: We performed an independent 1: 2 case:control retrospective radiographic and chart review of a consecutive series of adult KFS patients. Contrary to the finding in previous reports on pediatric patients, there were no differences between KFS and well-matched control group in terms of age of onset, presentation, revision rate, complication rates, surgical outcomes, and cross sectional spinal cord and canal dimensions at the operative level. This either suggests that previous reports may have erred or that KFS patients undergo a relative enlargement of the spinal cord as they grow.

Introduction: It has been recently shown that KFS children, compared with age-matched controls, have a significantly smaller cross-sectional spinal cord area. If a similar finding occurs in adults, it may predispose the KFS patient to a lower threshold for neurologic deficit.

Methods: We performed an independent 1: 2 case: control retrospective radiographic and chart review of a consecutive series of adult KFS patients (> 18 years old) who underwent surgical intervention. The control group consisted of a consecutive group of non-KFS surgical patients. Patients were matched in 1:2 case: control manner according to gender and BMI. Their charts were reviewed and the clinical characteristics were compared. Axial T2-weighted MRI was used to measure the AP and med-latl axial spinal cord and spinal canal of the operative levels. Spinal cord and canal area were then calculated using the equation of an ellipse: Area (ellipse) = pi x (AP dimension) x (med-lat dimension), a previously validated technique. If there were multiple levels in a patient, the average area of the levels was used for comparison.

Results: A total of 22 KFS and 44 control patients were identified. The most common congenital fusion level was C2-3 followed by C3-4. 27% patients had >1 congenital fusion level. In the KFS population, the surgical level was as follows: 1-level cephalad to the congenital fusion (17%), 1-level caudal to the congenital fusion (66%), in between 2 congenitally-fused areas (17%). The KFS group had a tendency of more myeloradiculopathy, and the control group had a tendency towards more radiculopathy. However, both tendencies were not significantly different. MRIs of 10 KFS and 22 control group were available. There was no difference in the area of both spinal cord and canal at the operative levels.

Conclusion: Contrary to the finding in previous reports on pediatric patients, there were no differences between KFS and well-matched control group in terms of age of onset, presentation, revision rate, complication rates, surgical outcomes, and cross sectional spinal cord and canal dimensions at the operative level.

Significance: This either suggests that previous reports may have erred or that KFS patients undergo a relative enlargement of the spinal cord as they grow.

	KFS	Controls	P- value
Age	50.5	50.5	0.98
%males	41	50	0.86
Body Mass Index category: Underweight=1, Normal=2, Overweight= 3, Obese= 4	2.86	2.86	1
%Myelopathy	4.55	9.09	0.72
%Radiculopathy	50	68.18	0.15
%Myeloradiculopathy	31.82	20.45	0.16
%Primary Surgery	59.10	54.55	0.85
Total #Anterior Levels Fused	1.77	2.16	0.2
Total #Posterior Levels Fused	0.36	0.91	0.14
Required revision surgery	0.10	0.14	0.32
Complications (0=N, 1=Y)	0.14	0.14	0.47
Pre-op NDI Score	18	21.2	0.25
Post-op NDI Score	20.05	17.87	0.24
Cross-section area of operative level spinal cord	3.45	2.93	0.22
Cross-section area of operative level spinal canal	7.31	6.41	0.28

57. Abnormalities Associated with Congenital Scoliosis

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China

Summary: The incidence of intraspinal and extraspinal abnormalities varied based on the investigating methods. Hospital medical records including: physical examination, plain radiograph, whole spine MRI screening , echocardiography, and abdominal ultrasound were reviewed. We found the intraspinal anomalies were present in 39% and extraspinal in 56% of 108 patients with congenital scoliosis. The most common anomalies were diastematomyelia and syringomyelia.

Introduction: The embryonic development of vertebrae is closely related with that of the spinal cord and the organs of the mesoderm. As a result, CS is often associated with intraspinal abnormalities and extraspinal abnormalities. The aim of this study was to assess the overall incidence of intraspinal anomaly and associated extraspinal abnormalities, and to study the associations between the different types of CS and the associated abnormalities

Methods: Between Jan 2005 and Dec 2009, 108 patients with (CS)ongenital scoliosis underwent a fully clinical assessment, plain radiograph, MRI screening of the spine, echocardiography, and abdominal ultrasound. MRIs were read by neuroradiologists. Diagnoses specifically looked for were Chiari malformation, syringomyelia, diastematomyelia, lipoma, intraspinal masses, arachnoid cyst, and tethered cord. All of our 108 patients have undergone surgical correction of the spinal deformity. The average age of these patients at surgery was 14.2 years (range, 8-40 years). The CS was classified as failure of formation, failure of segmentation, and mixed deformity. Pearson χ^2 test and Fisher test were used to evaluate the incidence of intraspinal anomalies and extraspinal abnormalities

Results: Intraspinal abnormalities were found in 42 patients (39%). These abnormalities were significantly more common in patients with scoliosis resulting from segmentation defects. Scoliosis patients with lumbar hemivertebrae had more intraspinal abnormalities than those with cervical and thoracic hemivertebrae. Patients with intraspinal abnormality had a higher incidence of positive clinical findings than those with a normal MRI (P=0.402). Other organic defects were found in 60 (56%) patients. Cardiac defects were detected in 20% and urogenital anomalies in 16% of the patients.

Conclusion: The abnormal findings on physical examination are unreliable indicators of intraspinal abnormality. Magnetic resonance imaging and echocardiography are suggested to be an essential part in the preoperative evaluation of patients with CS

Significance: Our study further demonstrated the preoperative invastigation like whole spine MRI screening , echocardiography, and abdominal ultrasound is essential for CS surgery

58. Single Stage Posterior Vertebral Column Resection of Lumbar Hemivertebrae in Children under the Age of Ten Years

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Egypt

Summary: Twenty nine patients with a hemivertebra of the lumbar spine had total resection of the hemivertebra and short segment posterior instrumentation. Patients were followed-up for an average of 4.5y (range 2 - 8y) and achieved adequate correction with satisfactory clinical and radiographic outcome without the need for anterior surgery.

Introduction: A single lumbar hemivertebra can result in a progressive spinal deformity. Total resection of these hemivertebrae is ideal for correcting these deformities and several alternatives were suggested including anterior and/or posterior approaches. The aim of this study is to evaluate the clinical and radiographic outcome of single stage total hemivertebrectomy in children less than 10 years old.

Methods: he study was performed between 2000 and 2008 and included twenty nine patients with a lumbar hemivertebra. The average age was 8.5 y (range 6 - 9.5y). The technique involved laminectomy, excision of the pedicle and hemivertebra, and curettage of both end plates; the gap created was filled with morselized cancellous bone. Short segment posterior instrumentation was performed; the gap was gently closed by compression over the pedicle screws and the remaining autograft bone was placed in the posterolateral gutter. A wake up test was done.

Results: Patients were followed-up for an average of 4.5y (range 2 - 8y). The operative time had an average of 2.5 h (range 2 - 4 h) and the average blood loss was 410 cc (range 230 - 650 cc). The scoliotic deformity corrected from an average of 41° to an average of 5° postoperatively and an average of 6° at final follow up; kyphosis corrected from an average of 32° to an average of 4° postoperatively and an average of 5° at final follow up. There were no vascular injuries, neurologic insult, implant failure or crank shafting.

Paper Abstracts

Conclusion: Single stage posterior excision of hemivertebrae with short segment pedicle screw instrumentation is a safe, efficient alternative that offers excellent correction in both sagittal and coronal planes without the need for anterior surgery.

59. Correction of Neglected Congenital Spinal Deformities Associated With Intraspinal Anomalies. Is it Safe?

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Egypt

Summary: Twenty patients with congenital spine deformities associated with intraspinal anomalies had concomitant surgical treatment of both pathologies. Correction was done through a posterior approach, up to total hemivertebrectomy if needed, using hybrid instrumentation. Patients were followed up for an average of 4.5 y (range 2 - 6 y) and achieved satisfactory clinical and radiographic outcome in both sagittal and coronal planes.

Introduction: The incidence of intraspinal anomalies associated with congenital spinal deformities is almost 30%. These anomalies were usually surgically managed first followed on an average of 3 months latter by correction of the congenital spinal deformity. As very few reports focused on managing patients with such challenging problems, we aimed to evaluate the outcome of concurrent surgical management for both pathologies.

Methods: This is a prospective study performed between 2002 and 2008. It included 20 patients, 13 females and 7 males, with an average age of 14.5y (range 10 - 19y). Fifteen patients had a hemivertebra, 3 had a block vertebra and 2 had mixed anomalies. All patients had a posterior correction +/- total hemivertebrectomy and hybrid instrumented fusion. The first six patients had an isolated tethered cord that was separately untethered while the following 14 patients had a diastematomyelia and tethered cord that were both managed in concomitantly.

Results: All patients were followed up for an average of 4.5 y (range 2 - 6 y). The total operative time had an average of 8.45 h (range 6 - 14 h) and the average blood loss was 1230 cc (range 800 - 1850 cc). All patients had a positive wake up test. The average scoliosis was 45° corrected to an average of 11° and the loss of correction had an average of 1.5°; the average kyphotic deformity was 83° corrected to an average of 35° and the loss of correction had an average of 2.2°. There were no neurological insults, CSF leaks or metal failures. The SRS-30 questionnaire ranged from 92 to 134 with an average of 112.

Conclusion: Concomitant surgical management of neglected congenital spinal deformities associated with intraspinal anomalies can be performed safely; meticulous untethering allows adequate correction with satisfactory clinical and radiographic outcome.

60. The Efficacy and Complications of Posterior Hemivertebra Resection with Monosegmental Fusion for Congenital Scoliosis

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China

Summary: There were lots of reports on hemivertebra resection. But reports on the posterior hemivertebra resection with monosegmental fusion of the 2 adjacent vertebra are few and the number of cases is limited.

Introduction: This is a retrospective study aiming to evaluating the efficacy and complications of posterior hemivertebra resection with monosegmental fusion in the treatment of congenital scoliosis.

Methods: For this study, 30 consecutive cases(15males,15females) of congenital scoliosis managed by posterior hemivertebra resection with monosegmental fusion were investigated retrospectively, with at least a 3-year follow-up period(36-92months). Radiograghs were reviewed to determine the coronal curve magnitude and sagittal alignment preoperatively, postoperatively and at last follow-up. Operative reports and patient charts were reviewed to record any perioperative and late complications.

Results: The total number of resected hemivertebra was 31. Mean operation time was 193.8 minutes with average blood loss of 369.0ml. The segmental scoliosis was corrected from 36.4° to 4.9°with a correction rate of 86.54%, and segmental kyphosis(difference to normal segmental alignment) from 21.2° to 6.6° with a correction rate of 66.87%. The correction of the compensatory cranial and caudal curve is 74.86% and 75.13%.There were 1 delayed wound healing, 2 pedicle cutting and 1 rod breakages . Radiolucent gaps were found on the lateral view in 2 cases without any sign of implant failure and correction loss.

Conclusion: Posterior hemivertebra resection with monosegmental fusion of the 2 adjacent vertebra allows for early intervention in very young children. Excellent correction can be abtained. And short segments of fusion allow for normal growth in the unaffected spine. The most common complication is implant failure.

Significance: Jianguo Zhang,Shengru Wang

61. Differences Between Patients with Cerebral Palsy whose Curves are treated Operatively vs. Non-Operatively

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United States

Summary: Patients with Cerebral Palsy treated operatively were older, more severely involved, had larger curves, more pelvic obliquity, lower health-related quality of life and more back pain.

Introduction: While scoliosis is common in patients with Cerebral Palsy (CP), decisions for surgery are usually made jointly by families and surgeons weighing

numerous factors. We prospectively compared patients who were treated with and without surgery to determine which factors were associated with the choice of treatments.

Methods: A multicenter prospective study of patients with CP was performed, including consecutive patients 8-21 years old with curves over 40° (whose families were offered surgery for scoliosis correction). Clinical and radiographic patient data as well as standardized questionnaires to measure health-related quality of life (CP CHILD) were collected preoperatively and compared between those patients who had surgery (Op) versus those who did not (Nonop).

Results: There were 120 patients in the study; 91 Op and 29 Nonop. Comparison by parameter is summarized. Age: Op pts were significantly younger (14.3 ± 2.1 yrs) than Nonop (15.4 ± 2.7 yrs) (P=0.049). Severity: 95% of Op pts were GMFCS level IV-V, versus 75% of Nonop (p=0.072). 42% of Op were profoundly delayed, versus 10% of Nonop (p=0.016), though combining severe and profound yields smaller differences, 62 vs 74%. There was no difference in presence of comorbidities, individually or combined (1.7 ± 1.3 for both). Pain and Function: Op patients had more severe back pain (VAS 3.2 ± 3.3 vs 1.1 ± 1.8, p=0.013) and less sitting endurance preoperatively (250 ± 222 vs 548 ± 206 minutes), despite no difference in the proportion of dependent sitters. The mean CPCHILD total score in the OP group was 50.9 ± 15 vs 57.7 ± 13 in the NonOp group (p<0.01). Curve characteristics: Op patients had larger coronal major curves (82 ± 27°) than Nonop (62 ± 27°) (p<0.001) and more pelvic obliquity (28 ± 15° versus 18 ± 17°, p=0.004) and more kyphosis (T5-12 = 36° vs 27°, p=0.07). There was no difference in the distribution of Lonstein curve types.

Conclusion: Parameters associated with the decision to have surgery for CP scoliosis included pain, decreased sitting endurance, larger curve size increased pelvic obliquity, younger teen years, and more profound cognitive impairment.

Significance: These factors should be considered when assessing patients with CP and guiding the family-based discussion about scoliosis surgery.

62. The Effect of Scoliosis Surgery on Upper Gastrointestinal Function in Patients with Neuromuscular Scoliosis - A Prospective Follow-Up Study

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Summary: Our aim was to assess how surgical correction of neuromuscular scoliosis affects the upper gastrointestinal function of patients by measuring pre- and immediate postoperative gastric electrical activity and emptying in 31 patients. The major curve averaged 81° preoperatively and 30° at FFU on average 2.7 yrs postoperatively. The incidence of normogastria and the mean rate of gastric emptying remained unchanged. The correction of sagittal balance correlated positively with increased postprandial normogastria.

Introduction: Gastrointestinal problems (e.g. gastroesophageal reflux, reduced motility and post correction ileus) are well recognized in patients with neuromuscular scoliosis (NMS). It is not known whether surgical correction of NMS (NMSC) complicates or alleviates these problems. We assessed how surgical correction affects gastric myoelectrical activity and emptying in these patients.

Methods: After an ethical approval 31 children (16 boys; CP 13; MMC 9; and other syndromic 9) who underwent NMSC were included. Mean (range) age at surgery was 14 (5-19) yrs and follow-up time 2.7 (2-5) yrs. Electrogastrography (EGG; n=28) and isotopic gastric emptying (IGE; n=16) were measured on average 65 (4-277) days before and 27 (7-94) days after surgery. Incidence of normo- and dysgastria, pre-/postprandial power ratio, and gastric emptying half-lives (T1/2) of solids and liquids, (reference values >70%, >2.0, <135 min. <57min., respectively) and effects of age, diagnosis, curve type, correction and complications on them, were assessed. SRS-24 was used to assess the health related quality of life.

Results: The major curve averaged preoperatively 81° (38-129°) and 30° (4-84°) at final follow-up (FFU). Pre- and postoperative incidence of normogastria was 14 / 28 (50%) and 12 / 28 (43%) (p=NS). Eight (62%) normogastrics deteoriated to dysgastric and 7 (50%) dysgastrics normalized (p=NS). The median EGG power ratio increased from 2.3 (0.3 - 50) to 4.3 (0.1 - 32) (p<.05). In the IGE pre- and postoperative T1/2 (min.) for solids was 90 (34 - 1600) and 100 (40 - 407) and for liquids 38 (22-380) and 42 (13 - 80), respectively (p=NS). Normal T1/2 deteriorated in 1/9 and delayed T1/2 normalized in 3/7 patients, (p = NS). Correction of sagittal balance correlated with increased postprandial normogastric activity, R = 0.4 (SD = 0.6) (p<.05). Complication rate was 35 % (2 gastroparesis). The mean SRS-24 total score was 96 (72-106) at FFU.

Conclusion: After NMSC the incidence of normogastria and rate of gastric emptying remained unchanged. Improvement and deterioration of myoelectrical activity were equally common. Correction of sagittal balance correlated positively with increased postprandial normogastric activity.

63. Larger Curve Magnitude is Associated with Markedly Increased Perioperative Complications after Scoliosis Surgery in Patients with SCI

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United States

Summary: Children with SCI are at high risk for developing scoliosis. Timing of surgical intervention is highly variable. The risk of sustaining a major perioperative complication increases substantially in larger curves.

Introduction: Although the literature suggests decreased complications in patients with smaller curves, the sparse reports for neuromuscular scoliosis are confounded by inclusion of patients with a variety of diagnoses. Children with SCI

Paper Abstracts

are likely to have a rapidly progressive scoliosis. Timing of surgical intervention in these children is highly variable. We sought to determine if earlier intervention can decrease the incidence of major perioperative complications.

Methods: After obtaining IRB approval a retrospective review was performed of all patients with a diagnosis of SCI and scoliosis who underwent a posterior spinal fusion. Radiographic, clinical, and major perioperative complication data were collected on 45 patients, divided into 2 groups: 1) Smaller curves (SC) <70°, N= 19; and 2) Larger curves (LC) >70°, N=26. Major perioperative complications included neurologic deterioration, dural tear, unintended staged surgery, respiratory (pneumonia, aspiration, intubation > 48hrs/reintubation), sepsis, ARDS, wound infection, and vision loss.

Results: The mean age at surgery for SC= 12.5±2 and LC= 14.7±2 (p<.05). Major curve magnitude was SC= 54±12° and LC=85±11° (p<.01). Average number of levels fused was similar for both groups (SC=16.1 versus 15.8, p=.60). However, the SC had a significantly shorter operative time (463±87 vs. 536±122 mins, p<.05) and blood loss (2673±1437 vs. 3524±2199, p=.08), although the latter did not attain statistical significance. Mean hospital stay was shorter in the SC group (10.9±4, 14.9±9, p<.05). 13 (29%) patients sustained 16 major complications. In the SC group, 4 patients (21%) had one each of dural tear, pneumonia, prolonged intubation, and wound infection. In the LC group, 9 patients (36%) sustained the following: 3 wound infections, 2 aspiration, 2 prolonged intubation, and one each of dural tear, surgery aborted secondary to excessive blood loss, sepsis, ARDS, and vision loss.

Conclusion: Larger magnitude curves in patients with SCI undergoing scoliosis surgery demonstrate longer operative times, more blood loss, longer hospital stays and an increase in major perioperative complications. Surgeons should consider earlier intervention in these children when the likelihood of continued curve progression is high.

64. Optimal RhBMP-2 Dose in TLIF: Long-Term Outcomes in 451 Patients

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United States

Summary: Outcomes from 451 adults who underwent TLIF with BMP at varying doses in 775 discs and were followed 4 years. Nonunions occurred in 8 patients with 4 - 12 mg/disc of BMP. Other complications possibly related to BMP include 4 seromas and 6 bony overgrowth, all occurring at BMP dose of 6-8mg/disc, all resolving with decompression. No BMP related complications occurred at 4mg BMP/disc. 6/8 nonunions occurred at L5-S1. Osteolysis and cage subsidence were not seen.

Introduction: Complications from TLIF have been described at varying BMP doses (largest series: 204 patients followed 3 months). This is the largest report of TLIF with BMP, with analysis of outcomes and complications by BMP dose, diagnosis, and surgery.

Methods: Prospective data was reviewed in 451 consecutive adults undergoing posterior instrumented fusion(PSF) with TLIF, PEEK cage, and BMP 8.2mg/disc(4-12mg/disc) in 775 discs, and followed 4 years(24-86months); Age 60years(19-91years), 51 smokers, 182 revisions. Diagnosis: degenerative-195, spondy-150, deformity-106. PSF ave 4.4 levels(2-17); TLIF ave 1.7 levels(1-4); TLIF 1 level-202, 2 levels-180, 3 levels-66, 4 levels-4. Fusion defined as bridging interspace bone, no loosening of instrumentation, no motion on flex-ext radiographs.

Results: Complications: Nonunion (NU)- 8 patients(8/775 discs: 3 scoliosis, 1 spondy, 4 degen), 5/8 were revised. NU distribution: L3/4-1, L4/5-1, L5-S1-6. BMP dose at NU: 12mg-1, 8mg-4, 6mg-2, 4mg-1. Possible BMP related: seroma-4, bony overgrowth-6, (all used 6-8mgBMP/disc, all resolved with decompression). Complications were too infrequent to be statistically related to BMP dose. Other complications: adjacent degeneration-142(18 revised), adjacent fracture-28(9 revised), infection-14, late instrumentation removal-9. Significant improvement was noted in VAS (pre-op-6.2, 2yr-3.1, P<.001) and ODI(pre-50, 2yr-28, P<.001), and pain medication requirements.

Conclusion: Instrumented PSF with TLIF, PEEK cage, and rhBMP-2 produces reliable fusion(98%) and improved outcomes in adults requiring arthrodesis. Most complications occurred in deformity patients; BMP related complications were uncommon, none at 4mg/disc dose.

Significance: The optimal dose of BMP to avoid seromas and bone overgrowth without increasing the risk of nonunion appears to be 4 mg/disc.

65. Relative Benefit of TLIF vs. PSF Stratified by Diagnostic Indication

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United States

Summary: In a propensity-matched case control study comparing HRQOLs of patients who underwent one- or two-level PSF vs. TLIF for degenerative spondylolisthesis, disc pathology and post-decompression instability, clinical outcome was not significantly altered with TLIF compared to PSF in patients with spondylolisthesis or disc pathology. However, TLIF resulted in better outcomes at 2 yrs post-op in patients with post-decompression instability.

Introduction: The optimal surgical technique for patients with spondylolisthesis or other degenerative conditions has not been defined. Historically, posterolateral spine fusion (PSF) was the most common procedure, while in recent years transforaminal interbody fusion (TLIF) has gained popularity. While theoretical advantages for TLIF have been outlined, evidence for improved outcomes with the addition of interbody support is limited. We compared the two-year HRQOLs of patients who underwent one- or two-level PSF vs. TLIF for degenerative spondylolisthesis, disc pathology and post-decompression instability.

Methods: 63 patients with degenerative spondylolisthesis, 68 with disc pathology and 38 with post-decompression instability who had one- or two-level TLIF and completed 2 yr post-op HRQOL measures that included the Short Form-

36 (SF-36), Oswestry Disability Index (ODI), Numeric Rating Scales (0-10) for back and leg pain were identified. These patients were propensity-matched to a cohort of PSF patients based on age, number of surgical levels, body mass index, sex, smoking status, workers' compensation status, and pre-operative outcome measures. This produced 63 matched pairs with degenerative spondylolisthesis, 46 with disc pathology and 32 with post-decompression instability.

Results: Patients in both groups reported statistically significant improvement in HRQOL scores at 2 yrs post-op. No significant differences in the magnitude of improvement with TLIF compared to PSF was observed, for any HRQOL measure in patients with spondylolisthesis or disc pathology. Patients with post-decompression instability had statistically significantly greater improvement in back pain (p=0.019) and SF-36 PCS (p=0.018) after TLIF compared to PSF. Though not statistically significant, this group also had more improvement in ODI after TLIF compared to PSF (13.7 vs. 8.8). The improvement observed with TLIF in the post-decompression group was similar to that seen with either TLIF or PSF in the other diagnostic groups.

Conclusion: Clinical outcome was not significantly altered with TLIF compared to PSF in patients with spondylolisthesis or disc pathology. However, TLIF resulted in better outcomes at 2 yrs post-op in patients with post-decompression instability.

66. Adjacent Disc Disease and Revision Surgery after 360-degree Lumbar Fusion. Outcome Comparison of 73 patients at 2.5 and Ten Years Follow-Up

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Spain

Summary: Seventy-three patients who underwent 360-degree fusion were analyzed at 2.5 and 10-year follow-up. From 2.5 to 10-years follow-up, fusion rate remains in 100%, but clinical outcome according to ODI and VAs scores showed a clear worsening. Excellent and good self-satisfaction also decrease significantly. Degenerative disc disease in the adjacent superior level was detected in 37 cases (50.7%) at last follow-up. The clinical worsening of ADD patients conducted to new surgical treatment in 24.6% of the total series.

Introduction: Circumferential fusion has shown to be superior to isolated instrumented posterolateral fusion at short-term outcome. However, few reports investigate long-term outcome, specially regarding the appearance of adjacent disc disease and the reintervention rate.

Methods: 73 patients underwent lumbar fusion involving one to three levels (from February 1998 to January 2000). Autologous iliac bone graft was used for fusion supplementation in all cases. Patients were evaluated preoperatively, at 2.5 years follow-up and 10 years as after surgery with static and dynamic radiographic studies, CT scan and MRI. Analyzed parameters included the fusion rate, adjacent disc disease (ADD) and the reintervention rate. Patients were also analyzed by the Oswestry-Disability index (ODI), VAs scores, and the patient self-satisfaction questionnaire.

Results: At 2.5-year follow-up there was a decrease in pain according to VAs (from 8.4 preop to 4), average ODI score was 30.5, an excellent and good self-satisfaction rate of 82.8%, and a 100% radiologic fusion rate. None of the patients exhibited ADD at this time. There was only a single case of revision surgery because of pedicle screw malposition. At 10-years follow-up, fusion rate remains in 100%. Clinical outcome according to ODI (65.6) and VAs scores (8) showed a clear worsening. Excellent and good self-satisfaction rate decrease to 41.1%. ADD was detected in 37 cases (50.7%). The clinical worsening of ADD patients conducted to new surgical treatment in 18 of these cases (24.6% of the total series).

Conclusion: Circumferential lumbar fusion provides high fusion rate although this factor had no relationship to long-term clinical status. From 2.5-year to 10-year follow-up outcome worsened significantly. The high rate of ADD occurrence questions the reliability of this technique for lumbar fusion.

Significance: Due to the high occurrence of ADD, the indications for 360-degree lumbar fusion should be revised, being stricter when selecting patients. Extreme rigid fusions such as the circumferential fusion technique deserve therefore a certain criticism

67. Long-Term Work Capability after Spine Surgery: Decompression vs. Fusion

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United States

Summary: A review of 146 consecutive patients age 19 - 60 years who were working before their spine surgery showed that long-term employability depends on the procedure performed. At 55 months follow-up, both decompression (89%) and fusion patients (93%) improved ODI and VAS outcomes and were still working: Discectomy-92%, Laminectomy 1-2 levels-80%, Fusion 1-2 levels-95%, Fusion > 2 levels- 89% were still working full-time at final follow-up. When counseling patients on spinal surgery, return to work is likely.

Introduction: The ability to return to work after spine surgery, remain working long-term, and nature of that work have not been well studied in the non-work comp population. Patients undergoing decompression typically return to work earlier than after fusion, but their long-term success in the work force is unknown. We analyzed patients' ability to work long-term at average 4.5 years after primary spinal surgery.

Methods: A review of prospective data on 146 consecutive patients from a surgical database who were working before surgery: Diskectomy-25, Laminectomy 1-2 level- 15, Laminectomy>2 levels- 6, Fusion 1-2 levels- 64, Fusion>2 levels- 36. Age averaged 45 years (19-60 years). Excluded: workers comp, revision surgery, unemployed, retired, or students. Work type defined: sedentary, medium, or heavy.

Paper Abstracts

Results: At 55 months follow-up (range 24 - 106 months), complications: nonunion-1, adjacent degeneration-24, painful hardware-2, infection-2, neuro-0. Decompression patients returned to pre-op levels of work sooner than fusion patients (7 vs. 19 weeks, p=0.008). Long-term work was similar; decompression- 41/46 (89%), fusion- 93/100 (93%). Working long-term by surgery: Primary diskectomy-23/25, Laminectomy 1-2 levels-12/15, Laminectomy>2 levels-6/6, Fusion 1-2 levels-61/64, Fusion>2 levels- 32/36. Significant improvements were seen in VAS (pre-6.0, post-2.9, P<0.001) and ODI (pre-44.7, post-25.2, P<0.001) for both decompression and fusion patients.

Conclusion: At 55 months follow-up, both decompression (89%) and fusion patients (93%) improved ODI and VAS outcomes, had returned to work and were still working. Returning to work after fusion takes an average of 3 months longer than returning after decompression.

Significance: The expectation of long-term employability after primary spinal surgery depends on the procedure performed: Diskectomy-92%, Laminectomy 1-2 levels-80%, Fusion 1-2 levels- 95%, Fusion > 2 levels- 89%. When counseling patients on spinal surgery, return to work is likely.

68. SF-6D Values Stratified by Specific Diagnostic Indication

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United States

Summary: Patients with lumbar degenerative disorders have health state values similar to patients with RA or COPD. SF-6D discriminates between patients with different indications for surgery. Revision cases had worse baseline SF-6D values and less improvement at two years after surgery compared to primary cases.

Introduction: There is increasing emphasis on providing treatments that are cost-effective. However, clinical outcomes are not generally reported using measures which facilitate cost analysis. In particular, utility values segregated by specific lumbar spine pathologies are unavailable. The purpose of this study is to present utility values among patients with different lumbar spine pathologies who underwent fusion surgery.

Methods: 1104 patients who had decompression and lumbar fusion with complete data to compute the SF-6D at baseline and two-year follow-up were identified. Primary surgical cases were classified as Disc Pathology (200 cases), Spondylolisthesis (288), Instability (43), Stenosis (134), or Scoliosis (44). Revision cases were classified as Nonunion (94), Adjacent Level Degeneration (98), or Post-Discectomy Revision (203).Baseline SF-6D and change in SF-6D at two years was compared among the groups as well as primary versus revision cases.

Results: The worst mean baseline SF-6D was in patients with Non-union (0.492) followed by Disc Pathology (0.493), Adjacent Level Degeneration (0.494), Post-Discectomy Revision (0.499), Stenosis (0.504), Instability (0.512), Spondylolisthesis (0.520) and Scoliosis (0.530). There was a statistically significant difference in baseline SF-6D among the different groups (p=0.002). Revision cases as a whole had statistically significantly lower SF-6D (0.496) compared to primary cases (0.510, p=0.010). Mean change in SF-6D was greatest in patients with Stenosis (0.088) followed by Spondylolisthesis (0.085), Scoliosis (0.076), Disc Pathology (0.076), Instability (0.073), Post-Discectomy Revision (0.070), Adjacent Level Degeneration (0.066), and Non-union (0.050). There was no statistically significant difference in change in SF-6D among the different groups (p=0.096). However, revision cases had statistically significantly smaller gains in SF-6D (0.064) compared to primary cases (0.082, p=0.012).

Conclusion: Patients with lumbar degenerative disorders have health state values similar to patients with RA or COPD. SF-6D discriminates between patients with different indications for surgery. Revision cases had worse baseline SF-6D values and less improvement at two years after surgery compared to primary cases.

69. Changes in the Oswestry Disability Index Domains that Predict Improvement after Lumbar Fusion

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Summary: The greatest disease-specific changes perceptible to a patient who improves after lumbar fusion surgery are decreasing pain, increased walking activity and a better social life. These domains are also the most responsive to change. In counseling patients who plan to have lumbar decompression and fusion, physicians may be able to set achievable goals in terms of pain control and walking tolerance.

Introduction: Increasingly, treatment effectiveness is measured in terms of improvements in patient-reported outcomes. In patients with lumbar degenerative spine disorders, the Oswestry Disability Index (ODI) is the most widely used disease-specific outcome measure. In counseling patients, it may be useful to determine which of the ten domains of the ODI are specifically improved after surgery. The purpose of this study is to determine which of the ten dimensions of the ODI correlate with or are predictive of improvement after lumbar decompression and fusion in patients with lumbar degenerative disorders.

Methods: 1104 patients who had decompression and lumbar fusion with complete Short Form-36 Physical Composite Score (SF-36 PCS) and ODI at baseline and two-year follow-up were identified. Spearman correlation coefficients between the ODI dimensions and achievement of the Minimum Clinically Important Difference (MCID) for the SF-36 PCS (≥5.4 point change) were calculated. Stepwise multi-variate logistic regression analysis was then done to determine which ODI dimensions are predictive of improvement in terms of achieving of the SF-36 PCS MCID. Finally, effect sizes (Change in score/Baseline SD) for each of the ODI domains were calculated to determine responsiveness to change. Effect sizes larger than 0.8 are considered large.

Results: The ODI domains of Pain Intensity (0.396), Social Life (0.437) and Walking (0.439) had the largest correlation coefficients in association with SF-36 PCS MCID. These were also the domains that were predictive of achieving SF-36 PCS MCID. These three factors also had the largest effect sizes. The effect size for Pain Intensity was 0.87, for Social Life it was 0.79 and for Walking it was 0.67.

Conclusion: The greatest disease-specific changes perceptible to a patient who improves after lumbar fusion surgery are decreasing pain, increased walking activity and a better social life. These domains are also the most responsive to change. In counseling patients who plan to have lumbar decompression and fusion, physicians may be able to set achievable goals in terms of pain control and walking tolerance.

70. Surgical Correction of Lumbosacral Spondyloptosis by a Posterior-Only Approach

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Summary: Reduction of spondyloptosis from 100% to 35% displacement with complete correction of lumbosacral kyphosis is accomplished in six patients. Sacral pedicle subtraction osteotomy combined with L-4 to pelvis instrumentation is employed.

Introduction: Surgical treatment of spondyloptosis has usually included in-situ fusion or combined anterior and posterior resection procedures. A one-stage posterior surgical procedure achieving correction of the lumbo-sacral translation and kyphosis is described.

Methods: With IRB approval, six patients who underwent the procedure are retrospectively studied by chart and radiograph review.

Results: 5 patients had same day posterior correction and 1 patient was staged with intervening halo traction (revision patient). 2 of 6 had previous surgery for spondylolisthesis and progressed to spondyloptosis.The procedure consisted of screw placement (L4,5,S1, ilium), gradual distraction, pedicle subtraction osteotomy of sacrum, and reduction of the deformity. Posterolateral and posterior interbody fusion with structural grafts were accomplished. Significant improvement of the lumbosacral anatomic abnormalities was accomplished (see Table). 5 of the 6 had neurological deficits before surgery. (1 bladder, 4 lumbar 5 roots). 3 of these 5 had increased deficits after surgery, lumbar 5 roots. All new and old neurological deficits resolved. No loss of correction, implant failure, or medical complications occurred. Follow-up was from 26 months to 7 years.

Conclusion: This posterior only procedure safely reduces spondyloptosis and corrects sagittal malalignment. Risk of lumbar 5 root injury is high, but, was uniformly temporary.

Significance: Combined anterior and posterior procedures for correction of lumbosacral spondyloptosis can be avoided by a single stage posterior procedure.

71. Spondylolisthesis, Sacro-Pelvic Morphology and Orientation in Young Gymnasts

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Canada

Summary: We assessed sacro-pelvic morphology and orientation in a population of 92 gymnasts, including 6 subjects presenting spondylolisthesis. Weekly training hours, as well as sacro-pelvic orientation and morphology were different between gymnasts with and without spondylolisthesis.

Introduction: Sacro-pelvic morphology and orientation in gymnasts and their relationship with spondylolisthesis have never been analyzed. The purpose of this study was therefore to evaluate the prevalence of spondylolisthesis in a cohort of gymnasts, from all age groups (under 21), with similar environmental risk factors, regardless of symptoms of low back pain, as well as the associated demographic characteristics and sacro-pelvic morphology and orientation.

Methods: Radiological evaluation of 92 gymnasts was performed to identify spondylolisthesis, and to measure pelvic incidence, pelvic tilt, sacral slope and sacral table angle. Different demographic and training characteristics were evaluated. Radiographic parameters were compared with reference values published for asymptomatic children and adolescents, and for subjects with spondylolisthesis. The level of significance was set to 0.05.

Results: A 6.5 % prevalence of spondylolisthesis was found in our cohort. The weekly training schedule was the only statistically significant different demographic characteristic between subjects with and without spondylolisthesis. Pelvic incidence, pelvic tilt, sacral slope and sacral table angle were respectively 69±20°, 15±13°, 54±11° and 88±7° in gymnasts with spondylolisthesis, and 53±11°, 10±6°, 43±9° and 94±6° in gymnasts without spondylolisthesis. When compared to asymptomatic individuals, pelvic incidence and pelvic tilt were slightly increased in gymnasts without spondylolisthesis. Pelvic incidence, sacral slope and sacral table angle were significantly different between gymnasts with and without spondylolisthesis.

Conclusion: The prevalence of spondylolisthesis in young gymnasts was similar to that observed in the general population. This prevalence is lower than that reported in previous studies, presumably due to modified training methods related to the awareness of potential risks for spondylolisthesis in the two centers involved in this study. Sagittal sacropelvic morphology and orientation was abnormal in gymnasts with spondylolisthesis. Sagittal sacropelvic morphology and orientation was also slightly different in gymnasts without spondylolisthesis when compared to the normal population.

Paper Abstracts

72. Direct Decompression and Interlaminar Stabilization Compared to Laminectomy and Posterior Spinal Fusion with Pedicle Screw Instrumentation for Spinal Stenosis with Back Pain or Degenerative Spondylolisthesis: Two-Year Results from the Prospective, Randomized, Multicenter FDA IDE Trial

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United States

Summary: Direct decompression and interlaminar stabilization (IS) proved equivalent or superior to laminectomy and posterior spinal fusion at 2 years in the treatment of spinal stenosis with back pain or degenerative spondylolisthesis. The IS group experienced significant improvements over fusion with respect to operative times, blood loss, hospital length of stay, ODI, ZCQ, and SF-12 (Physical Component) at minimum 2 years. Operative and adjacent level motion was maintained with IS, while fusions experienced significantly increased adjacent level angulation and translation.

Introduction: Laminectomy and posterior spinal fusion are commonly performed for patients with degenerative spondylolisthesis and spinal stenosis with significant low back pain. Limitations of lumbar fusion have led to the search for motion-preserving, less-invasive alternatives.

Methods: Prospective, randomized, multicenter FDA IDE trial comparing coflex® interlaminar stabilization with laminectomy and posterior spinal fusion to treat 1- and 2-level spinal stenosis with low back pain or up to Grade 1 degenerative spondylolisthesis. Study inclusion consisted of moderate spinal stenosis with significant low back pain (VAS Back Pain ≥50/100) and significant disability (ODI ≥40%), with up to Grade I spondylolisthesis, at spinal segments from L1-L5.

Results: 219 patients (146 IS and 73 fusion controls) were randomized and treated from 21 sites in the United States. Followup at 2 years was 96.6% (IS) and 98.6% (fusions). IS patients experienced shorter operative times ($p<0.0001$), blood loss ($p<0.0001$), and length of stay ($p<0.0001$). Significant improvements with IS over fusion were seen in ODI ($p=0.021$), SF-12 Physical Component ($p=0.027$), and ZCQ (Symptom Severity ($p=0.013$); Physical Function ($p=0.013$); Satisfaction ($p=0.025$)). According to FDA criteria, 66.4% of IS and 59.7% of fusion subjects met composite criteria for overall device success. At 2 years fusion controls exhibited significantly increased sagittal plane translation ($p=0.05$) and angulation ($p<0.0001$) at the superior adjacent level, while IS maintained normal operative and adjacent level motion.

Conclusion: Our results demonstrate safety, efficacy, and non-inferiority with interlaminar stabilization compared with fusion. Stabilization led to significantly improved perioperative outcomes, significant improvements in multiple clinical outcomes measures compared with fusion at 2 years, and maintenance of motion at operative and adjacent levels. Interlaminar stabilization is a safe and efficacious alternative, and provides several distinct advantages over lumbar spinal fusion with pedicle screw instrumentation.

73. Fusionless Scoliosis Management using a Growth Modulating Intravertebral Epiphyseal Device in a Porcine Model

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Canada

Summary: A novel fusionless intravertebral device modified spinal alignment, vertebral wedging, growth plate morphology, and maintained disc health in a porcine model. This is the first disc excluding device of its kind to offer a promising novel approach to early treatment of adolescents with idiopathic scoliosis.

Introduction: Fusionless growth sparring instrumentation may provide an appealing alternative to conventional treatments. To date, fusionless devices achieve unilateral growth modulation by compressing the intervertebral disc. This study explores a device to control spinal alignment and vertebral morphology via growth modulation while excluding the disc in a porcine model.

Methods: Skeletally immature pigs were divided into experimental (4), sham (3), and control (2) groups. Experimental pigs were introduced anteriorly with the device from T5-T8. Device head was inserted between disc and growth plate and body fixed to bordering vertebra with a bone screw. Sham underwent surgery without instrumentation. Control experienced no intervention. Inverse method was adopted (creation of scoliosis). Over 12 weeks, bi-weekly anteroposterior and lateral radiographs provided Cobb angle, vertebral wedging, and disc height measures. Histological analyses examined growth plate morphology and disc health.

Results: Control and sham groups showed no alteration in spinal alignment or morphology. No sagittal modification occurred in all groups. Experimental pigs achieved vertebral wedging of 4.1°±3.6°, resulting in a cumulative vertebral deformity of up to 25° over 4 instrumented levels. Adjacent to device, disc height increased 0.8mm±0.2 and growth plate hypertrophic zone and cell height reduced by a factor of two. Histology confirmed positive disc viability.

Conclusion: Intravertebral epiphyseal device controlled spinal alignment through local growth modulation exclusive of the intervertebral disc.

Significance: This device is the first to achieve growth modulation in a large animal model without spanning the disc space. Fusionless treatment of pediatric scoliosis must ensure long term disc health. Local growth modulation achieved without disc compression is a plausible solution.

Paper Abstracts

Fluoroscopic image of harvested porcine spine after 12 weeks with intravertebral epiphyseal device

74. A Randomized Controlled Trial Assessing the Safety and Efficacy of a Novel Superelastic Rod in Comparison to Conventional Titanium Rod for Scoliosis Curve Correction

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Summary: By use of a novel superelastic nitinol rod, we were able to demonstrate in a randomized controlled trial that it has the same safety profile as standard titanium rods, but can result in a superior degree of correction in both the sagittal and coronal plane in patients with Adolescent Idiopathic Scoliosis.

Introduction: Current implant technologies correct scoliosis at the time of surgery and thus are unable to overcome viscoelastic properties of the spine. If this can be achieved, in a similar manner to the Ilizarov technique, superior correction may be possible. A novel superelastic nitinol rod that can maximize curve correction by gradually correcting scoliosis after surgery has been developed by the authors. This is a parallel, double-blinded, randomized controlled trial comparing the safety and efficacy of these nitinol rods (Group 1) to conventional titanium rods (Group 2).

Methods: Twenty-three adolescent idiopathic scoliosis (AIS) subjects, with mean age of 15 years, were recruited. All subjects had single thoracic curves and were randomized at the time of surgery to receive either the nitinol rods or conventional rods. Assessments were carried out based on preoperative anteroposterior and lateral standing and fulcrum bending radiographs, postoperative standing radiographs, and serum nickel levels. All assessments were made by two blinded observers.

Results: Eleven subjects were in Group 1 and 12 in Group 2. All subjects were followed for a minimum of 12 months and a mean of 24 months. Mean preoperative Cobb angles in Group 1 and Group 2 were 58.18° and 53.51° respectively, while mean post-operative Cobb angles at 6 months were 17.79° and 16.70° respectively. The fulcrum bending correction index of group 1 subjects improved a mean of 6% from post-operative week 1 to week 24 while that of group 2 subjects improved a mean of 3% within the same time. Of those subjects who had abnormal pre-operative sagittal alignments, 80% from group 1 improved by post-operative week 4, while 67% from group 2 subjects improved. Balance parameters, nickel levels, and complication rates did not differ significantly.

Conclusion: This is the first study to demonstrate that the novel superelastic rods are safe, can gradually correct curves after surgery, ultimately resulting in better coronal and sagittal alignments compared to traditional rods. Larger multi-center trials are needed to further substantiate these findings.

75. Next Generation of Growth-Sparing Techniques: Preliminary Clinical Results of a Magnetically Controlled Growing Rod in 14 Patients

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Summary: Growth-sparing techniques are commonly used for the treatment of progressive EOS. The standard growing rod (GR) technique requires multiple surgeries for lengthening. The preliminary results of MCGR has shown the comparable outcomes to standard GR without the need for repeated surgery which can be expected to reduce the overall complication rate in GR surgery.

Introduction: Growing rod technique (GR) has been a viable alternative for the treatment of progressive early onset scoliosis (EOS). However, a high complication rate associated with GR has been attributed to frequent surgeries required for lengthening. The safety and efficacy of a non-invasive Magnetically Controlled Growing Rod (MCGR) has been previously reported in a porcine model. We are reporting the preliminary clinical results of the use of this device.

Methods: Multicenter prospective review of early clinical and radiographic data of EOS patients underwent MCGR surgery. Patients who had at least 3 distractions were included. The technique was not significantly different from standard GR surgery. Distractions were performed in clinic without anesthesia or analgesics. The "Target" length (the intended distraction amount in mm which is set on the external magnet) and "Achieved" length (The distraction measured in mm on post distraction radiograph) were also recorded for each distraction.

Results: Patients (N=14, F=7,M=7) had mean age of 8y10m (3y6m to 12y7m) and underwent 14 index surgeries, single rod (SR) in 5, dual rod (DR) in 9 and 68 distractions. Diagnosis was idiopathic 5, neuromuscular 4, congenital 2, syndromic 2 and NF one. Mean FU was 9 months (4-15). Average distraction achieved was 4.2 mm per patient. The average time between index surgery and the first distraction was 66 days (28-185) and thereafter was 43 days (23-184). Complications included superficial infection in 1 (SR), prominent implant in 1 (DR) and minimal loss of initial length in 3 (21%) index surgery (all SR). Partial loss of distraction was observed following 14 of the 68 distractions

Paper Abstracts

(1 in DR,13 SR). This loss was regained in subsequent distractions. There was no neurologic deficit or implant failure.

Conclusion: Preliminary results indicate that MCGR appears to be safe and provided the distraction comparable with standard GR procedure without the need for repeated surgeries. No major complications have been observed in the short follow up period.

	Mean Pre-op	Mean Post-op	Final FU
Scoliosis (Cobb angle)	60°	34°	34°
Global thoracic kyphosis	35°	28°	32
Total T1-T12 (mm)	186	204.6	230
Total T1-S1 (mm)	303	333.2	341.5
	Single Rod	Dual Rods	
Target Length (mm)	4.1	R=2.5, L=2.6	
Achieved Length (mm)	2.9	R=2, L=2.2	
Mean Monthly T1-T12 (mm)	1.42	1.61	
Mean Monthly T1-S1 (mm)	1.72	2.38	

76. Pars Interarticularis Repair with Percutaneous Screw Fixation

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United Kingdom

Summary: We describe the results of a technique of direct pars repair which preserves the motion segment function and minimises the damage done at surgery to muscles that control movement.

Introduction: Pars interarticularis repairs are conventionally done using instrumentation and bone grafting through open surgical exposures. As the goal of surgery is to preserve the motion segment function, it is logical to minimise the damage done at surgery to the muscles that control movement.

Methods: We describe a 2 stage operation that allows the insertion of a cannulated compression screw [Perpos] using a single midline 1 cm incision, followed by limited exposure of the fracture to enable preparation and grafting using a Endoscopic camera system. Intra-operative screening on a radiolucent table in AP, lateral and 45 degree oblique views is essential. 6 patients (15 to 42 years) underwent the aforementioned procedure. 4 patients had bilateral pars defects and 2 patients had an unilateral pars defect. Pars repair was performed on 10 sites at the L5 level in all patients.

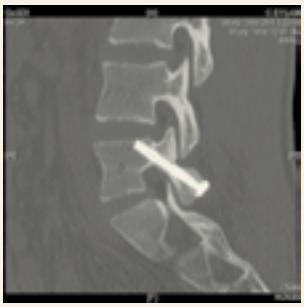
Results: Post-operatively the patient is discharged after a one night stay, with a simple corset to be worn for 6 weeks. Running is commenced at 3 months and full activity at 6 months following a CT to confirm healing.

Out of a total of ten surgical sites, nine demonstrated union on CT at 6-8 months. No screw required repositioning. 4 patients are without symptoms, 2 have improved significantly (including the patient with non-union). There were no wound related problems, and operating time averaged circa 2.5 hours. CT scans showed no diminution of multifidis muscle post operation.

Conclusion: As the operation allows easy return to daily activities in a short period of time, we have the opportunity to treat symptomatic pars defects in adolescents with minimal disruption to their academic and physical development, preventing the long term consequences of lytic spondylolisthesis in many cases.

With adults, the clinical and structural situation is usually more complex, but the technique can still be applied with a rapid return to sedentary work.

Significance: This operation enables a rapid return to activities, and provides the opportunity to treat symptomatic pars defects especially in adolescents with minimal disruption to their academic and physical development.



77. Repair of Spondylolysis using Compression with a Modular Link and Screws

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United Kingdom

Summary: We describe the results of a prospective case series of patients with spondylolysis, evaluating a technique of direct stabilisation of the pars interarticularis with a construct that consists of a pair of pedicle screws connected by a U-shaped modular link passing beneath the spinous process.

Introduction: A number of techniques have been described for direct repair of the pars defect, but have been associated with complications such as loosening and breakage of the internal fixation, technical difficulty, extensive muscle and tissue dissection, and variable rates of consolidation of the defect.

We describe a prospective case series evaluating a technique of direct repair of the pars stabilised with a construct consisting of a pair of pedicle screws connected by a U-shaped modular link passing beneath the spinous process.

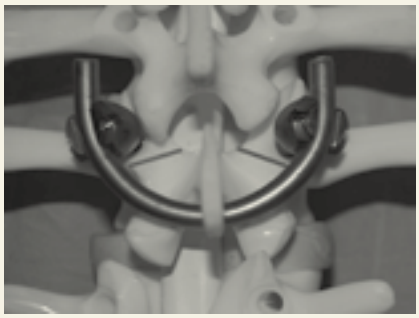
Methods: We describe the results of a prospective case series of patients with spondylolysis, evaluating a technique of direct stabilisation of the pars interarticularis with a construct that consists of a pair of pedicle screws connected by a U-shaped modular link passing beneath the spinous process. Tightening the link to the screws compresses bone graft in the defect in the pars, providing rigid intrasegmental fixation. We have carried out this procedure on 20 patients aged between nine and 21 years with a defect of the pars at L5, confirmed on CT. The mean age of the patients was 13.9 years (9 to 21). They had a grade I or less spondylolisthesis and no evidence of intervertebral degeneration on MRI. The mean follow-up was four years (2.3 to 7.3).

Results: The patients were assessed by the Oswestry Disability Index (ODI) and a visual analogue scale (VAS). At the latest follow-up, 18 patients had an excellent clinical outcome, with a significant ($p < 0.001$) improvement in their ODI and VAS scores. The mean ODI score at final follow-up was 8%. Assessment

of the defect by CT showed a rate of union of 80%. There were no complications involving the internal fixation.

Conclusion: Our technique uses readily available instrumentation to provide a strong construct. The bone graft in the pars defect is not hindered by screws, allowing for high rates of union. Post-operative recovery is made easier as the strength of the construct removes the need for post-operative immobilisation.

Significance: Our technique for spondylolysis repair provides a strong construct and high rates of union. Post-operative recovery is made easier as the strength of the construct removes the need for post-operative immobilisation.



Photograph showing the construct in a model spine. The shaded lines illustrate the location of the pars defects.

78. Preliminary Experience with Clinical Use of a DNA Prognostic Test for Adolescent Idiopathic Scoliosis in 196 Patients

Suken A. Shah, MD; Petya Yorgova; Geraldine I. Neiss, PhD; E. Patrick Curry, MD; Brain S. Winters, MD; Peter G. Gabos, MD; J. Richard Bowen, MD

United States

Summary: A prospective series of patients who underwent prognostic AIS genetic testing is described. 48% of patients tested low risk and had smaller curve magnitudes on the test date, a longer period between follow up visits and X-rays, and a lower incidence of bracing.

Introduction: A commercially available saliva-based prognostic DNA test has been developed which utilizes a panel of 53 SNPs to predict the risk of progression in pts with mild adolescent idiopathic scoliosis (AIS) to a severe curve (>40°).

Methods: 196 pts with mild AIS who were skeletally immature underwent this test in a prospective, consecutive fashion. Scores were reported in a range of 1 to 200, stratified as follows: Low risk (LR) (1-50), Intermediate risk (IR) (51-179) and High risk (HR) (180-200).

Results: 95 pts (48%) tested LR; 92 pts (47%) tested IR; and 9 pts (5%) tested HR. Mean age was 11.8 yrs (range 9-14 yrs). The mean Cobb angle (CA) at testing was 16.6° (range 10-25°) and did differ significantly between groups: the mean CA at testing was 13.3° in LR, 19.2° in IR, and 24.1° in HR ($p<0.001$). Pts presenting with curves of less than 20° tested LR 63% of the time. Thus far, 101 pts have had at one follow-up (f/u) visit at a mean interval of 7.0 months and had a mean CA of 19.2°. The length of first f/u is significantly different: 3.4 months for HR, 6.7 months for IR, and 8.5 months for LR ($p<0.001$). 43 pts have had a second f/u visit at a mean interval of 6.5 months after the first f/u with a mean CA of 21.2°. There was no difference among groups in the change in CA between visits. One pt in the HR group has progressed to 44° at the latest f/u. 36 pts overall (23%) are being treated with a brace: 60% pts in HR, 33% in IR, and only 7% in LR ($p<0.001$).

Conclusion: A prospective series of pts who underwent prognostic AIS genetic testing is described. 48% of pts tested low risk and had smaller curves on the test date, a longer period between follow up visits and X-rays, and a lower incidence of bracing. Follow up to at least skeletal maturity is required to make any statements about validation of the test for risk of children with mild AIS progressing to a severe curve.

Significance: Proportions of AIS prognostic test results in our practice are different than those described by the developers of the test; it may be that our high acuity practice does not reflect a school screening population. This is important for clinicians in similar situations since it affects recommendations for anticipatory guidance.

79. The Impact of a Distal Expansion Mechanism Added to a Standard Pedicle Screw on Pullout Resistance: A Biomechanical Study

Heiko Koller, MD; Michael Mayer, MD; Juliane Zenner, MD; Wolfgang Hitzl, PhD; Oliver Meier; Herbert Resch

Germany

Summary: Besides using cement augmentation in spinal reconstruction of osteoporotic bones, we still have to search for alternatives increasing screw-bone anchorage characteristics. Therefore, we performed a biomechanical analysis of pullout resistance of a modified standard pedicle screw with a distal expansion mechanism added. Testing in thoracolumbar vertebrae indicated that using a modern expansion pedicle screw failure load could be significantly increased ($p=0.03$). The percentage increase of failure load of the expansion screw compared to the standard screw was about one third.

Introduction: Spinal deformity surgery in osteoporotic bone goes w/ increased risk of implant loosening.Several techn. exist increasing screw anchorage characteristics.Cement augmented screw fixation was shown most efficient, but, it goes w/ a risk for complications related to vertebral cement deposition & leakage and reduces the possibilities for redo surgery.Hence, there is a need to further elaborate alternative screw augmenting techniques that might reduce indications for bone cement.

Methods: 40 vertebrae from 7 fresh-frozen human specimens were harvested & subjected to CT-scans & analysis of BMD. Vertebrae were instrumented with standard 6.0mm pedicle screws & modified 6.0mm pedicle screws w/ a distal expansion mechanism added.Actual working length of both screws inside the vertebrae were identical.The distal expansion mechanism made up one fifth

Paper Abstracts

of the shaft length. Screw insertion accuracy was assessed using biplanar radiographs.Analysis of resistance to pullout was done using coaxial alignment of pedicle screws & attachment to an electromechanical testing machine. Pullout rate was 5mm/min.The peak load-to-failure was measured in Newton and reported as the failure load.With each test the mode of failure was noted.

Results: 17 vertebrae with matched pairs of standard & expansion pedicle screws were eligible for final statistical analysis. BMD was 0.67g/cm. The actual working length of both screws was 40.3mm.Failure load of the standard screw was 726.7N and of the expansion screw 910.5N.Statistical analysis revealed a sign. increased failure load with the expansion screw (p=.028).The percentage increase of failure load of the expansion screw compared to the standard screw was 28.3%. With the expansion screw abrupt vertebral fracture at the vertebral body-pedicle junction & the pedicle occurred 8 times, w/ the standard screw only 4 times.Variations of BMD had no impact on failure load, neither had the screw working length.

Conclusion: Our study indicates that adding a distal expansion mechanism to a standard pedicle screw increases failure load by one third.Modern expansion screws might offer intermediate solutions for augmentation of screw-rod constructs in osteoporotic bone while reducing the need for cement augmented screws & avoiding related risks.

80. Comparison of Anterior/Posterior to Posterior-Only Correction of Scheuermann's Kyphosis: A Matched Pair Analysis of 166 Patients

Heiko Koller, MD; Lawrence G. Lenke, MD; Yutaka Nakamura, MD, PhD; Keith H. Bridwell, MD; Linda Koester, BS; Axel Hempfing, Consultant; Luis Ferraris, MD; Oliver Meier; Juliane Zenner, MD; Wolfgang Hitzl, PhD

Germany

Summary: 90 anterior/posterior (A/P) Scheuermann's kyphosis instrumented corrections were compared to 76 post-only procedures performed at 2 different institutions. Both approaches showed efficacy in radiographic correction of kyphosis into a more normal range, while stiffer kyphoses (residual hyperextension >60°) still required a combined A/P approach or aggressive post-only osteotomies/resections.

Introduction: Scheuermann's kyphosis (SK) can be treated by a combined anterior/posterior (A/P) or posterior-only (post-only) approach. To our knowledge, this is the largest series and first matched pair study comparing these 2 approaches in order to evaluate the amount of instrumented correction obtained.

Methods: 166 pts with SK were treated at 2 centers. 90 pts were treated by a combined A/P approach at 1 center compared to 76 pts treated by a post-only approach at a different center. Ave age for the A/P group was 23.2yrs vs 19.8yrs for the post-only group (p=0.03). The ave preop sagittal Cobb for the A/P group was 69.0° vs 84.1° for the post-only group (p<0.0001),but the maximum residual hyperextension (HE) sagittal Cobb measurement of the A/P group of 48.7° vs the post-only group of 50.8° was not different (p=0.3). However, the preop flexibility was less in the A/P group at 29.7% vs 39.3% in the post-only group (p<0.0001). Additionally, a matched cohort of 92 pts (46 from each center) was established according to similar preop sagittal Cobb (±10°) and HE Cobb (±10°) measurements.

Results: The ave postop Cobb of the A/P group was 38.5° vs 49.5° for the post-only group (p<0.0001). The overall correction of the A/P group of 30.5° vs 34.6° for the post-only group was not different (p=0.07). The difference between the HE Cobb angle and the postop Cobb was 10.2° for the A/P group vs 1.3° for the post-only group (p<0.0001); number of fusion levels was 9.4 vs 11.9 (p<0.0001). For the 46 matched pts, the preop A/P Cobb of 75.9° was similar to the post-only Cobb of 78.8° (p=0.2) and the preop A/P HE Cobb of 52.4° was similar to the post-only Cobb of 51.1° (p=0.6). The 2 matched groups showed similar corrections of 33.7° vs 30.6° (p=0.3) and no significant difference in postop Cobb measurements of 43.4° vs 47.1° (p=0.2).

Conclusion: In this 2 center comparison of 166 pts with Scheuermann's kyphosis, the A/P and post-only approaches resulted in similar average degrees of correction. The A/P pts were more likely to correct more than the preop HE sagittal Cobb measurement, while the post-only group tended to correct very closely to the preop measurement. Thus, in large and stiff SK pts, an A/P approach or post-only approach with vertebral resection may be required.

81. Gradual Scoliosis Correction over Time with Shape-Memory Metal: An Experimental Study

José Miguel Sánchez Márquez, MD; Francisco Javier Sánchez Pérez-Grueso; Nicomedes Fernández-Baillo; Alfredo García Fernández

Spain

Summary: An experimental scoliosis model is produced to analyze the corrective properties of nitinol over time. The model showed structural deformity. Two groups were defined to assess the reliability of the model and the efficacy of this material in correcting the scoliosis over time. The memory-shaped wire produced a gradual correction of the deformity

Introduction: The nickel-titanium alloys, due to its ability to return to a previously defined shape when subjected to a thermal treatment, could be suitable for use in scoliosis correction over time. The aim of this study is to evaluate the shape-memory property for the deformity correction in a rat induced-scoliosis model

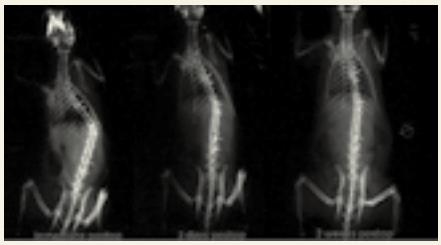
Methods: Right thoracolumbar kyphoscoliosis was produced in 21 days old male Sprague-Dawley rats (n=20), by tethering sutures between the left scapula and pelvis, using Sarwark`s modified model. Eight weeks later, mean scoliosis measured 81 and mean kyphosis 97. After scoliosis induction, rats were randomized in two groups: Group I, tethering was released to assess its lasting effect on the spine. Group II, tethering was released and a straight nitinol wire was inserted to the spine, attached to spinouss processes. Serial x-rays were analyzed to determine the efficacy of the nitinol in the correction of the scoliosis

over time. After rats were killed, histological sections were obtained to analyze morphologic changes at the apical vertebra

Results: Progressive deformity was induced by tethering till a mean angle of 81 of scoliosis and 97 of kyphosis. In group I, after tethering release, an initial decrease of deformity was noted but remained stable and permanent over time (mean angle 55 and 71, respectively at two weeks). In group II, gradual correction of the kyphoscoliosis was noted, decreasing the cobb angle over time (mean scoliosis at inmediate postop: 52, at 3 days postop:28, at 2 weeks postop:8).

Histological changes were noted in the apical vertebral body and end-plates after the deformity induction, which normalized after the scoliosis correction

Conclusion: In this scoliosis correction model, the straight nitinol wire attached to the spine demonstrated efficacy in gradual correction of scoliosis, due to the viscous behavior of the spine by keeping it force loaded, which may offers theoretical advantages over traditional techniques



82. Use of Quantitative Ultrasound (QUS) for Predicting Curve Progression in Adolescent Idiopathic Scoliosis - A Prospective Cohort Study of 294 Cases Followed Beyond Skeletal Maturity

Tsz-ping Lam, MB, BS; Vivian WY Hung; Hiu Yan Yeung, PhD; Bobby KW Ng, MD; Kwong-man Lee, PhD; Jack C. Cheng, MD

China

Summary: We evaluate the use of QUS for predicting curve progression in AIS

Introduction: The main challenge in managing AIS is to predict curve progression so that appropriate treatment can be given. Previous investigation confirmed Bone Mineral Density(BMD) as a significant prognostic factor. It is desirable if a radiation-free modality can be used in lieu of BMD for AIS subjects. Quantitative ultrasound(QUS) is useful for assessing bone density and quality. The objective of this study was to evaluate the use of QUS in predicting curve progression in AIS.

Methods: This was a prospective cohort study on 294 AIS girls between 11-16 years old. They were followed beyond skeletal maturity for curve progression defined as an increase of Cobb angle≥6°. Three calcaneal QUS measurements were done at baseline, namely BUA(Broadband Ultrasound Attenuation), VOS(Velocity of Sound) and SI(Stiffness Index). BMD, Age, Menarchal Status and Cobb angle were also recorded. Logistic regression model was used for evaluating their prognostic values for AIS progression.

Results: The mean age at baseline was 13.4 years old(SD=1.23). 73(24.8%) were pre-menarchal and the mean Cobb angle was 26.3°(SD=8.2). The average follow up was 3.4 years(SD=1.57). Initial univariate analysis indicated all independent variables had p <0.2. Subsequent logistic regression analysis indicated the p-values of their regression coefficients were: Age(p<0.001), Menarchal Status(p<0.001), Cobb(p=0.008), BMD(p=0.084), BUA(p=0.722), VOS(p=0.112) and SI(p=0.027). SI, Age, Menarchal Status and Cobb were retained in the final prediction model. The adjusted odds ratio of curve progression for Z-score of SI was 2.00(95% CI: 1.08 - 3.71) indicating deranged bone quality was related to curve progression. The area under the ROC curve was 0.831(95% CI: 0.785 - 0.877).

Conclusion: SI is an independent and significant prognostic factor for AIS. SI could be considered for estimation of progression risks and treatment planning especially when DXA is not available.

This study is supported by Research Grant Council of Hong Kong Government (CUHK4498/06M)

Significance: QUS can be used for predicting curve progression in AIS. The prognostic value of QUS may indicate the role of deranged bone quality in the etiopathogenesis of AIS and further studies on this are warranted.

83. Total En Bloc Spondylectomy: A North American Experience

Addisu Mesfin, MD; Amit Jain; Ahmed S. Mohamed, MD; Hamid Hassanzadeh, MD; Khaled Kebaish

United States

Summary: Total En Bloc Spondylectomy is a technique first described in Japan in 1994. It provides an alternative to the piecemeal resection of spinal tumors. We report the first North American series with this technique.

Introduction: Total en bloc spondylectomy (TES) was first described in 1994 in Japan. Our objective is to report surgical and oncological results of a North American series of spinal tumors managed via TES.

Methods: Retrospective review of prospectively collected data from 2001-2009. Inclusion criteria were: benign, primary malignant/metastatic spinal tumors managed via TES. Exclusion criteria were spinal tumors not managed via TES and patients lost to follow up. Demographics, lesion location, ASIA scores, Kostuik classification, diagnoses, complications, EBL, recurrences and survival were recorded.

Results: There were 6 males and 1 female with a mean age of 48.2 (37.2-67.3). The diagnoses were metastatic renal cell (n=3), chondrosarcoma (n=1), metastatic chondrosarcoma (n=1) epithelioid hemangioendothelioma (n=1) and fibrous dysplasia (n=1). All patients had pain pre-op and were ASIA grade F. Kostuik classification was 2.3 columns (r=1-4). The lesions were all in the thoracic spine (T3-T11). Reconstruction was with allograft (n=4), Harms cage (n=2) and a PMMA block (n=1). Mean EBL was 3.9L (1.5-8.9). Mean hospital stay was 7.6 days (5-10). Marginal (n=6) and wide margins (n=1) were obtained. Post-op all patients were an ASIA grade F. Five intraop complications

Paper Abstracts

were: pleural tear (n=2), aortic tear (n=1), vena cava tear (n=1), retained sponge (n=1), and five post-op complications were: pulmonary embolism (n=1), urinary tract infection (n=1), pneumothorax (n=1), anterior column support failure (n=1), prominent instrumentation requiring removal (n=1). There were no local recurrences but were 3 recurrences at other sites at a mean of 24 months (6-41). Five patients died at a mean of 35.4 months (9-71). 2 patients are alive at latest follow up.

Conclusion: This is the first reported series of TES in North America. TES is a safe yet challenging technique for the management of benign and malignant spinal tumors.

Significance: Total en bloc spondylectomy (TES) is a technique originally reported in Japan for the management of spinal tumors. This is the first North American series reported with TES for spinal tumors. The technique provides an alternative to the piecemeal resection of spinal tumors and provides decreased local recurrence as seen in our series.

84. Validation of EOS 3D Reconstruction Accuracy Against CT

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United States

Summary: Scoliosis is a 3D deformity; still 3D morphological analyses are rare. The 3rd dimension is critically important, but clinically 2D-radiographs are used due to high CT radiation. A new low-dose radiation machine (EOS) was clinically evaluated for intra/interobserver variability, but data are limited for EOS reconstruction accuracy compared to CT. Our study evaluated the shape, position and orientation accuracy, and how they differ based on the subject's positioning within EOS.

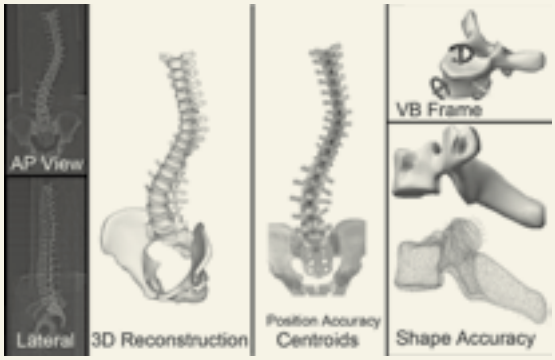
Introduction: Scoliosis evaluation based on 2D radiographs is a simplification of the true 3D deformity. The objective of this study was to assess the accuracy of 3D reconstructions from the new low-dose radiation EOS device compared to CT.

Methods: A synthetic scoliotic phantom (T1-L5; 42deg Cobb) was scanned in the upright position using EOS in 0, ±5, ±10deg axial rotation and in the supine position using CT. 3D EOS reconstructions, 2000 points per vertebra body (VB) were superimposed on corresponding CTs. For each VB, shape accuracy was reported as mean and root-mean-square (RMS) error from point-to-surface distances. Global spinal position precision was determined by optimizing the mean vertebral centroid distances for all levels between CT and EOS and reporting resulting RMS. VB orientation accuracy was defined as the max deviation of Lateral-Sagittal-Axial angles based on the VB local reference frames.

Results: Mean EOS shape accuracy was 1.04mm with 95%CI less than 2.75mm. VB, pedicles and posterior arch were modeled equally well. Spinal position and VB orientation accuracy were very high: max RMS was in the AP direction (0.89mm) and max mean (RMS) in lateral rotation was 1.03deg (0.97deg). The only parameter that changed with varying phantom's positioning was AP offset (0.35mm, p=0.016). Accuracy was equally good for all levels (T1-L5) with no systematic error.

Conclusion: EOS provides for accurate 3D representations of the scoliotic spine and can present a low radiation alternative for obtaining accurate spinal measurements for clinical and research purposes.

Significance: The study results will provide orthopedic surgeons with validity evidence pertaining to this new technology for routine clinical diagnosis and patient care.



85. Effect of Spinal Shortening on Motor-Evoked Potentials and Spinal Cord Blood Flow

Hitesh N. Modi, MS, PhD; Seung-Woo Suh, MD, PhD; Jae Hyuk Yang, MD; Jae-Young Hong, MD

Korea, Republic of

Summary: Animal study for spinal cord injury using spinal shortening is imperative to be helful.

Introduction: Objectives were to study effect of spinal cord injury (SCI) on trans-cranial motor-evoked potential (Tc-MEP) and changes in the spinal cord blood flow (SCBF) on the LASER Doppler.

Methods: Experiment was performed in 10 farm-pigs under general anesthesia. Neuromonitoring was done using Tc-MEP, and SCBF was measured using LASER Doppler flow meter. After dissection, pedicle screws were inserted in T10 and T13 level; which was followed by osteotomy and two level (T11-T12) corpectomy. A gradual staged (phase 1:without morphological change, phase 2:cord buckling, and phase 3:cord kinking) spinal shortening was performed, and simultaneously Tc-MEP and SCBF was monitored. After 30 minutes wake-up test was performed and animal was sacrificed and cord biopsy was obtained.

Paper Abstracts

Results: During spinal shortening MEP signals were maintained in phase1 and phase2; however, during phase 3, all leads were lost suggesting complete SCI (32.2±3.6 mm). The average spinal shortening showing SCI (35±2.7 mm) was similar to average vertebral body height of T11-12 (33.6±1.9 mm) (p=0.115). However, when the distance of spinal shortening was compared with the average segmental height (27.7±1.3 mm) of spinal column (T1-L6), it showed a statistically significant difference (p<0.0001). Considering into percentage of spinal column length, SCI was not occurred at the shortening of 5.1% length of spinal column (safe zone); however, SCI occurred at shortening of 6.3% length of spinal column (unsafe zone). On SCBF measurement, during phase 3 of shortening where it produced SCI, SCBF decreased by 43.1±11.4% (p<0.0001). On wake-up test, we could not observe movements. Histopathology exhibited axonal cutting with ischemic and necrotic changes.

Conclusion: Spinal shortening at TL level can be done safely with the shortening of average segmental height or 5.1% length of spinal column (T1-L6); however, it creates SCI if shortening is of average vertebral body height at T11-T12 or 6.3% length of spinal column.

Significance: Spinal shortening induced SCI model in pig will highlight its relation with spinal shortening amount in future.

86. Pediatric Pedicle Screw Placement Using 3D Image-Guided Navigation is Safe and Accurate

A. Noelle Larson, MD; Edward Rainier G. Santos, MD; Charles Gerald T. Ledonio, MD; David W. Polly, MD; Jonathan N. Sembrano, MD; Cary H. Mielke, MD; Kenneth J. Guidera, MD

United States

Summary: Image-guided navigation and intraoperative CT imaging are new tools to aid in the safe, accurate placement of pedicle screws. In a consecutive series of 50 pediatric patients, 984 pedicle screws were placed with a 96.4% accuracy rate and no complications due to screw malposition.

Introduction: Navigation systems are now available as an adjunct to fluoroscopy and anatomic techniques for pedicle screw placement. This study reports the accuracy of open pedicle screw placement in pediatric patients using image-guided navigation and intraoperative CT.

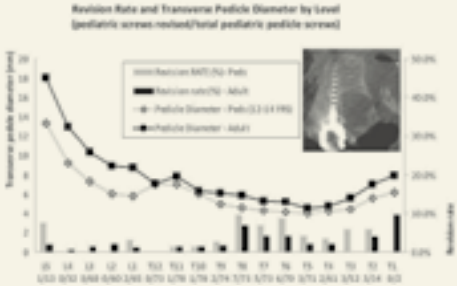
Methods: Between 2007-2010, 984 pedicle screws were placed for spinal deformity correction in a consecutive series cohort of 50 pediatric patients. Mean patient age was 14.4 years (range, 7-18). Underlying diagnoses included idiopathic or neuromuscular scoliosis (43), Scheuermann's kyphosis (3), other (4). Intraoperative CT (O-arm) was performed to establish reference points for the computerized navigation system (Stealth). Screws were placed under real-time navigation guidance and then imaged. Need for screw redirection or removal based on the intraoperative CT is the primary outcome measure for this study.

Results: 984 pedicle screws were placed in pediatric patients using real-time navigation. Based on intraoperative CT, 35 screws (3.6%) were revised (27 redirected, and 8 removed), representing a 96.4% accuracy rate. Screw malposition was most common at T6-T8 (see Figure). No patients returned to the OR for screw malposition.

During the study period, 1511 screws were placed in adult patients using the same image guidance system. 28 screws (1.8%) were revised intraoperatively due to malposition on CT imaging for a 98.2% accuracy rate. Thus, the accuracy in screw placement was higher in the adult versus the pediatric population (chi-square, p=0.008). Kosmopolous et al. found a lower accuracy rate (86.6%) in adult non-navigated screws (p<0.0001) and a comparable rate in adult navigated screws (93.7%). Further, our navigated pediatric screw accuracy rate (96.4%) is somewhat higher than the 94.9% accuracy rate reported for non-navigated pediatric screws in a recent meta-analysis (p=0.03).

Conclusion: We report 96.4% accuracy in pediatric pedicle screw placement based on intraoperative 3D imaging and navigation, which is higher than reported accuracy rates for non-navigated screws.

Significance: Pedicle screw placement in children using image-guided navigation resulted in no identified complications and is a promising technique for improving the safety of pedicle screw placement.



87. Long-Term Functional Results after Anterior Surgery with Screwed / Plate Construct for Treatment of (AIS): Correlation between Results and Sagittal Balance

Guillaume Riouallon; Thierry Odent, MD, PhD; Caroline Elie; Jean-Paul Padovani; Christophe Glorion

France

Summary: Based on a monocentric series of operated AIS, the objective of this study was to report the influence of sagittal balance on the long-term functional outcome after an anterior spinal arthrodesis. Outcomes were studied with a minimum follow-up of 15 years (mean follow-up: 22 years). Anterior spinal surgery for Lenke I,V have predictable long-term functional results with good sagittal and coronal corrections. Better functional results were obtained in patients who maintained and found a more anterior sagittal balance in time.

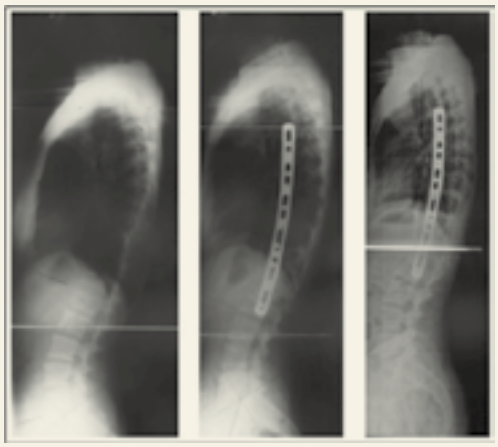
Introduction: Based on a monocentric series of operated AIS, the objective of this study was to report the influence of sagittal balance on the long-term functional outcome after an anterior spinal arthrodesis.

Paper Abstracts

Methods: One hundred and eleven patients were operated on with titanium shaped anterior plates between 1975 and 1993. Thirty-five patients, 6 males and 29 females, were available for review with complete clinic and radiographic assessment. Clinical outcomes were assessed using the SRS-30 Questionnaire (French Canadian version) and the Oswestry disability index. Long films enabled to evaluate the curve correction, coronal and sagittal balances including pelvic parameters. Clinical results were analyzed and correlated to radiographic findings.

Results: Average age of patients at time of surgery was 14.5 Years. Curves were classified as type 1 in 24 cases and type 5 in 11 cases according to Lenke. Mean pre-op Cobb angle was 44° (16-80) and 11° (0-50) after surgery. Mean C7 plumb line value which was located 34 mm behind the superior anterior aspect of the S1 body was not modified after surgery. Average follow-up was 21 years (16-31). The average SRS 30 score was 3.8/5 and correlated with the ODI score (13.8%). A 4.5° global kyphosis evolution was observed equally in the spine fusion and into the adjacent levels and a mean anterior translation of the C7 plumb line of 8 mm associated with an increase of 3° of the pelvic retroversion. The best results of the functional score were observed in patients who had the anterior translation of the C7 plumb line ($p<0.005$).

Conclusion: Anterior arthrodesis offers good long-term functional outcome. After the surgery, the frontal alignment was well restored and sagittal balance was not changed. The C7 plumb line is one of the major component to evaluate sagittal balance. Its "normal" range of value is not defined yet. However, we noticed the better functional results with patients who found a more anterior new balance status with time.



88. Treatment of Lenke 1 AIS Curves: Where to Stop Proximally and How does it Affect Shoulder Balance? Comparison of Selective vs. Non-Selective Thoracic Fusions

Jaspaul Gogia, MD; Darren R. Lebl, MD; Akilah B. King, BA; Matthew E. Cunningham, MD, PhD; John S. Blanco, MD; Roger F. Widmann, MD; Oheneba Boachie-Adjei, MD; Complex Spine Study Group

United States

Summary: A retrospective radiographic evaluation of Lenke 1 Adolescent Idiopathic Scoliosis (AIS) pts treated with fusion and pedicle screw fixation demonstrated no differences in proximal thoracic (PT) curve correction or shoulder symmetry when the fusion did not include the flexible non-structural proximal thoracic curve. Instrumentation of proximal thoracic curves in the treatment of Lenke 1 AIS pts may not be indicated.

Introduction: Shoulder symmetry is an important factor to consider in surgery for AIS. Many surgeons currently fuse flexible PT curves in an effort to obtain improve shoulder balance. This study investigated the need to include or exclude the PT curve in Lenke 1 pts with the hypothesis that no difference would be present with respect to shoulder symmetry.

Methods: A retrospective review of 148 consecutive AIS pts treated with fusion was performed. 22 pts met inclusion criteria of Lenke 1 curve type, posterior pedicle screw fixation, and 2-yr f/u. The 22 pts were divided into 2 groups: Group 1 (n=9) included those who were fused to the upper end vertebra or one level higher. Group 2 (n=13) included those fused 2 or 3 levels proximal to the upper end vertebra. Radiographic measurements including PT, main thoracic (MT), T1 tilt, clavicle angle (CA) and shoulder height difference (SHD) were performed for each patient at preop, 6 wk and final f/u.

Results: The avg age in both groups was 14 yrs (10-17yrs). The avg f/u in Group 1 was 28 mos (24-36mos) and 30 mos (24-47mos) in Group 2. There was no difference between the 2 groups in preop angles for MT ($p=0.77$), T1 tilt ($p=0.25$), CA ($p=0.54$), and SHD ($p=0.22$). Preop PT curves averaged 19.6 deg (12-28deg) in Group 1 and 28.3 deg (14-41deg) in Group 2 ($p=0.02$). Preop PT curve flexibility averaged 35% (range 21-61) in Group 1 and 50% (range 14-73) in Group 2 ($p=0.04$). Postop, no significant differences were seen in PT ($p=0.21$) or MT ($p=0.06$) curve correction or changes in T1 tilt ($p=0.44$) or SHD ($p=0.19$). Changes in CA averaged 4.1 deg in Group 1 and 2.1 deg in Group 2 ($p=0.02$).

Conclusion: While Group 2 had larger preop PT curves, these curves were also much more flexible. No significant differences were seen in either group with respect to postop measures of T1 tilt or SHD. Increased changes in CA were seen in Group 1.

Significance: This study indicates that there is no benefit to incorporating the PT curve in the surgical Lenke 1 AIS pts. This can potentially avoid the increased implant cost, neurologic risk, and operative time required to extend instrumentation proximally.

89. Frontal or Sagittal Spinal Imbalance Does Not Affect Quality of Life Two Years after Posterior Spinal Instrumentation and Fusion for Adolescent Idiopathic Scoliosis

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United States

Paper Abstracts

Summary: Although curve correction by posterior spinal instrumentation and fusion (PSIF) for adolescent idiopathic scoliosis (AIS) is correlated with improved self-image and quality of life (QOL), this study demonstrates that coronal or sagittal imbalance at 2 years does not negatively affect self-perception or QOL.

Introduction: Literature suggests that curve correction by PSIF for AIS is correlated with improved self-image and QOL. Despite segmental fixation with modern techniques, ~20% of patients have significant spinal imbalance after PSIF. This study aims to investigate the influence of sagittal and coronal balance on QOL and self-perception 2 years following PSIF for AIS.

Methods: Review of a multicenter database identified 761 patients who underwent PSIF with minimum 2 years follow-up. Scoliosis Research Society-30 (SRS-30) and Spinal Appearance Questionnaire (SAQ) scores were compared in patients with and without imbalance. Coronal imbalance was defined as > ±2cm deviation of the C7-plumbline from the central sacral vertical line. Sagittal imbalance was defined as > ±2cm deviation of the C7-plumbline from the posterior-superior corner of the S1 vertebra.

Results: Major preop Cobb angle was positively correlated with both an improvement in self-perception and QOL. Body Mass Index (BMI) was positively correlated with increased pain and improved QOL. While statistically significant, the relationships with Cobb angle and BMI were quite small and potentially clinically insignificant. In contrast, spinal imbalance at 2 years postop did not correlate with change or absolute magnitude of either SRS-30 or SAQ scores.

Conclusion: Moderate spinal imbalance is currently considered to be >2cm deviation in either the coronal or sagittal planes, and the presence of coronal or sagittal imbalance at 2 years does not negatively affect self-perception or quality of life.

Significance: Care must be taken interpreting this data, as although AIS patients did not report issues with QOL or self-perception 2 years following PSIF, our definition of imbalance may not be fully correct and spinal imbalance may have long-term implications beyond two years. However, if these findings persist with longer follow-up, surgical strategies including the choice of more extensive levels of fusion may need to be revisited.

90. Unintended Change in Physiological Lumbar Lordosis and Pelvic Tilt after Posterior Spinal Instrumentation and Fusion: How Much is Too Much?

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United States

Summary: Patients who undergo posterior spinal instrumentation and fusion (PSIF) for adolescent idiopathic scoliosis (AIS) commonly loose lumbar lordosis (LL) which is associated with a concomitant increase in pelvic tilt (PT).

Introduction: Spino-pelvic relationship highly influences sagittal balance. This study investigates the effect of decreased LL after PSIF on the change in PT. Furthermore, this study examines the patient-specific relationship between LL and pelvic incidence (PI), testing the hypothesis that lumbar spinal fusion resulting in "mismatched LL" is associated with increased PT.

Methods: Query of a prospective multicenter database identified 155 AIS patients at least 2 years after PSIF with lowest instrumented vertebra between L2-L5. LL (T12-S1), LL within fusion (LLIF), LL below fusion (LLBF), sagittal balance (SB), PT, and PI at preop and 2 years postop were measured. Change in PT was compared between patients with "appropriate" or "inappropriate" LL as defined by the relationship between LL and PI. Appropriate LL was defined by both the relationship commonly used in clinical practice (LL = PI+10), and a research driven model from the literature (LL = 0.56PI + 33.43). Health related quality of life measures (HRQOL) were also examined.

Results: 38% of patients had loss of LL 2 years after PSIF. Patients with loss of LL had a significantly higher rate of increased PT than patients without loss of LL (73% vs. 40%, $p<0.0001$). In multiple regression, change in LL, LLIF and change in SB all had significant predictive effect on PT ($p<0.001$, $R2=0.21$). Using either the clinical practice definition or the research driven model, patients with LL < 2SD (12°) from predicted were more likely to have increased PT ($p=0.046$ and $p=0.027$, respectively). There were no significant associations between changes in LL or PT and HRQOL.

Conclusion: Iatrogenic loss of LL commonly occurs in lumbar fusion for AIS. This loss of LL is strongly associated with a reciprocal increase in PT. As such, spinal fusion can have unintended effects on sagittal alignment which may have unknown consequences in the future.

Significance: Correlation between HRQOL and adequate LL (defined as LL proportional to a patient-specific PI) has been established in the adult population. The possible implications of poor sagittal balance after PSIF for AIS warrants continued attention and investigation.

91. Role of Intervertebral Release and Three-Column Spinal Osteotomy in Corrective Surgery for Degenerative Thoracolumbar/Lumbar Spinal Deformity in Patients over 60 Years of Age

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Japan

Summary: Consecutive 27 patients over 60 years of age with degenerative thoracolumbar/lumbar spinal deformities were prospectively enrolled in this observational cohort study. Correction rate of scoliosis was significantly higher in posterior spinal fusion (PSF) with intervertebral release (IVR) than in non-IVR. Whereas, bending correction index of kyphosis was significantly better in 3-column spinal osteotomy (3CO) than in non-3CO. Although PSF with IVR or 3CO is major invasive procedure, rigid and imbalanced deformities in the elderly were effectively corrected without severe complications.

Paper Abstracts

Introduction: Aim of this study was to investigate merits and demerits of intervertebral release (IVR) and 3-column spinal osteotomy (3CO) in posterior spinal fusion (PSF) for the elderly with spinal deformity.

Methods: Consecutive 27 patients (average age: 67 years, range: 60-76) who underwent PSF for degenerative thoracolumbar/lumbar spinal deformities were prospectively enrolled in the observational cohort study. There were 14 patients with scoliosis and 13 with kyphosis. Preop Cobb angle of scoliosis and kyphosis was 50.6 +/- 11.0° and 38.9 +/- 18.9°, respectively. Preop coronal and sagittal global balance evaluated by C7 plumb line deviation was 40 +/- 37mm and +104 +/- 80mm, respectively. Efficacy of IVR or 3CO for deformity correction was evaluated by correction rate (CR) and bending correction index (BCI). BCI is calculated by dividing degree of surgical correction by degree of bending correction.

Results: A mean follow-up period was 20 (12-45) months. Cobb angle and CR of scoliosis at follow-up was 16 +/- 11° and 72 +/- 15% in IVR, whereas 26 +/- 8° and 40 +/- 17% in non-IVR. There was statistically significant difference in CR between the two procedures (p=0.01). CR of coronal balance in IVR (82 +/- 41%) was significantly higher than CR in non-IVR (29 +/- 42%) (p=0.02). BCI of scoliosis was 1.4 +/- 0.5 in IVR and 1.2 +/- 0.3 in non-IVR (p=0.73). Whereas, BCI of kyphosis in 3CO (2.9 +/- 2.1) was significantly higher than that in non-3CO (0.9 +/- 1.2) (p=0.03). Final sagittal Cobb angle of the thoracolumbar (T10-L2) and lumbar spine (T12-S1) was +4 +/- 4° and -48 +/- 7° in 3CO and +16.3 +/- 12° and -33 +/- 14° in non-3CO, respectively. Sagittal alignment of thoracolumbar/lumbar spine was significantly better in 3CO than in non-3CO ($p<0.05$). Complication was junctional problem in 6 patients, surgical site infection in 2, transient radiculopathy in 1. There is no permanent paralysis and perioperative death.

Conclusion: Although PSF with IVR or 3CO is major invasive procedure, rigid and imbalanced deformities in the elderly were effectively corrected without severe complications.

92. Long Adult Spinal Deformity Fusion to Sacrum Using Low Dose rhBMP-2: A Retrospective Evaluation and Comparison to Reported High Dose rhBMP-2 vs. Autogenous Iliac Crest Bone Graft(ICBG)

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United States

Summary: A low pseudarthrosis rate (4.3%) for long adult spinal deformity fusions using rhBMP-2 was recently reported by the Washington University group. The mean quantity of BMP they used to achieve such an impressive fusion rate (119mg) can be considered high, and may be cost prohibitive. We report our experience in a similar cohort fused using rhBMP-2 at a considerably lower dose (38.6mg). Despite fusing older patients with multiple medical comorbidities, our pseudarthrosis rate (21.4%) was similar to that reported for ICBG (28.1%).

Introduction: The Washington University group(WashU) reported a favorable fusion rate for high dose rhBMP-2(95.7%)vs ICBG(71.9%)(p=0.057) in long adult spinal deformity fusions (thoracic-sacrum/iliac)(Spine V34,#20,p2205-12). The average dose BMP(Posterior 91.2mg; Anterior 30.9mg; Total 119mg) may be cost prohibitive at many centers.

We perform similar fusions using a lower mean dose BMP(Posterior 25.7mg; Anterior 15.0mg; Total 38.6mg). We hypothesize our pseudarthrosis rate is comparable to ICBG.

Methods: Retrospective analysis of long adult spinal deformity fusions consecutively performed by the senior author(1/06-12/08). 51 long fusion cases(thoracic-sacrum) performed on ambulatory adult patients without other musculoskeletal diagnoses. 32 had prior fusions. Of the remaining 19, 14 were fused to the ilium with minimum 2yr follow-up. Pseudarthrosis was determined radiographically.

Results: Of 14 patients(3 male/11 female), 5 had prior lumbar decompression and 1 had prior vertebroplasty. Mean age 67.4(51-80), 100% with multiple medical comorbidities. The WashU cohort was younger with less comorbidity. Number of levels 7.6(7-9) was less than WashU. 13 treated via an all posterior approach(WashU all but 2 AP), 12 had interbody fusion(11 TLIFs, 1 ALIFs). Mean # of interbody levels fused was 2.25 using a mean of 6.7mgBMP/level (WashU 11.7mg/level). Posterior fusion with a mean of 3.4mgBMP/level (WashU 10mg/level). Cortical allograft, local autograft and a small quantity of ICBG(obtained as a consequence of technique for placement of iliac screws) was used in addition to BMP. The average total BMP used per case 38.6±5.1mg is considerably less than WashU (119mg).

3 patients had pseudarthrosis(21.4%), 2male, 1female, mean age 64.3. All had posterior surgery with interbody fusion 6.7mgBMP/level and posterior fusion 3.4mgBMP/level. 1 of these patients had PSO for correction of severe sagittal deformity (no BMP at PSO site). There were no statistically significant differences in age, levels, or BMP use in those with pseudarthrosis.

Conclusion: Despite fusing older patients with multiple comorbidities, our pseudarthrosis rate using a 67% lower dose of BMP is similar to that reported for ICBG alone. A prospective evaluation of high vs. low dose BMP is warranted.

93. Factors Influencing the Transition from Non-Operative to Operative Treatment in Elderly Adults with Degenerative Scoliosis

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United States

Summary: The rate of transition to operative therapy of patients initially managed nonoperatively for elderly degenerative scoliosis and the factors influencing this transition have not been demonstrated. In order to address these questions, we examined a group of such patients presenting to a surgical clinic for evaluation. A significant portion of these patients transitioned to operative therapy and reported higher ODI and lower SF-12 scores.

Paper Abstracts

Introduction: Few studies report the long term outcomes of elderly adult degenerative scoliosis patients treated nonoperatively. In addition, the rate of transition to operative therapy of patients initially managed nonoperatively and the factors influencing this transition have not been demonstrated. In order to address these questions, we evaluated a group of such patients presenting to a surgical clinic.

Methods: 92 consecutive adult degenerative scoliosis patients (age >60, mean 69) were followed prospectively upon presentation to the surgical clinic. All were initially managed nonoperatively. Quantitative measures of health status (SF-12 and ODI), VAS pain scores, and radiographic parameters were recorded. Patient followup was recorded at specified biennial time points or when a patient transitione to surgery. Statistical analysis was performed via T-Test with a P<0.5 considered significant.

Results: 73 patients (79%) were followed for a minimum of 2 years (mean 2.64 years) or became operative patients. Of these 18 (25%) went on to have surgery in the followup period with a mean time to surgery of 1.6 years. There were no differences at presentation in age, health status (SF-12, ODI), leg pain, back pain, or sagital balance between those that transitioned and those that were maintained with nonoperative treatment. At last follow-up or pre-surgical follow-up, crossover patients had lower SF-12 scores (P=.033), higher disability scores (p=0.04), and worse back (6.8 vs 4.8 (p=0.002)) and leg (5.4 vs 3.0 (p=0.002)) pain. There were no differences in radiographic parameters. Of note there was no significant overall progression of sagittal balance or maximum coronal curve. Patients continuing nonoperative therapy did not demonstrate significant changes in SF -12 and ODI scores.

Conclusion: There is a significant transition to surgery rate in nonoperatively managed elderly scoliosis patients. Those transitioning reported higher disability and worse pain and health. Patients continuing conservative therapy report stable outcome measures.

94. Over Correction by Osteotomy for Sagittal Plane Deformity: It Happens and Here is Why

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Summary: Clinical and radiographic analysis of 183 adult spinal deformity patients that underwent pedicle subtraction osteotomies was performed to identify surgical strategies leading to over-correction of the sagittal plane alignment. Over-corrected patients (postoperative Sagittal Vertical Axis <0mm), were younger, had a significant lower post-operative pelvic incidence, pelvic tilt, and Sagittal Vertical Axis than patients not over-corrected.

Introduction: Sagittal malalignment has shown significant correlation to pain and disability and can be surgically addressed with pedicle subtraction osteotomies (PSO). Key radiographic spino-pelvic objectives to reach improvement in clinical outcomes include: Sagittal Vertical Axis (SVA) <50mm, Pelvic Tilt (PT) <20° and Pelvic Incidence-Lumbar Lordosis (PI-LL)=10°. While under-correction has been reported as a cause of poor outcome, the impact of over-correction for PSO has not been reported.

Methods: A multicenter, retrospective clinical and radiographic analysis of 183 consecutive ASD patients undergoing PSO. Inclusion criteria were patients older than 18 with lumbar lordosis <20°, SVA > 5cm, PT > 25°, or thoracic kyphosis (TK) > 60°. Patients were divided into 3 groups based on SVA correction: well-corrected (0<SVA<50mm), under-corrected (SVA>50mm) and over-corrected (SVA<0mm). All patients had full-length lateral spine x-rays taken pre and postoperatively. Correlation between radiographic parameters and amount of sagittal correction was evaluated using chi-square and t-tests.

Results: The three groups were comparable preoperatively in terms of previous surgeries and regional alignment (LL and TK). Patients over-corrected were younger than the two other groups and had a significant lower pelvic incidence (53° vs 62°), PT (30 vs 36°), and SVA (94 vs 185mm) than patients under-corrected. No significant differences were found for the amount of PSO resection, and instrumented levels. Changes in LL were not significantly different between groups. Patients over-corrected showed a significant higher improvement in SVA and PT correction than the others groups (p<0.05) but with a lower gain in thoracic kyphosis (5 vs 12°).

Conclusion: Over-corrected patients showed a significantly lower PI than the others and over-correction was related to a lack of restoration of TK. Special attention must be paid to preoperative planning before sagittal realignment procedures. Further studies will be necessary to evaluate long term clinical outcomes of these overcorrected patients.

95. Pedicle Subtraction Osteotomy with Extension of Fusion to the Pelvis: Does Anterior Interbody Support at L5-S1 Improve Sagittal and Pelvic Parameters?

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United States

Summary: Evaluation of 77 adult spinal deformity patients receiving lumbar pedicle subtraction osteotomy (LPSO) with fusion to the sacro-pelvis for sagittal spinal malalignment (SSM) demonstrated that performance of L5-S1 interbody fusion did not enhance correction of sagittal spino-pelvic parameters compared to patients not receiving L5-S1 interbody fusion. Additionally, the type of interbody fusion performed at L5-S1 (anterior vs. posterior approach) and timing of the anterior interbody fusion (prior vs. after the LPSO procedure) did not impact SSM correction.

Paper Abstracts

Introduction: Lumbar pedicle subtraction osteotomy (LPSO) improves lumbar lordosis (LL), sagittal vertical axis (SVA), and spino-pelvic alignment (SPA). Reports have indicated that interbody fusion at the L5-S1 improves arthrodesis rates at the lumbosacral junction; however, the contribution of L5-S1 interbody procedure toward sagittal alignment correction when performing LPSO is unknown.

Methods: Multi-center, retrospective, radiographic analysis of adult spinal deformity (ASD) patients undergoing LPSO with fusion to the sacro-pelvis for sagittal spinal malalignment (SSM) using a prospective collected database. Inclusion criteria: age >18 years, pre and postoperative spine radiographs permitting spino-pelvic parameter measurement. Exclusion criteria: post-traumatic, infectious, neuromuscular or tumor associated spinal deformities. Patients evaluated according to type of interbody fusion performed at L5-S1 (anterior approach= ALIF, posterior approach=T/PLIF, no interbody= NONE). ALIF patients divided into timing of the ALIF procedure: prior to (ALIFpre) or after (ALIFpost) the LPSO procedure. Radiographic analysis included coronal and sagittal spino-pelvic parameters and degree of focal PSO correction.

Results: 105 patients were treated with LPSO with fusion to the sacro-pelvis, of which 77 patients met inclusion criteria. Interbody procedures included: NONE, n=32; T/PLIF, n=15; ALIFpre, n=19; ALIFpost, n=11. Mean preoperative radiographic parameters, correction of and postoperative values for SVA, L5-S1 angle, lumbar lordosis and PSO angle were similar for all treatment groups (ANOVA<0.05). T/PILF had greater postoperative pelvic tilt (PT) than ALIFpost (29.4° vs. 17.1°and p=0.014), however PT correction was similar for all groups.

Conclusion: Anterior interbody graft at L5-S1 has been reported to enhance fusion rates at the lumbosacral junction despite higher reported complication rates. There was, however, no added benefit of ALIF vs. TLIF with respect to sagittal SPA correction when performing LPSO and fusion to the sacro-pelvis. Further research is needed to evaluate long-term outcomes to determine the ideal interbody approach at L5-S1 when performing LPSO.

96. Validation of the SRS-Schwab Adult Deformity Classification

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United States

Summary: While classifications in the pediatric population are well established, there is still a need for a complete classification for adult spinal deformity. A previous classification system has been revised to include pelvic parameters, which have shown marked correlation with HRQOL measures in recent studies. Initiated by the SRS Adult Deformity Committee, this study demonstrates that the proposed new adult spinal deformity classification system is clear and has excellent intra- and inter-rater reliability and agreement.

Introduction: A classification of adult spinal deformity (ASD) can serve several purposes, including: a) consistent characterization of a clinical entity, b) a basis for comparing different treatments, and c) recommended treatments. While scoliosis classifications in the pediatric population are well established, an ASD classification is still being developed. A previous classification system has met with clinical relevance, but did not include pelvic parameters, which have shown marked correlation with HRQOL measures in recent studies. Based upon a Scoliosis Research Society effort, this study seeks to determine if the proposed new ASD classification system is clear and reliable.

Methods: Initiated by the SRS Adult Deformity Committee, this study used a classification system previously published by Schwab, revised to include pelvic parameters. Modifier cutoffs were determined using HRQOL data analysis from a multi-center database of adult deformity patients. 9 readers graded 21 pre-marked cases twice each, approximately one week apart. Inter- and intra-rater reliability and inter-rater agreement were determined for the curve type and each modifier separately. Fleiss' Kappa was used for reliability measures, with values of 0.00-0.20 considered slight, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial, and 0.81-1.00 almost perfect agreement.

Results: Inter-rater Kappa for curve type was 0.80 and 0.87 for the two readings respectively, with modifier Kappas of 0.75 and 0.86, 0.97 and 0.98, and 0.96 and 0.96 for PI-LL, PT, and SVA, respectively. By the second reading, Curve type was identified by all readers consistently in 66.7%, PI-LL in 71.4%, PT in 95.2%, and SVA in 90.5% of cases. Intra-rater Kappa averaged 0.94 for Curve Type, 0.88 for PI-LL, 0.97 for PT, and 0.97 for SVA across all readers.

Conclusion: Data from this study show that there is excellent inter- and intra-rater reliability and inter-rater agreement for curve type and each modifier. The high degree of reliability demonstrates that applying the classification system is easy and consistent. Greater Kappa values in the second set of readings also demonstrate a learning curve in application of the classification system.

97. Multiplanar Radiological Assessment and Outcomes of Minimally Invasive Surgical Treatment (XLIF) in Adult Deformity: Follow-Up out to 36 Months

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Venezuela

Summary: The current study was undertaken to evaluate one site's early experience with XLIF in lumbar degenerative scoliosis and kyphosis and analyze the role of indirect decompression of the neural elements through restoration of foraminal dimensions and its effect on clinical outcomes.

Introduction: The direct lateral approach (XLIF) offers a less invasive and therefore more tolerable surgical option for patients with degenerative lumbar disease. XLIF allows for minimally invasive placement of a large anterior graft, facilitating disk height and alignment restoration.

Methods: 62 patients underwent XLIF for the treatment of symptomatic degenerative scoliosis. In all cases the far-side annulus was disrupted to ensure

symmetric disc space distraction and a 50-55mm PEEK interbody implant filled with DBM in a lipid carrier mixed with hydroxyapatite and tri-calcium phosphate granules was placed from side to side across the disc space at the scoliotic levels such that it rested on the strong ring apophysis. 10% of cases included additional internal fixation. Patients were followed clinically and radiographically for up to 36 months postoperatively.

Results: 62 patients with symptomatic degenerative scoliosis and spinal stenosis were included. Mean patient age was 58 yrs (range: 41-76 yrs). XLIF was performed at 1 to 4 lumbar levels (mean 2 levels) between L2 and L5. Mean operative time was 130 minutes and in all cases measured blood loss was less than 50cc. Patients were typically out of bed, ambulating and advanced to regular diet on the day of surgery, and discharged home the following day. There were no procedural complications. Mean pain VAS decreased from 8.1 preoperatively to 2.8 at 3 months postoperatively, 3.4 at 1 year, 4.8 at 2 years, and 4.6 at 30 months. Mean ODI improved from 53 preoperatively to 19 at 3 months postoperatively, 22 at 1 year, 21 at 2 years, and 28 at 36 months. Scoliotic deformity was corrected from a mean Cobb angle of 22° to 12°, and lumbar lordosis was improved from a mean of 34° to 41°.

Conclusion: The rapid postoperative recovery suggests XLIF to be a less morbid procedure than traditional large reconstructive surgeries for the treatment of symptomatic degenerative lumbar deformity. Clinical and radiographic outcomes up to 30-months follow-up show that the XLIF procedure for this condition provides continued pain relief, improved physical function, and maintenance of sagittal and coronal plane deformity correction.

98. Surgical Outcomes of Long Spinal Fusions for Scoliosis in Patients with Rheumatoid Arthritis

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United States

Summary: The management and outcomes of surgery for thoracolumbar scoliosis in patients with rheumatoid arthritis (RA) is not known. Our experience with long spinal fusions (≥9 levels) in RA patients demonstrates high complication and revision rates.

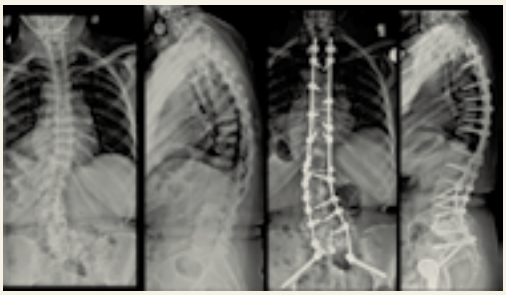
Introduction: Outcomes of long spinal fusions for scoliosis in patients with rheumatoid arthritis (RA) are not known. Our objective was to document surgical outcome and complications associated with the management of scoliosis in patients with rheumatoid arthritis.

Methods: Retrospective review of prospectively collected data from 2000 - 2009 for patients with RA who underwent long spinal fusions for scoliosis. Our inclusion criteria were: RA, nine or higher vertebral levels fused and a diagnosis of degenerative or idiopathic scoliosis. We excluded patients that had eight or fewer levels fused, non-RA patients and patients who did not have scoliosis. Demographics, co-morbidities, levels fused, complications and revisions were recorded.

Results: Ten consecutive RA patients who met the inclusion criteria were identified. There were 9 females and 1 male. Average age at surgery was 65.6 (40.5-81.9). There were 0 smokers and 1 patient with diabetes mellitus. Average follow up was 40.3 month (0.03 - 88.5). 6 cases were index spinal fusions and 4 cases were revisions. All patients had degenerative scoliosis, 8 had lumbar stenosis and 2 had kyphosis. RA medications used included 8 oral steroids, 7 disease modifying antirheumatic drugs (DMARDs) and 1 biologic DMARD. There were an average of 10.5 levels fused (9 -17). 8 cases were posterior only and 2 were combined anterior/posterior. Average estimated blood loss was 3.1L (1.3 - 5). Average hospital length of stay was 14.2 days (5 -55). 12 complications in 8 patients included: incidental durotomy (2), pseudoarthrosis (2), epidural hematoma (2), post-op death 2nd to respiratory failure (1), distal junctional kyphosis (1), pulmonary embolism (1), respiratory failure requiring tracheotomy (1), neurologic deficit(1), deep infection (1). 7 patients required a revision procedure.

Conclusion: Long spinal fusions in patients with RA are associated with high rates of complications and revisions.

Significance: This is the first study documenting surgical outcomes following the management of scoliosis in patients with rheumatoid arthritis.



99. A Prospective Study to Assess the Utility of MRI Planning in the Use of a Lateral Transpsoas Approach to the Lumbar Spine

Hazem Nicola; Manuel Da Silva

Venezuela

Summary: To propose a classification based in the location of the lumbar plexus in psoas muscle in MRI scans and intraoperative confirmation with EMG monitoring. Relationship between these structures at L4-L5 level is described for assisting in preoperative planning in candidates for lateral approach surgery.

Introduction: The lateral transpsoas approach is being increasingly employed to treat common spinal disorders. A concern with this approach is the safe accessibility of the disc space around the nerves of the lumbar plexus. Neuromonitoring techniques and MRI images have been employed to aid in the identification of intra-psoas nerves and the useful in preoperative planning.

Methods: 42 patients underwent lateral approach interbody fusion at L4-5 for the treatment of symptomatic degenerative disease. Preoperative axial MRI of the disc level were assessed by two independent reviewers for position of the

Paper Abstracts

lumbar plexus in relation to both the intervertebral disc and the psoas muscle. Classifications of plexus position were made by dividing the vertebral footprint into quadrants (A to D) from posterior to anterior, with zone A occupying the posterior margins of the disc space and zone D in anterior quadrant. The position of the lumbar plexus on preoperative MRI was analyzed with respect to both intraoperative EMG readings and postoperative lower extremity muscle strength immediately postoperative, 2 and 6 weeks, 3,6, and 12 months postoperative.

Results: In 42 patients treated, the lumbar plexus on preoperative MRI resided in the following zones: Zone A: 22 patients (52.3%), Zone B: 13 (30.9%), Zone C: 7 (16.6%), Zone D: 0 (0.0%). The concordance MRI-EMG was Zone A: 22/22 patients (100%), Zone B: 10/13 (76,9%), Zone C: 7/7 (100%). All but one patient (Zone C) was approachable at L4-5, based on the feedback of intraoperative evoked directional EMG. Five (11.9%) patients exhibited postoperative quadriceps weakness; 2 with 2/5 strength (Zone C), 1 with 3/5 (Zone B), and 2 with 4/5 (one Zone B and one Zone C).

Conclusion: This study describes a system that may help to prevent injury to the lumbar plexus at L4-L5 using the lateral approach based on a radiographic classification used in preoperative planning. The following guidelines are proposed: lumbar plexus in Zone A: low risk of nerve injury, safe indication for any size implants; Zone B: moderate risk for nerve injury, safe indication for narrow implants and partial indication for larger implants; Zone C: high risk for nerve injury, a narrow implant is recommended and be prepared to switch to another approach.

100. Short Segment Posterior Instrumentation for Unstable Burst Fractures of the Dorsolumbar Spine. Is Fusion Really Necessary?

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Egypt

Summary: A prospective randomized study of 101 patients with unstable burst fractures of the dorsolumbar spine followed for a minimum of 2 years. All patients had short segment posterior instrumentation; 54 patients were treated without fusion; while 47 patients had posterolateral fusion using iliac crest autograft. There was no significant difference in neurological recovery, VAS outcome, kyphosis correction, anterior height restoration or canal compromise clearance. Patients who had fusion had significantly more operative time, blood loss, hospital stay and overall complications.

Introduction: The concept of 'Ligamentotaxis' using short segment posterior instrumentation and fusion is widely accepted for managing unstable burst fractures of the dorsolumbar spine in patients who score ≤ 6 at Gaines' Classification. The aim of this work is to evaluate the role of fusion in these patients and to study the possibility of performing this procedure without fusion.

Methods: This is a prospective randomized study performed between 2000 and 2008. It included 54 patients with burst fractures of the dorsolumbar spine treated with short segment posterior instrumentation without fusion (Group 1); compared to a similar group of 47 patients that were treated by the same technique with posterolateral fusion using iliac crest autograft. Patients were followed up for an average of 5y (range 2 - 8y).

Results: In Group 1, all patients with neurological impairment improved 1 to 2 Frankel grades; the VAS improved from an average of 7.8 to 1.3 and the overall complications were 4/54. The kyphotic deformity was corrected from an average of 22.6 degrees to an average of 3.1 degrees; the average anterior height of the fractured vertebrae was corrected from an average of 65% to an average of 92% and the compromise of the spinal canal improved from an average of 42% to 14%. Implant failure occurred in 2 patients. There was no significant difference in these parameters between Groups 1 and 2. In Group 2 there was significantly more operative time, blood loss, hospital stay and 10/47 complications including 2 implant failures.

Conclusion: Short segment posterior instrumentation without fusion is a safe efficient procedure with significantly less operative time, blood loss, hospital stay and complications than when fusion was performed. The possibility of removing the implants after 1 year to restore motion segments is still for future consideration.

101. Modified Posterior Vertebral Column Resection For The Treatment Of Osteoporotic Fractures With Neurological Deficit In Elderly Patients

Cagatay Ozturk, MD; Ahmet Alanay; Meric Enercan; Mehmet Aydogan; Mehmet Tezer; Azmi Hamzaoglu, MD

Turkey

Summary: Decompression of the spinal canal and reconstruction of anterior column via a posterior approach provided satisfactory results in osteoporotic elderly patients. This procedure obviated the need for anterior approach which might have caused significant morbidity.

Introduction: Purpose of this retrospective study was to evaluate the results of posterior vertebral column resection and spinal canal decompression via unilateral approach in elderly patients having osteoporotic vertebral fractures with neurological deficit by eliminating disadvantages of anterior approach.

Methods: Twenty-five consecutive patients (22 female and 3 male) with more than 2 years follow-up were included. Fractures were at thoracic in 10 and thoracolumbar spine in 15 patients. Nine patients had Frankel D and 16 patients had radiculopathy and spastic paraparesis and pain unresponsive to medication. Radiographic analysis included Local kyphosis angle (LKA). Clinical outcome and complications were also evaluated. Surgical technique included placement of cement augmented pedicle screws, followed by hemilaminectomy, unilateral pediculectomy, sacrification of nerve root in thoracic levels, decompression of spinal canal by doing subtotal vertebrectomy and adjacent discs and anterior column support by titanium mesh. Contalateral posterior elements were preserved for fusion.

Results: Av. age was 71.4 (56-88) years and follow-up was 65 months (24-96). Av. level of instrumentation was 5.6 (4-8), operation time was 380 (180-600) minutes and blood loss was 580 (450-700) ml. Av. preoperative LKA of 13.2 degrees improved to 3.6 degrees postoperatively and was 3.8 degrees at last follow-up. Preoperative VAS of 8.0 was 2.1 postoperatively and 3.1 at final follow-up. Full neurologic recovery was achieved in all patients. There was no pseudoarthrosis. Two patients developed superficial wound infection. One patient had dural tear and one had adjacent segment fracture requiring revision.

Conclusion: Decompression of the spinal canal and reconstruction of anterior column via a posterior approach provided satisfactory results in osteoporotic elderly patients. This procedure obviated the need for anterior approach which might have caused significant morbidity. Preservation of ipsilateral bone stock might have helped to obtain higher fusion rates.

Significance: -

102. Combat vs. Noncombat Spine Injures in Operation Iraqi Freedom and Operation Enduring Freedom

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United States

Summary: The burden of combat and noncombat spine injuries in these wars is substantial. Service members involved in combat are much more susceptible to explosions, gunshot wounds (GSW) and motor vehicle collisions that inflict significant spine injuries. The anatomic distribution of combat and noncombat spine injuries is largely similar, with lumbar being the most common.

Introduction: The nature of noncombat injuries to the spine sustained by service members during the Iraq(OIF) and Afghanistan(OEF) conflicts have been poorly documented in the literature. The purpose of this study was to characterize the noncombat spinal column injuries and compare them to combat-related injuries.

Methods: The Joint Trauma Theater Registry (JTTR) was queried for all US service members sustaining injuries to the spinal column and spinal cord in OIF and OEF from Oct 2001 to Dec 2009. Combat(C) and noncombat(NC) injuries were differentiated and compared according to anatomic location, mechanisms of injury (MOI), actual direct MOI, and concomitant injuries.

Results: 502 service members sustained a total of 1832 combat injuries to the spinal column, including 1687 fractures (92.1%); compared to 92 service members sustaining 269 noncombat, spinal column injuries (SCI), with 241 (89.6%) fractures. Categorization by type/location of injury is in The most common C and NC injuries were transverse process fractures (combat: 546,29.8%; noncombat: 105,39.0%), followed by compression fractures (C=308,16.8%; NC=70,26.0%), and burst fractures (C=156,8.5%;NC=33,12.3%). 91 service members (18.1% of patients) sustained spinal cord injuries (SCI) in combat with 41(45%) being ASIA A, compared to 13(13.5% of patients) NC-SCI with 6(46.2%) complete injuries. The reported MOI for 335 combat service members (66.7%) was an explosion compared to 1 noncombat (1.0%) explosive injury. 190 patients (37.8%) sustained gunshot wounds(GSW) in C compared to 5(5.2%) NC GSWs. 15 patients (3.0%) sustained a combat-related fall compared to 29(30.2%) NC falls. The actual direct MOI was classified as blunt for 335(66.7%) patients sustaining C injuries and for 91(94.8%) patients sustaining NC injuries. 190 had a penetrating MOI(37.8%) in combat patients and 5(5.2%) in NC patients.

Conclusion: The burden of combat and noncombat spine injuries in these wars is substantial. Service members involved in combat are much more susceptible to explosions, GSW and motor vehicle collisions that inflict significant spine injuries. The anatomic distribution of combat and noncombat spine injuries is largely similar, with lumbar being the most common.

103. Pediatric Spine Trauma in the United States - Analysis from the Healthcare Cost and Utilization Project (HCUP) Kid's Inpatient Database (KID)

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United States

Summary: Kid's Inpatient Database (KID) includes data from 3,452,325 non-birth discharges in 38 states from children 0-19 years old representing 88.8% of the age-specific US population. A 6-fold increase in the prevalence of spine injuries occurs when children reach the legal driving age to 240.2 per million population.

Introduction: There is a scarcity of data in the literature describing the epidemiology of spinal injuries in children and adolescents. The purpose of this study is to examine the prevalence, risk factors and treatment of pediatric spine injuries in a large national (US) database.

Methods: The Kid's Inpatient Database (KID) consists of data from 3739 hospitals in 38 states and includes 3,452,325 non-birth discharges from children 0-19 years old. These states represent 88.8% of the US population. Weighed data is presented for 2006 US population, which consists of 82,079,106 children (US Census Bureau).

Results: The prevalence of spinal injuries for 2006 was 77.1pmp (per million population) under the age of 20. Children between 15-20 accounted for 81.2% of all injuries (prevalence of 240.2pmp) (chart 1). Sixty percent of all spine injuries in children and adolescents were related to motor vehicle collisions. This was particularly relevant, in the group older than 15 years. Other risk factors included alcohol (5.9%) and drugs (4.9%). Neurological injury was also present in 28.2% of these cases (prevalence of 25.1pmp) of which, 50% resulted from cervical spine injuries.Treatment of these injuries included 1 or more interventions in 62.2% of the patients. These patients had longer hospitalizations (8.6±13 days vs. 2.9±2.9 days, $p<0.0001$) and incurred in significantly higher medical expenses ($83,387±$103,195 vs. $18,127±$17,003; $p<0.001$). The vast majority (93.9%) of injuries were treated in urban hospitals, although 52.45% of the children were originally from smaller communities.

Paper Abstracts

Conclusion: The prevalence of spinal injuries for 2006 was 77.1pmp under the age of 20, representing a 34.7% increase in 10 years. Children between ages 15 and 20 accounted for 81.2% of all injuries, with a prevalence of 240.2pmp, a significant increase from younger age groups. The majority of spine injuries in the 15-20 year old group are related to motor vehicle collisions, concurring with reports from the National Trauma Data Bank (NTDB). Neurological injury was also present with a prevalence of 25.1pmp. Fifty percent resulted from cervical spine injuries.

Significance: A 6-fold increase in spine injuries occurs when children reach the legal driving age.

104. Prevalance of Associated Injuries in Children with Spine Fractures

Jeffrey R. Sawyer, MD; Ben Guevara, MD; William C. Warner, MD; Derek M. Kelly, MD

United States

Summary: A spine fracture in a child may be an marker of high energy trauma. Spine fractures are assocaited with a high rate of associated injuries including additional spinal fractures, frequently noncontiguous. Imaging studies should include the entire spinal column to avoid missing these fractures.

Introduction: While spine fractures represent 1% of all pediatric fractures, they can be devastating injuries. To determine if associated injuries could be predicted by age and fracture type, we investigated the type and prevalence of associated injuries in pediatric patients with spinal fractures.

Methods: Records and x-rays of 332 consecutive children with spine fractures treated a pediatric trauma center were reviewed. Patients were divided into three age-based groups: 0-3 yrs, 4-12 yrs, and >12 yrs. Associated injuries were classified as abdominal, thoracic, head injury, other fracture. Of special interest was the frequency of noncontiguous spinal fractures.

Results: There were 332 patients(mean age 14.9, range 6 mo-19 yrs: 62% male and 38% female. There were 15 patients in the 0-3 year old group, 39 patients in the 4-12 year old group, and 278 in the 13-19 year old group. Overall, 77% had some kind of associated injury; 46% had multiple spinal fractures, 36% of which were at noncontiguous levels. 30% of the spinal fractures were located in the cervical level, 24% were thoracic, and 37% were in the lumbar spine. 61% of the children had a fracture at either the thoracic or lumbar spine while 8% had a fracture both of the cervical spine as well as the thoracolumbar spine. 22% of patients also had another orthopedic injury. The most common overall non-spine fracture was upper extremity long bone (53%) followed by lower extremity long bone (26%) and pelvis (12%). Thoracic trauma was very common with 40% of children suffering a thoracic injury, followed in prevalence by head or face trauma 35%, abdominal injury 27%, and finally neurologic injury of 10%.

Conclusion: Spinal fractures in children, especially those aged 0-3 years, have a high rate of associated injuries. Nearly half of pediatric spinal fracture patients have additional spinal fractures, over a third of which are noncontiguous. Imaging studies should include the entire spinal column to avoid missing these fractures.

Significance: Children with spinal fractures have a high rate of associated injury, including multiple spine injuries. Many of these spine injuries are non-contiguous. Examination and imaging studies should include the entire spinal column to avoid missing these fractures.

105. Pediatric Cervical Spine Injury: A Single Institution Study

James Barnes; Parthak Prodhan, MD; Richard E. McCarthy

United States

Summary: A retrospective study for a single institution investigating cervical spine injury patterns and outcomes. Injury patterns included were multi-level fractures, location of fracture, and associated ligamentous injury. Outcomes were cases requiring surgical intervention, post-injury CNS impairment and other associated injuries, ICU stay/ventilation required and mean hospital stay.

Introduction: Background: Cervical injuries are the most common of all spinal injuries in children and may be associated with significant disability and mortality.

Objective: Investigate patterns and outcomes of cervical spine injuries in children.

Methods: This retrospective study analyzed trauma-related data from 88 children (0-20 years) with cervical spine injuries from 2006-2010 at our institution. Fisher and t-test were used for group comparisons.

Results: The mean age was 13.9 years (range: 1.4-19.6 yrs), mean ISS-14 (range: 4-75). Injury characteristics included: 44 (50%)-multi-level fractures; 40 (45%)-associated ligamentous injury (subluxation injury was the most common [33%]); Anterior fracture-27 (31%), with the majority (18 [66%]) having a compression fracture; 57 subjects (65%) had a posterior fracture with over half (29) involving fractures of the facet; involvement: upper level (C1-C2)-46 (52%), middle level (C3-C5)-40 (45%), and lower level (C6-C7)-70 (79.5%). Patients younger than 9 years showed more involvement in the upper c-spine (67%), whereas those older than nine had more involvement in the lower levels (59%) (p value=0.08). Significantly more children below 9 years required mechanical ventilation, compared to those above 9 years (8 vs 16; p value: 0.023). Outcomes included: surgical intervention required in 32 cases (36.4%), with most requiring one operation (88%), most often spinal fusion with graft (27 cases [85%]); post-injury CNS impairment-10 (11%); 67% (59 cases) had associated injuries, with head trauma the most common (37 patients [63%]). ICU stay in 42 (48%); overall mean ICU-LOS was 7.6 days (range: 1-27), (<9 years - mean LOS=4.3 vs >9 years-mean LOS=3.6 [p value=0.04]), mean days of ventilation-11 days (range: 0-27) and mean hospital-LOS -16.5 days (range: 1-233).

Conclusion: Unique patterns exist in children with cervical spine injuries. Children <=9 years old show more involvement in the upper c-spine and have significantly longer ICU-LOS than those >9 who show more involvement in the lower c-spine. Most children do not require operative intervention; those who do, require one surgery.

Paper Abstracts

106. Functional and Quality of Life Outcomes in Geriatric Patients with Type II Odontoid Fracture: One Year Results from the AOSpine North America Multi-Center GOF Prospective Study

Alexander R. Vaccaro, MD, PhD; Branko Kopjar; Jens R. Chapman, MD; Christopher I. Shaffrey, MD; Michael Fehlings, MD, PhD, FRCSC; Paul Arnold; Ziya L. Gokaslan, MD; Roger Hartl, MD; Darrel S. Brodke, MD; John C. France, MD; S. Tim Yoon; Mark B. Dekutoski, MD; Rick C. Sasso, MD; Christopher Bono

Canada

Summary: Treatment outcomes of geriatric odontoid fracture seems to be better in surgical group although possibility of selection bias needs to be carefully considered.

Introduction: This lack of consensus among clinicians as to the optimal management strategy (surgery or conservative) for geriatric odontoid fractures is exacerbated by the paucity of objective, prospective information regarding treatment outcomes in this condition.

Methods: A total of 166 subjects > 65 years presenting with an odontoid fracture were recruited between January 2006 and May 2009 at 13 sites in North America. Patients received nonoperative or surgical treatment at the discretion of the surgical team and were followed for 12 months.

Results: The average age was 80.7 (SD 7.6) with a range from 65 to 101 years. 59.6% were females. 65.6% patients were treated operatively (15.2% anterior odontoid screw; 76.2% posterior C1- C2 screw fixation; 6.7% posterior transarticular screw fixation and 1.9% other) and 34.4% with conservative approaches. A total of 26 (15.7%) subjects expired and 5 subjects withdrew from the study.

The pre-injury NDI was 20.5 (SD 16.7) and the 12-month NDI was 28.3 (SD 20.1) ($P < .01$). SF36v2 PCS at baseline was 41.8 (SD 10.05) and at 12-month 39.4 (SD 10.1) ($P = .03$). SF36v2 MCS at baseline was 52.48 (SD 10.3) and at 12-month 48.1 (SD 11.9) ($P < .01$).

There were no differences in age, gender and mortality between the surgically and conservatively treated subjects. SF36v2 PCS outcomes were similar between the two treatment groups but the SF36v2 MCS outcomes were better in the surgical group as compared to the cohort of patients managed nonoperatively (49.8 and 45.2 in surgical and conservative groups, respectively, $P = .05$). After adjustment for baseline characteristics, the 12-month NDI was 34.1 in the nonoperatively-managed group as compared to 25.1 in the operative group ($P < .01$).

Conclusion: Elderly patients with type II odontoid fracture experience significant mortality which is probably due to advanced age and generally compromised health status. However, the vast majority of patients (85% in our study) survive 12 months following the initial injury. Our results do suggest that functional and quality of life outcomes may be better in the surgical group, though the possibility of selection bias needs to be carefully considered.

107. Corpectomy of the Fifth Lumbar Vertebra: A Challenging Procedure

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Germany

Summary: L5 corpectomy and cage replacement is a demanding procedure due to the vascular anatomy at that level. Between 2003 and 2008 twenty five consecutive cases underwent L5 corpectomy in our institution. The indications for surgery were fracture (44%), bony destruction by tumour (44%), and spondylodiscitis (12%). The mean amount of intraoperative blood loss was 3.4 L. The mean follow-up period was 3.4±1.6 years. Intraoperative techniques and complications are discussed. Cases necessitating revision surgery are demonstrated.

Introduction: Corpectomy of the fifth lumbar vertebra is a challenging procedure. The location of the vascular bifurcation in front of that vertebra renders its removal one of the difficult operations in spine surgery. Publications dealing with this item are scanty.

Methods: Between 2003 and 2008 twenty five consecutive cases (13 females and 12 males, mean age 54.5 years) underwent L5 corpectomy in our institution, followed by titanium cage implantation and posterior stabilisation.

Results: The indications for surgery were fracture (44%), bony destruction by tumour (44%), and spondylodiscitis (12%). The mean amount of intraoperative blood loss was 3.4 L (4.7 L for fractures, 2.9 L for tumours, and 600 ml for spondylodiscitis). The cage was implanted through a posterior approach in a single patient with lymphoma and L5 root infiltration. In the remaining 24 patients, an expandable cage was implanted through a ventral approach. The cage was applied between the vascular bifurcation in 6 patients, while in the majority of cases (18 patients), the cage was applied from lateral to the bifurcation. Intraoperative complications occurred in two patients presenting with fracture. This was in the form of injury to the left common iliac vein in one patient and extensive epidural bleeding reaching 10 L in the other patient. Five patients (mean age 67 years) died within two years after surgery: two of them were presenting with spondylodiscitis and died later due to sepsis, while the remaining three patients had advanced malignancy. In the remaining 20 patients, the mean follow-up period was 3.4±1.6 years. Local recurrence of infection occurred in one patient necessitating change of the cage. Recurrence of metastasis occurred in two patients; one of them underwent posterior decompression and the other one was treated successfully with local irradiation.

Conclusion: L5 corpectomy and cage replacement is a demanding procedure due to the vascular anatomy at that level. Large amount of blood loss should be expected, especially in cases presenting with fracture or tumour. In case of complication or recurrence of the pathology, revision surgery is more demanding and necessitates a wide experience.

Paper Abstracts

108. Percutaneous Stabilization of Spinal Metastasis

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Denmark

Summary: Eighteen patients with spinal metastasis were stabilized with percutaneous pedicle screw technique. All patients reported reduced back pain after to surgery. The median survival time was three months. One patient had implant failure. Percutaneous pedicle screw fixation may be a relevant treatment option in patients with spinal metastasis.

Introduction: The use of percutaneous techniques for instrumented spinal fusion procedures have gained increasing interest over the last decade. Patients undergoing stabilization because of spinal metastasis are especially prone to wound complications. We report the primary experiences with a percutaneous technique for spinal stabilization in this group of patients.

Methods: Eighteen patients were operated; nine males and nine females. All patients had a known primary malignant disease at the time of surgery; the dominating diagnosis being breast and lung cancer. In all cases the indication for surgery was back pain corresponding to a spinal metastasis on one or two adjacent spinal levels. None of the patients had neurological compromise.

The median age at the time of surgery was 60 years (range 27-80 years).

All patients were operated with a titanium pedicle screw system, allowing a multi-level, percutaneous spinal fixation. In all patients, except four, decompression at the affected level was done through the tube retractor.

Results: The median number of stabilized segments was 4 (range 2-7). The median surgery time was 180 minutes (range 128-294) and the median time of perioperative radiography was 4 minutes (range 2-10). All patients reported reduced back pain after surgery.

All patients underwent postoperative radiation therapy initiated 7-10 days after surgery.

The median survival time after surgery was 107 days (range 8-726 days).

One patient was re-operated after six months due to implant penetration of the skin. The protruding part of the implant was removed, and the skin healed.

Another patient developed root symptoms after six months due to tumor tissue. In that patient the rod on the affected side was removed through a minimal incision and decompression performed.

Conclusion: Due to the high mortality in this group of patients, a minimum of six months follow up is acceptable. Percutaneous fixation of spinal metastasis can be considered in cases with metastatic affection on one or two adjacent spinal levels, when the primary indication for surgery is back pain.

Significance: Percutaneous fixation of spinal metastasis in a selected group of patients is a feasible treatment option; and may reduce the risk of wound complications.

109. Results of Surgical Management of Metastatic Spinal Tumours Based on an Epidural Spinal Cord Compression Scale

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United Kingdom

Summary: The aim of this retrospective cohort study is to demonstrate the outcome of surgical treatment in patients with different grades of ESCC from metastatic tumours.

Introduction: An Epidural Spinal Cord Compression scale (ESCC) has recently been validated and shown to be reliable for metastatic tumours.

Methods: Sixty-nine consecutive patients (mean age 63.5 years (38-82); 41M, 28F) with metastatic spinal cord compression were treated with surgical decompression/stabilisation from January 2009 to October 2010 (22 months). The mean follow-up was 7.3 months (range 3 months - 23.3 months).

Results: The distribution of patients according to the ESCC was as follows:

4 - grade 0 (bone-only disease)

2 - grade 1a (epidural impingement without deformation of the thecal sac)

6 -grade 1b (deformation of the thecal sac without spinal cord abutment)

6 - grade 1c (deformation of the thecal sac with spinal cord abutment)

15 - grade 2 (spinal cord compression but with CSF visible around the cord)

36 - grade 3 (spinal cord compression and no CSF visible around the cord).

The moost common primary tumours were Prostate, Myeloma, and Breast. Most patients presented with both pain and neurological deficit.

In all patients with cord compression (n=51, ESCC grades 2-3), neurological status improved by at least one Frankel grade in 19/51 (37%), remained stable in 31/51 (61%), and deteriorated by one Frankel grade deterioration in 1/51 (2%). In patients without cord compression (n= 16, ESCC grades 0-1c), neurological status improved by at least one Frankel grade in 3/16 (19%), and was preserved in the remaining patients (13/16, 81%).

39% of patients with metastatic spinal cord compression (grades 2-3) had complications when compared to 26% without spinal cord compression (grades 0-1c).

The mean survival period following surgical decompression was 220 days. Survival period was better in patients without cord compression versus those with cord compression (242.2 days versus 176.4 days ($p = 0.01$).

Conclusion: Our study shows that neurological improvement is seen even in patients with more severe cord compression following decompression/stablisation surgery. However, there is a higher rate of complications in these patients and the survival period appears to be significantly greater in patients without spinal cord compression.

Paper Abstracts

110. Surgical Outcomes of a Posterior Approach for Large Ventral Intradural Extramedullary (IDEM) Spinal Cord Tumors

Chi Heon Kim, MD, PhD; Chun Kee Chung; Soo Eun Lee, MD

Korea, Republic of

Summary: Although a posterior approach has been stated to be feasible for ventral intradural extramedullary (IDEM) spinal cord tumors, it is always challenging to operate on a large one that occupy >50% of the spinal canal. Here the authors report that even large ventral IDEM tumors can be removed via conventional laminectomy without postoperative instability.

Introduction: Most IDEM spinal cord tumors are meningiomas and schwannomas, which are separated from the spinal cord by a discrete anatomical barrier (the arachnoid or pia membrane). As a result of this anatomical barrier, a tumor can be removed using the posterior approach with conventional laminectomy. Although many reports have demonstrated the feasibility of the posterior approach for ventral tumors, there have been no studies detailing large ventral IDEM tumors.

The object of this study is to present surgical outcomes for treatment of large ventral intradural extramedullary (IDEM) spinal cord tumors with conventional laminectomy.

Methods: From 2001 to 2008, we operated on 18 consecutive patients with a large ventral IDEM tumor using the posterior approach (8 cervical, 10 thoracic). Preoperatively, eight patients were classified as having Nurick grade 1 myelopathy, six patients had grade 2, and four had grade 3. Tumors were removed through a slit-like space between the dura and spinal cord without retraction of the spinal cord. Complete removal of the tumor was possible in 17 cases. The follow-up period was 39±28 months (range: 10-97).

Results: Seven cases were meningiomas, and 11 were schwannomas. One schwannoma was mixed with the cervical rootlets, and the mass in the foramen was left behind. Clinical symptoms improved in 16 patients and stabilized in 2. The one residual mass was stable for 62 months. There were no cases of recurrence. Neither kyphotic change nor instability developed in any patients during the follow-up period.

Conclusion: Large ventral IDEM spinal cord tumors can be completely removed using a posterior approach and conventional laminectomy. An understanding of the anatomical and growth characteristics of these tumors is extremely important for successful removal. However, this approach should be applied prudently and with a thorough understanding of its limitations.

111. Surgical Outcome of Spinal Hepatocellular Carcinoma Metastases

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Korea, Republic of

Summary: Although there are many papers about spinal metastasis, reports focusing on spinal hepatocellular carcinoma (HCC) metastasis have been scarce due to the low incidence in western countries. Spinal HCC metastasis is notorious for profuse bleeding during surgery and poor outcome. Therefore, it is very important to determine optimal surgical indications. Our study showed that patients with spinal HCC metastasis survived about 7 months. Child class was the most significantly correlated with survival time and preoperative ambulatory status was significantly correlated with postoperative ambulation period. Both ambulatory status and hepatic function should be prudently considered in selecting surgical candidates.

Introduction: Spinal hepatocellular carcinoma (HCC) metastases are increasing with improved survival of patients with HCC. However, its treatment outcome, particularly regarding functional outcome, has not been adequately investigated. This study aimed to present the surgical outcome of spinal HCC metastases and to demonstrate prognostic factors for survival and ambulation time.

Methods: Thirty-three patients (M:F=30:3) were retrospectively reviewed. Child-Pugh classification (Child class) was used to assess hepatic function. Preoperatively, 19 patients could ambulate (groupA) and 14 patients (groupB) could not. Preoperatively, 18 patients received conventional fractionated radiotherapy.

Results: The spinal metastases were removed to achieve sufficient neural decompression. If destabilization developed, instrumentation and/or vertebroplasty were performed. Postoperatively, conventional radiotherapy was administered to 13 patients. Patients survived for 203 ± 31 days. Child class and preoperative/postoperative ambulatory ability were correlated with survival time, with Child class being the most significant factor (HR, 3.75; 95% CI, 1.38-10.22). After the operation, ambulatory ability was maintained in all patients from groupA and was recovered in four from groupB. Twenty-three patients could ambulate for 285 ± 62 days. Preoperative ambulatory status and Child class were correlated with a longer ambulatory period, with preoperative ambulatory status most significant (HR, 8.62; 95% CI, 2.39-31.04). Patients expired 81 ± 71 days after the loss of ambulatory ability, regardless of postoperative ambulatory status.

Conclusion: In spinal hepatocellular carcinoma metastasis, ambulatory status and hepatic function were significantly correlated with survival and ambulation time. Both ambulatory status and hepatic function should be considered in the selection of surgical candidates.

112. Surgical Treatment of Aneurysmal Bone Cysts of the Spine

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United States

Summary: Aneurysmal bone cysts of the spine can be successfully treated surgically. Pain is the most common presenting symptom. Surgical management with reconstruction and fusion yields a low recurrence rate.

Introduction: Aneurysmal bone cysts (ABC) are rare, benign, highly vascular pseudotumors of unknown etiology. Our objective was to describe the

Paper Abstracts

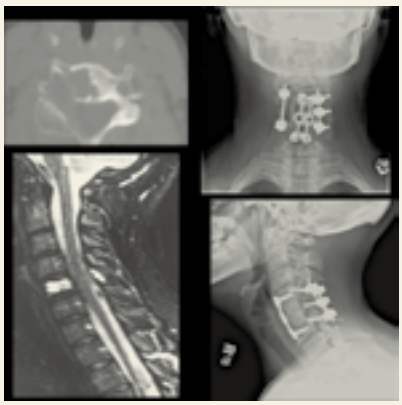
presentation, complications, recurrence rate and long term follow up of patients with ABCs of the spine treated surgically.

Methods: A retrospective review of prospectively collected data of patients diagnosed with ABCs of the spine (excluding the sacrum) at our institution was performed. From 1995-2006, 17 patients were identified; 14 of the 17 patients underwent surgical management at our institution. 3 of the 17 patients were managed at outside institutions. From the 14 patients managed at our institution, 9 had greater than 2 year follow up. The location of the ABCs, recurrence rates, presenting symptoms, treatment and complications were documented for these 9 patients.

Results: The cervical spine, five, was the most common location, with two in the lumbar and two in the thoracic spines. Mean age of presentation was 17.2 (5-32). The average follow up was 49.6 month (24-88). All patients underwent either resection and combined anterior and posterior spinal fusion (six) or resection and posterior spinal fusion (three). Two recurrences within 3 month were noted. Pain was the presenting symptom in 100% of cases. Four complications were noted.

Conclusion: ABCs of the spine can be successfully treated with surgical resection and in this study no recurrence was noted in seven of nine patients after a minimum of two year follow up.

Significance: Aneurysmal bone cysts of the spine can be successfully treated surgically. Surgical management with reconstruction and fusion yields a low recurrence rate.



113. A Novel Approach to Upper Lobe Tumors Involving the Spine: Video-Assisted Thoracoscopic Surgery with Posterior Spinal Reconstruction

Geoffrey E. Stoker, BS; Jacob M. Buchowski, MD, MS; Michael P. Kelly, MD; Bryan F. Meyers, MD; G. Alexander Patterson, MD

United States

Summary: In conjunction with posterior spinal reconstruction, video-assisted thoracoscopic surgery may be a viable alternative to thoracotomy for the treatment of superior sulcus tumors involving the spine.

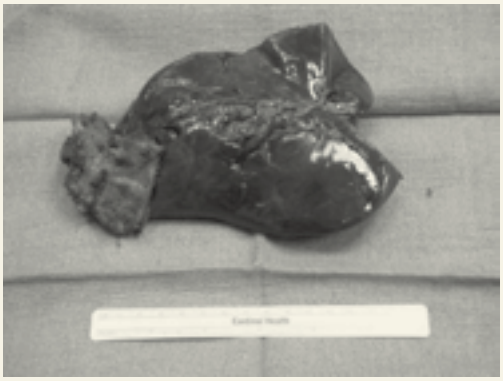
Introduction: Video-assisted thoracoscopic surgery (VATS) is associated with less morbidity and recovery time than traditional open thoracotomy (OT) for the resection of non-small cell lung cancer (NSCLC). Expanding apical NSCLC may involve adjacent vertebrae. To our knowledge, VATS and posterior spinal reconstruction (PSR), as a single procedure, has yet to be described.

Methods: Eight consecutive patients who underwent PSR for treatment of an upper lobe tumor at a single institution were identified. VATS or OT were performed at the time of the reconstruction. All eight patients were treated with preoperative neoadjuvant chemotherapy and seven of eight received preoperative radiotherapy. All tumors were biopsy-confirmed NSCLC without metastases (Stage III).

Results: The groups were similar ($p>0.05$) with respect to age (VATS: 54±11 vs OT: 54±3 years), BMI (24±4 vs 22±5 kg/m2), tumor volume (237.0 mL vs 237.8 mL), and levels fused (6.5±1.0 vs 7.8±1.7). Although not statistically significant, operative time (367±117 vs 518±264 min) and estimated blood loss (813±463 vs 1250±1500 mL) were less in the VATS group than the OT group. Excluding one OT patient who was hospitalized for 70 days due to incidental durotomy, septic shock, and bronchopleural fistula, length of stay tended to be shorter in the VATS group (5.8±1.0 vs 8.3±2.3 days). Mean follow-up was 1.1±0.9 years. One patient died in each group due to tumor recurrence and metastasis. One patient in the OT group had wound dehiscence requiring a local advancement flap. In total, complications occurred in three patients in each group. Reoperation was required in one patient in the VATS group and in two patients in the OT group.

Conclusion: VATS performed under the same anesthesia as PSR may be a viable surgical option for upper lobe tumors invading the spine.

Significance: Superior sulcus tumors infiltrating the spine often entail a poor prognosis. VATS with PSR is a novel method allowing potentially curative resection of Stage III superior sulcus tumors and may offer some benefits when compared to traditional OT with PSR.



Pathological specimen including the left upper lobe and T2 and T3 vertebrae.

Paper Abstracts

114. Comparison of Unilateral vs. Bilateral Kyphoplasty in Patients with Multiple Myeloma

Frank D. Vrionis, MD, PhD; Mohammed Eleraky, MD; Kamran Aghayev; Ioannis Papanastassiou, MD

United States

Summary: The purpose of this study was to compare unilateral vs bilateral kyphoplasty in a uniform cancer population. 69 patients with 105 treated levels were included (51 bilateral vs 54 unilateral). Differences in height restoration were not significant postoperatively or 3 months after the operation. Cement filling was more in the bilateral group, whereas extravasation in the spinal canal was similar. We conclude that radiological outcome is similar for both methods; unilateral kyphoplasty may be applied whenever feasible without compromising results.

Introduction: There is no consensus if bipedicular is superior to unipedicular kyphoplasty. The aim of this study was to determine if a difference in height restoration and cement extravasation in the spinal canal exists between unilateral and bilateral kyphoplasty in a uniform multiple myeloma population.

Methods: We retrospectively reviewed 112 myeloma patients who underwent 690 consecutive balloon kyphoplasty procedures of the thoracolumbar spine in a single institution. Inclusion criteria were: acute/sub acute fractures, satisfactory visualization of the end plates, minimal follow up of three months and index level fracture with collapse and edema in the MRI. 69 patients (57% males, mean age 61.6 years [range 44- 79 years]) with 105 levels overall met the inclusion criteria (51 levels bilateral vs 54 levels unilateral).

Results: Mean anterior height before the operation was 2.71cm and was restored to 2.78cm postoperatively and 2.77 three months after the operation. Middle height was 2.50 and was restored at 2.68 and 2.67 at 3 months. Posterior height measurements were 2.79, 2.81 and 2.80 respectively. The height restoration in the anterior border was 6.2 mm in the unilateral vs 7.4mm in the bilateral group (pre vs post-op, p: 0.3, unpaired t-test). In the middle of the vertebrae was most of the height gain was encountered values were 17.5 vs 18 mm respectively (p: 0.8). In the posterior border as expected there was minimal restoration as expected (1mm vs 1.9 mm, p: 0.2). At the 3- month interval there was less than 1mm collapse, (more pronounced in the middle aspect- 0.95mm), with minimal difference between procedures. Mean cement volume in the unilateral group was 4.1 cc vs 4.9 (p: 0.002). No serious complications were encountered in any cases. In 13.3% of the levels cement extravasation was reported in the disk space and in 4.8% in the spinal canal. From the latter extravasations 3 happened in the unilateral vs 2 in the bilateral group (p: 0.5, Fisher exact test); none was symptomatic.

Conclusion: There was no difference in the radiological outcome or complication rate between unilateral and bilateral approach. Therefore, unilateral kyphoplasty may be performed whenever it is technically feasible without compromising results.

115. A Prospective, Randomized, Controlled Clinical and Radiological Study to Evaluate and Compare the use of Silicated Calcium Phosphate and rh-BMP2 in Interbody Lumbar Spine Fusion. 36-Month Follow-Up

Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD

Brazil

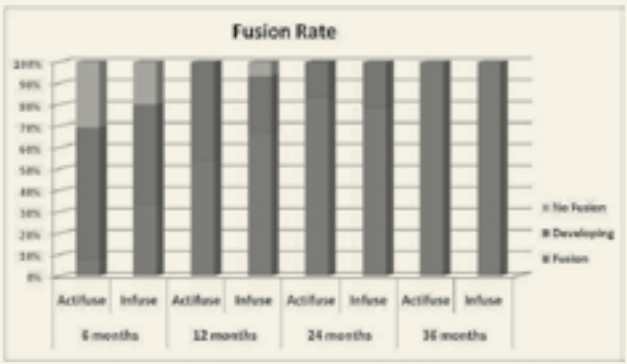
Summary: Comparison between a gold standard bone graft (rh-BMP2) to a silicated calcium phosphate. Radiological and clinical outcomes were assessed to evaluate and compare the performance of these two bone substitutes.

Introduction: Autograft has traditionally been the "Gold Standard" for orthopedic bone grafting applications, but presents some clinical challenges specific to spinal fusion. The biological bone substitute has been comparable to autologous bone graft, but its price makes difficult its use. This work shows a prospective, randomized, controlled single-center study evaluating and comparing the rh-BMP2 to a silicated calcium phosphate bone graft.

Methods: Thirty patients (47.6 ± 11.5 y/o) were randomized and fifteen patients underwent spinal fusion using Silicated Calcium Phosphate (group I) and 15 patients using rh-BMP2 (group II) as a bone graft substitute. Patients underwent lateral interbody fusion for single level DDD at L4-L5. The subjects were evaluated preop and postop at 1 and 6 weeks and 3, 6 and 12, 24 and 36 months. Analysis consisted of pain assessment through the VAS, ODI, SF-36 and radiological assessments were done by three independent radiologists.

Results: Clinical results improved similarly in both groups compared to the baseline. At six-month follow-up early fusion it was present in 33% (5 patients) of group II and only in one group I patient. At 12-month follow-up fusion rate was 67% and 54% respectively for group II and I. At final CT assessment 100% of enrolled patients achieved solid fusion at the index level.

Conclusion: These clinical results are consistent with previous studies indicating that the unique surface charge of the silicate calcium phosphate stimulates the formation of robust bone in the interbody fusion site and both products provide an effective graft material for lumbar fusion applications. Based on the clear evidence of high rates of fusion in this spinal application, completing larger studies with longer periods of follow-up to further confirm the efficacy of Silicated Calcium Phosphate is encouraged.



Paper Abstracts

116. Free-Hand Transpedicular Screw Placement in the Process of Applying Posterior Vertebral Column Resection to Treat Severe Spinal Deformity

Jingming Xie; Zhi Zhao; Yingsong Wang, MD; Ying Zhang; Tao Li; Zhendong Yang; Ni Bi; Hong Chen

China

Summary: In the process of applying posterior vertebral column resection (PVCR) to treat severe spinal deformities, complex morphological deformation with abnormal anatomical structures presents great difficulties in trandpedicular screw placement.

Introduction: After failing to place pedicle screw using regular free-hand method, a series of remedial methods can be applied to achieve screw placement successfully.

Methods: Forty-six severe spinal deformity cases treated through PVCR with pedicle screw fixation were included in this study. The preoperative Cobb's angle in scoliosis cases was 108.2°±33.6°. Thirty-four patients combined with kyphosis, and the Cobb's angle ranged was 77.3°±29.4°.During the operation, the screw tract establishment was initially attempted using the regular free-hand method; if failed, a five-step remedial method was attempted in the following order: Step 1: the "funnel" method; Step 2: guided by the exploration of the pedicle exterior edge through the costotransverse joint; Step 3: guided by the exploration of the superior and inferior edges of pedicle through the nerve root canal; Step 4: vertebral plate fenestration; Step 5: hemilaminectomy.(Figure 5)

Results: In all patients, 603 screws were planed to be placed and 599 were finally placed into pedicles, in which, 207 (34.3%) were failed during the first attempt. All initially failed screw placements occurred in thoracic vertebrae. After using the remedial method, 203 screws were successfully placed. Among them, 121 screws were successfully placed using Step 1, 49 were placed by Step 2, 16 were placed through Step 3, 14 (6.9%) were placed by Step 4, 3 (1.5%) after Step 5. Four pedicles could not be placed finally. No nerve or blood vessel damages occurrence.

Conclusion: The five-step remedial transpedicular screw placement method is effective to increase the success rate of screw placement when treating patients with severe spinal deformities; the keys of this method include a detailed preoperative plan, a meticulous hand feeling of the trajectory walls, an experienced probing skill for screw tract.In order to provide sufficient stability and controllability of the gap after PVCR, at least each three pairs of screws places into the upper and lower segments of this gap, which is an essential prerequisite for PVCR. And the pedicles screws placement in the adjacent upper one segment and lower one of the gap after PVCR are the most crucial for keeping the stability of this gap and improving the deformity corrective results.

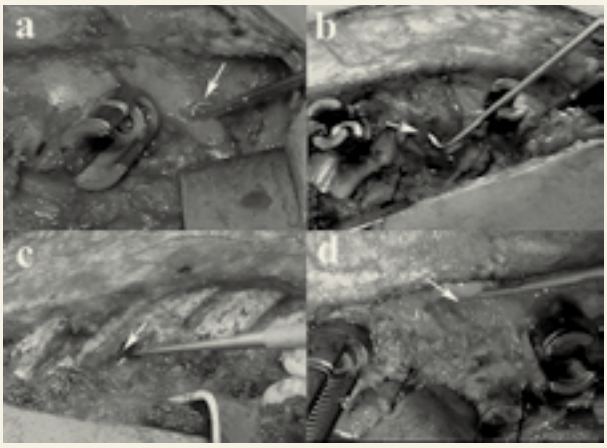


Figure 1. Five-step remedial screw placement method.

117. Retrieval Analysis of Lumbar Total Disc Replacements - A Study of in vivo Wear, Surface Properties, and Fixation

Darren R. Lebl, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD; Samantha M. Lee; Fred Mo, MD; Timothy Wright, PhD; Celeste Abjornson, PhD

United States

Summary: Lumbar degenerative disc disease is often treated by fusion of the spinal motion segment. In this retrieval study of Lumbar Total Disc Replacements (L-TDRs) pain and loosening were the predominant indications for explantation. High loads and lumbar physiologic range of motion predispose L-TDRs to backside wear and anterior-posterior metal-on-metal impingement at early time points. Precise matching of the L-TDR center of rotation to the physiologic center of rotation in the anterior-posterior plane may minimize impingement.

Introduction: To understand the mechanical performance of L-TDRs in vivo, we performed a prospective analysis of retrieved devices to examine for evidence of wear, surface damage, and bony fixation.

Methods: Explanted ProDisc-L® TDRs were cleaned and catalogued according to an IRB-approved retrieval program. Polyethylene(PE) and metallic(CoCrMo) components were examined using light stereo-microscopy(6X-31X) and areas of interest by SEM.

Results: 20 Lumbar TDRs from 18 patients at a mean age of 44.5±2.8 yrs(range 25-60) after a mean implantation time of 396±114 days(range 3days-5 yrs) were studied. The operative level was L4-L5 in 30%(n=6), L5-S1 in 60%(n=12), and unavailable in 10%(n=2). Indications for revision surgery were pain(n=7), prosthesis loosening or dislodgement(n=6), periprosthetic fracture/traumatic loosening(n=3), infection(n=2), and unavailable (n=2). No devices were retrieved due to gross component failure.

Bone ongrowth was present on the Ti plasma sprayed coating on the superior component in 80%(n=16) and on the inferior component in 70%(n=14). No evidence of ongrowth on either component was found in 20% (n=4). Impingement was seen in 75%(n=15); burnishing of the CoCrMo endplates was seen in 60%(n=12) and on the polyethylene insert in 15% (n=3).

Paper Abstracts

Impingement was on the posterior aspect in 50%(n=10) and on the anterior aspect in 40%(n=8). Evidence of backside wear was observed in 78%(11/14) of disassembled implants and wear consistent with 3rd body wear was observed in 30%(n=6).

Conclusion: Metal-on-metal impingement of the posterior aspect of the L-TDRs was seen more commonly than anterior impingement, circumferential patterns were not seen. Backside wear and evidence of bony ongrowth were common. Pain and loosening were the most common indications for explantation of L-TDRs.

Significance: Anterior-posterior metal-on-metal impingement, and backside wear are seen at early time points of retrieved L-TDR devices. Long-term follow-up studies are needed to evaluate the clinical significance of backside wear, 3rd body wear, and anterior-posterior impingement of L-TDR's.

118. A Prospective, Randomized Clinical Investigation of the Porous Coated Motion (PCM) Artificial Cervical Disc: Two Year Results from the US IDE Study

Frank M. Phillips, MD; Andrew Cappuccino, MD, BES; Fred H. Geisler, MD, PhD; Christopher Chaput, MD; John G. DeVine, MD; Christopher J. Reah, PhD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA

United States

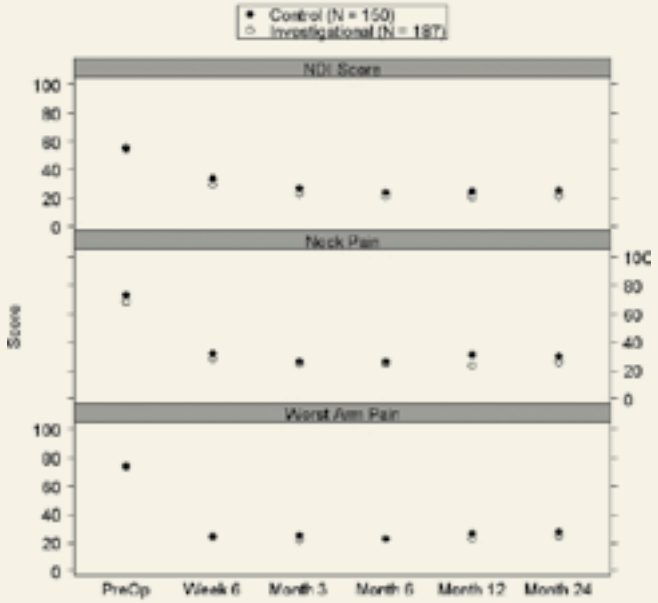
Summary: Cervical arthroplasty with PCM device shown to be equivalent to anterior cervical instrumented fusion in a prospective randomized clinical trial, with advantages in complication profile, rates of dysphagia, and patient satisfaction.

Introduction: The results following the use of cervical disc arthroplasty devices as an alternative to fusion after anterior cervical discectomy in the treatment of symptomatic cervical spondylosis have been reported. The PCM prosthesis is a new non-constrained device that has just completed a large FDA IDE clinical trial in the United States (US).

Methods: Patients 18-65 years of age with single-level symptomatic cervical disc disease unresponsive to conservative care were included in this prospective, randomized, multicenter, IRB-approved FDA IDE clinical trial evaluating longitudinal outcomes over 2 years comparatively between arthroplasty (CDA) and fusion groups. The per protocol patient sample at 2 years included 211 in the CDA group and 184 in the ACDF control group.

Results: At 2 years, NDI success (≥20% decrease) was 83.4% CDA, 81.5% control. Neck pain improved significantly (≥20mm decrease on VAS) in 74.3% CDA, 75.3% control. Arm pain improved significantly in 79.1% CDA, 75.3% control. SF-36 (PCS/MCS) improved significantly (≥15% increase) in 71.1%/46.5% CDA, 64.9%/49.7% control. Neurological success was 94.7% CDA, 89.5% control. Secondary surgeries were performed in 5.8% CDA, 6.6% control. None of these differences between groups were statistically significant, and there were no baseline differences between groups. Statistically significant differences were noted in the following: 93.3% CDA and 82.0% control were without any major complications (p=0.001). On a 100-point VAS, patients reported lower dysphagia scores in CDA than the control at 1 year (10 vs 12.6, p=0.0364) and at 2 years (8.8 vs 12.1, p=0.0453). Patient satisfaction at 2 years on a 100-point VAS was high in both groups: 82.8 CDA and 81.4 control (p=0.0071). At 2 years the ROM at the index level averaged 5.7 degrees (range 0-17.2) for the CDA group and 0.8 degrees (range 0-6.3) for the controls.

Conclusion: This randomized, prospective FDA IDE study found that the treatment of symptomatic single-level cervical spondylosis with the PCM device achieves clinical outcomes that are equivalent to ACDF. Additionally, patients receiving the CDA device had a statistically lower rate of both major complications and prolonged dysphagia along with greater patient satisfaction scores.



119. Factors Associated with Perioperative Complications in the Treatment of Cervical Spondylotic Myelopathy Based on 302 Patients from the AOSpine North America Cervical Spondylotic Myelopathy Study

Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; Paul Arnold; S. Tim Yoon; Alexander R. Vaccaro, MD, PhD; Darrel S. Brodke, MD; Eric J. Woodard, MD; Robert Banco; Jens R. Chapman, MD; Michael Janssen, DO; Rick C. Sasso, MD; Mark B. Dekutoski, MD; Ziya L. Gokaslan, MD

United States

Summary: The AOSpine North America cervical spondylotic myelopathy (CSM) study is a recent prospective multicenter study of 302 patients surgically treated for CSM. The vast majority of perioperative complications associated with CSM surgery were treatable and without long-term impact. Increased risk of complications was not associated with anterior versus posterior approaches or specific surgical procedures (e.g. fusion, laminoplasty, corpectomy). Multivariate

Paper Abstracts

factors associated with increased risk of complications include greater age, increased operative time, and use of combined anterior and posterior procedures.

Introduction: Surgery is often warranted for cervical spondylotic myelopathy (CSM). Our objective was to assess for factors associated with the occurrence of complications in the surgical treatment of CSM.

Methods: The AOSpine North America CSM study is a prospective multicenter study of surgical treatment for CSM. Rates of perioperative complications (within 30 days of surgery) were assessed based on clinical and surgical factors.

Results: 302 patients were enrolled (mean age=57 yrs; range: 29-86). Of 332 adverse events, 73 were adjudicated to be complications, including 25 major (8%) and 48 minor (16%). Of patients treated with anterior-only (n=176), posterior-only (n=107), and combined anterior-posterior (A-P) procedures (n=19), 11%, 19%, and 37%, respectively, had one or more complications. Posterior approaches had a higher rate of infection (6.3% vs 0.6%, p=0.005). Dysphagia was more common with anterior-only (2.3%) or A-P (21.1%) procedures, compared with posterior-only procedures (0.9%, p<0.001). C5 radiculopathy was not associated with surgical approach (p=0.8). Occurrence of complications was associated with increased age (p=0.006), A-P procedures (p=0.016), increased operative time (p=0.009), and increased operative blood loss (p=0.005), but not with body mass index, mJOA, smoking, anterior versus posterior approach, or specific procedures (e.g. laminoplasty, corpectomy). Multivariate analysis of factors associated with minor or major complications identified age (p=0.003) and operative time (p=0.045). Multivariate analysis of factors associated with major complications identified age (p=0.008) and A-P procedures (p=0.005).

Conclusion: For the surgical treatment of CSM, the vast majority of complications were treatable and without long-term impact. Increased risk of complications was not associated with anterior versus posterior approaches or specific surgical procedures. Multivariate factors associated with increased risk of complications include greater age, increased operative time, and use of A-P procedures.

120. Predictors of Outcomes in Surgical Treatment For Cervical Spondylotic Myelopathy: The AOSpine North America Multi-Center Prospective Study

Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; S. Tim Yoon; Paul Arnold; Alexander R. Vaccaro, MD, PhD; Darrel S. Brodke, MD; Christopher I. Shaffrey, MD; Eric J. Woodard, MD; Robert Banco; Jens R. Chapman, MD; Michael Janssen, DO; Rick C. Sasso, MD; Christopher Bono; Mark B. Dekutoski, MD; Ziya L. Gokaslan, MD

Canada

Summary: Surgery improves neurological outcomes in about 80% of the patients with CSM. Of modifiable factors, psychiatric diagnosis and long symptoms duration adversely affect the outcome.

Introduction: Surgery is a treatment of choice in patients with symptomatic CSM. Identification of predictors of success of surgical treatment in CSM would be important.

Methods: 278 patients receiving surgery for CSM were enrolled at 12 North American sites. Multivariate stepwise regression analysis was used to model mJOA at 12 months and, changes in mJOA score from baseline to 12 months. Predictors evaluated included demographics, comorbidties, baseline mJOA, Neck Disability Index, SF36v2, Nurick Score, history of CSM, source of stenosis, spinal level, surgical approach.

Results: The average change in mJOA at 12 months was 2.84 (SD 2.93). 83.3% improved for at least one point while 16.7% failed to improve. Lower mJOA scores (i.e. more severe disease), were associated with larger gains in neurological function. After adjustment for the baseline mJOA, poorer outcomes were associated with male gender, circumferential surgery, psychiatric diagnosis, congenital cervical stenosis, longer duration of symptoms, and poorer Nurick scores. Better overall physical health (SF36v2 PCS) was associated with more favorable outcome. Better final outcome (i.e. higher mJOA score) was positively associated with better overall physical health (SF36v2 PCS) and negatively associated with the male gender, higher age, being recipient of social security, psychiatric diagnosis as baseline comorbidity, congenital cervical stenosis, longer duration of symptoms, and poorer Nurick scores.

Conclusion: Surgical treatment appears to be effective in over 80% of the patients. Male gender, circumferential surgery, psychiatric comorbidity and, longer duration of symptoms appear to be associated with less favorable treatment response.

121. Cervical Disc Arthroplasty in Patients with Prior Fusions

Fred H. Geisler, MD, PhD; Frank M. Phillips, MD; Christopher Chaput, MD; Andrew Cappuccino, MD, BES; John G. DeVine, MD; Christopher J. Reah, PhD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA

United States

Summary: The results of a post hoc analysis of a subset of patients in a prospective RCT suggest that the cervical arthroplasty at levels adjacent to prior fusions can result in similar clinical outcomes to those following primary procedures or anterior discectomy and fusion.

Introduction: The efficacy of cervical arthroplasty in the treatment of symptomatic levels adjacent to prior fusions is largely unstudied due to prior fusion being an exclusion in most trials. The US FDA IDE trial of the PCM device compared to ACDF was the first such trial to allow for treatment adjacent to prior fusion.

Methods: A subset of patients from the US IDE trial of cervical disc arthroplasty (CDA) versus ACDF was studied to examine the clinical and radiographic success of each in the treatment of symptomatic cervical spondylosis at levels adjacent to prior fusion. Of the 395 per protocol patient sample at 2 years (211 CDA, 184 ACDF), 37 (21 CDA, 14 ACDF) had an adjacent fusion an average of 7.2

yrs (range 0.4-26.3 yrs) prior. Success was defined as ≥20% improvement in neck disability index (NDI), no worsening of neurological status, no subsequent secondary surgical interventions (SSSI), absence of major adverse events, and absence of radiologic complication at 2 years. Subgroup analyses were performed between CDA and ACDF patients with prior fusions, as well as between those with and without prior fusions within each of the CDA and ACDF groups.

Results: NDI success was met in 76%(16/21) CDA and 86%(12/14) ACDF with prior fusions, and 84%(138/165) CDA and 81%(109/135) ACDF without. Neurological status success was met in 96%(21/22) CDA and 100%(14/14) ACDF with prior fusions, and 95%(156/165) CDA and 88%(120/136) ACDF without. SSSI success was met in 83%(19/23) CDA and 100%(14/14) ACDF with prior fusions, and 96%(159/166) CDA and 93%(127/137) ACDF without. Radiographic success was met in 95%(18/19) CDA and 77%(11/14) ACDF with prior fusions, and 99%(160/162) CDA and 93%(127/136) ACDF without. No comparisons were statistically significantly different between or within groups. Average range of motion after PCM in patients with prior fusions was 9.7° at baseline and 6.2° at 2 years ($p<0.001$), similar to CDA in patients without prior fusions (7.7° to 5.6°; $p<0.001$).

Conclusion: The outcomes following the treatment of symptomatic degeneration at levels adjacent to prior fusions were equivalent to those in primary surgeries and to those following ACDF, suggesting that prior cervical fusion need not be a contraindication to cervical arthroplasty.

122. Clinical Outcomes after Lumbar Fusion Complicated by Deep Wound Infection: A Case-Control Study

Julio Petilon, MD; Steven D. Glassman, MD; John R. Dimar, MD; Leah Y. Carreon, MD,MSc

United States

Summary: In a propensity-matched case control study, patients with acute postoperative deep wound infections following instrumented lumbar spinal fusion have improved outcome measures after surgery but have greater back pain and a decreased probability of achieving MCID for ODI than patients without infection two years following surgery.

Introduction: Postoperative infection following instrumented spinal fusion often results in substantial short term morbidity. There is limited literature on how these patients do long term. This study evaluated the two year clinical outcomes of patients who had instrumented spinal fusions complicated by deep wound infections and compared them to a propensity-matched control group.

Methods: Thirty patients who underwent instrumented lumbar spinal fusion with complete pre-operative and two-year postoperative outcome measures and had acute (≤3 months) postoperative deep wound infections necessitating irrigation and debridement were identified. Outcome measures included the Oswestry Disability Index (ODI), SF-36 Physical (PCS) and Mental (MCS) composite summaries and Numeric rating scales (0-10) for back and leg pain. A noninfected control group was identified using propensity-matching techniques based on demographics, baseline clinical outcome measures and surgical characteristics. Two year postoperative outcome measures of both groups were compared. The proportion of patients achieving the minimum clinically important difference (MCID) for the outcome measures was also assessed. Independent t-tests were used to compare continuous variables and Fisher's exact test was used to compare categorical variables between the two groups.

Results: Consistent with the propensity-matching technique, there were no significant demographic or surgical differences between the two groups at baseline (Table 1). ODI, PCS, back and leg pain scores were statistically significantly better at two years post-operative compared to baseline in both groups. However, at two years post-operative, the infection group had statistically significantly worse back pain scores compared to the control group (6.4 v. 4.7, p=0.020). Also, a greater proportion of patients in the control group (18, 60%) achieved MCID for ODI compared to the infection group (8, 27%, p=0.018).

Conclusion: Patients with acute postoperative deep wound infections following instrumented lumbar spinal fusion have improved outcome measures after surgery but have greater back pain and a decreased probability of achieving MCID for ODI than patients without infection two years following surgery.

	NO INFECTION	INFECTION	p-value
N	30	30	
Sex (male)	12	8	0.402
Surgery			
ALIF	2	2	1.000
TLIF	8	8	
PSF	17	17	
ASF/PSF	3	3	
Smoker	6	8	0.761
Workers' comp	2	1	
Diagnosis			
Spondylolisthesis	8	8	1.000
Instability	1	1	
Stenosis	2	2	
Scoliosis	2	2	
Disc pathology	5	5	
Non-union	3	3	
Post-decompression	5	5	
Adjacent level	4	4	
Age	44.77	44.57	0.864
Length of Stay	5.37	5.57	0.731
Operative Time	288.17	250.27	0.298
Estimated Blood Loss	857.59	790.86	0.617
ASA Grade	2.63	2.83	0.136
No. of Levels	1.93	1.83	0.705
BMI	31.62	34.22	0.200
Baseline			
Back Pain	7.33	7.87	0.413
Leg Pain	7.52	7.67	0.821
ODI	56.82	55.30	0.721
PCS	26.91	26.49	0.832
MCS	35.06	37.40	0.548
Two-Year Post-operative			
Back Pain	4.70	6.45	0.020
Leg Pain	5.07	5.73	0.592
ODI	39.73	48.20	0.198
PCS	34.25	30.04	0.144
MCS	37.98	37.65	0.931
Proportion achieving MCID			
Back Pain	17	13	0.439
Leg Pain	23	22	1.000
ODI	18	8	0.018
PCS	15	15	1.000

Paper Abstracts

123. Lateral Lumbar Arthroplasty: Clinical and Radiological Evaluation on a New Metal-on-Metal Device

Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD

Brazil

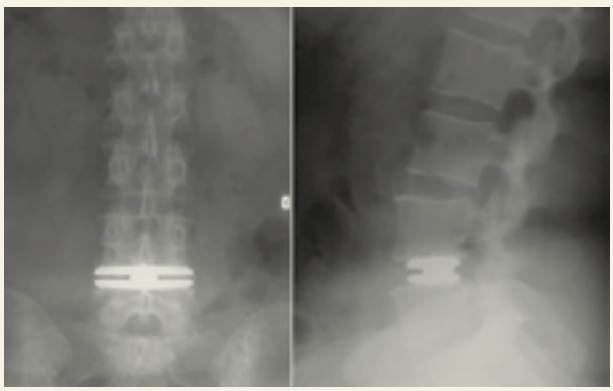
Summary: Here we evaluate clinical and radiological results on the new minimally invasive lumbar disc replacement which don't requires ALL or PLL ressection. Results of a laterally placed TDR device demonstrate maintenance of pain relief and functional improvement, but still not free from bone formation at the index level.

Introduction: Current lumbar total disc replacement (TDR) devices require an anterior approach for implantation. Besides approach-related risks, there is resection of the anterior longitudinal ligament (ALL). Placement of a TDR device from a true lateral approach offers a less invasive access and also preserves the stabilizing ligaments. Additionally, the footprint of the lateral TDR device capitalizes on the biomechanical support of the ring apophysis

Methods: Sixteen males and 20 females, average age 43 y/o (24-60). Radiological (dynamic x-rays, CT and MRI) and clinical outcome assessment (ODI and VAS) were performed at the preop and postop up to 60 months (minimum 48 mos). A TDR device designed for implantation through a true lateral, retroperitoneal, transpsoas approach (XLIF) was implanted in 36 patients with discography-confirmed 1- or 2-level DDD.

Results: Surgeries included 14 1-level, 3 2-level, and 19 hybrid TDR/ALIF cases. The surgery was performed through a 4cm lateral incision in an average of 134 minutes (90-300) and with an average 58cc blood loss (30-150). There was no intra-op or post-op major complications. Postoperative x-rays showed good device placement, with restoration of disc height, foraminal volume, and sagittal balance. VAS and ODI improved compared to baseline. After 48 months we observed an expected incidence of 27.8% of bone formation at the index level, but only 2.8% of consequent fusion (heterotopic ossification grade IV).

Conclusion: The benefits of this technique included minimal morbidity, avoiding mobilization of the great vessels, preserving the anterior longitudinal ligament, biomechanically stable orientation, and broader revision options suggest a promising new direction for TDR procedures.



124. Readmission Rates after Decompression Surgery for Lumbar Spinal Stenosis among Medicare Beneficiaries

Steven Takemoto, PhD; Urvij M. Modhia, MD; Robyn A. Capobianco, MA; Mary Jo Braid-Forbes, MPH; Sigurd H. Berven, MD

United States

Summary: The purpose of this study to calculate readmission and re-operation rates following spine stenosis decompression surgery.

Introduction: Operative management of lumbar spinal stenosis has significant and measurable benefits compared with non-operative care. Revision rates for lumbar decompression have been reported with significant variability.

Methods: This retrospective study of medicare claims data was performed on a 5% randomly selected sample of medicare beneficiaries. A total of 4902 patients had a decompression procedure (ICD-9 procedure code 03.09), and stenosis diagnosis (724.02) with or without fusion from 2005 to 2007 and were followed through 2008. Readmission rates for decompression with fusion, decompression without fusion and spine injections were calculated using Kaplan-Meier censoring for death and de-enrollment.

Results: The overall rate of readmission was 7.7%, 13.9%, 18.8% at 1,2 and 3 years after index operation. Rates of readmission for patients who underwent fusion with spine decompression were slightly higher after one year than patients who underwent decompression alone [7.4% for without fusion vs. 8.8% with fusion]. However, the difference was not significant-P=0.293. Patients receiving decompression with fusion were more likely female [58% vs. 42%, P<0.0001] and slightly younger. Procedures performed during readmission were similar for the fusion and no fusion cohorts: fusion was performed in 58%, decompression without fusion in 21% and injection in 21%. Of readmitted patients, 16% had multiple readmissions.

Conclusion: Re-operation rates for spinal stenosis decompression were approximately 6-7% per year. Fusion at the index procedure did not protect against subsequent readmission. Revision surgeries included revision decompression, revision decompression with fusion, and injection procedures.

Significance: Large databases can inform choice of surgical options by focusing examination on indications for surgery and reasons for readmission.

125. Impact of Peri-Operative Complications in Lumbar Fusion Surgery on Clinical Outcome Measures

Manish Lambat, MD; Leah Y. Carreon, MD,MSc; Mitchell J. Campbell, MD; Steven D. Glassman, MD

United States

Summary: In a propensity-matched case-control design, patients sustaining major peri-operative complications following lumbar fusion had comparable clinical outcomes at two-years to those with minor or no complications. The effect of these major complications on a patient's quality of life within the first two years after surgery need further study.

Paper Abstracts

Introduction: Although lumbar fusion is effective in well-selected patients, it is not without complications that are associated with short term morbidity. There is paucity of literature on the effect of these complications on long term clinical outcomes.The purpose of this study is to determine whether peri-operative complications alter long term clinical outcome measures after lumbar fusion.

Methods: Surgical and clinical databases from 2001 to 2008 were reviewed for eligible subjects. Inclusion criteria consisted of patients who underwent instrumented lumbar spinal fusion with complete pre-operative and two-year postoperative outcome measures and had a major complication. Outcome measures included the Short Form-36 Physical Composite Summary Score (SF-36 PCS), Oswestry Disability Index (ODI), Numeric Rating Scales (0-10) for back and leg pain. Seventy-eight subjects met criteria for analysis. Two comparison groups, one with only minor complications and another with no complications were created using propensity matching techniques based on demographics, baseline clinical outcome measures and surgical characteristics. Two year postoperative outcome measures of the groups were compared. One way ANOVA were used to compare continuous variables and Fisher's exact test was used to compare categorical variables between the groups. Significance was set at $p < 0.05$.

Results: Eighty-one major complications and 199 minor complications were reported. Comparison between the 3 complication groups revealed that two-year postoperative outcome measures were not statistically different for any of the outcome measures. The overall ODI at two years was better in those patients having no complication (39.59) or minor complication (36.99) than those having major complications (44.49) but this was not statistically significant ($p=0.074$).

Conclusion: Patients sustaining major peri-operative complications following lumbar fusion have comparable clinical outcomes at two-years to those with minor or no complications. The effect of these major complications on a patient's quality of life within the first two years after surgery need further study.

126. Procalcitonin as an Early Marker for Postoperative Infection for Cases of Elective Spine Surgery

Katharine Cronk, MD, PhD; Nikolay Martirosyan; Nicholas Theodore, MD, FACS

United States

Summary: Prospective study examining the utility of procalcitonin in the detection of infection following spinal surgery. Procalcitonin is more specific in detecting infection when compared to ESR and CRP.

Introduction: Post-operative infections can be difficult to detect using the standard available blood test including WBC, ESR, and CRP. While the sensitivity of these tests is high, the specificity is extremely low. The low specificity of these markers can lead to medical treatments that are costly, inconvenient and ultimately not necessary. Procalcitonin is known to be released in most cases in response to bacterial infections and reaches maximum levels within 12 hours. We believe that procalcitonin is not a non-specific inflammatory marker and will not be affected by just spine surgery. The increased specificity of this marker for bacterial infections will allow it to be more reliable in detecting infections in the acute post-operative period.

Methods: Patients (N=44) whom underwent elective spine surgery had WBC, ESR, CRP and Procalcitonin levels drawn pre-operatively and 24 hours post-operatively. Patients (N=16) with complaints suggestive of an infection and had WBC, ESR, CRP and procalcitonin drawn prior to antibiotics and who went to the operating room for wound exploration were included. Infection was determined at the time of surgery based on evidence of inflammation and gram stain.

Results: Procalcitonin had a 98% positive predictive value (PPV) as compared with ESR (89%) and CRP (91%) for not a non-specific inflammatory marker. As a predictor for early wound infection (N=16), the sensitivity, specificity and positive predictive value for procalcitonin was 90%, 83.3% and 90% respectively. This is compared with ESR values 90%, 20% and 69.2% and CRP 100%, 16.7% and 64.3% respectively.

Conclusion: The diagnostic accuracy of procalcitonin in detecting post-operative infection was higher than C-reactive protein or ESR. Procalcitonin is an extremely efficient marker that warrants further study to explore its potential. In addition, the use of procalcitonin may allow tailoring of antibiotic courses that could result in more cost effective treatment for patients.

Significance: Procalcitonin is more useful than ESR and CRP in the early detection of infections following spinal surgery.

127. Is Subjective Outcome Better and Persistent with Microendoscopic Discectomy (MED) than Open Discectomy?

Bhavuk Garg; Arvind Jayaswal, MS (ortho)

India

Summary: In the current prospective, randomized study, the subjective outcome of open discectomy procedure was compared with those of Microendoscopic discectomy at various intervals of time

Introduction: In the current prospective, randomized study, the subjective outcome of open discectomy procedure was compared with those of Microendoscopic discectomy at various intervals of time

Methods: One hundred and twelve patients who had objective evidence of a single level, central or paracentral herniation of a lumbar disc caudal to the first lumbar vertebra were randomized into two groups; Group 1 (55 patients) was managed with Microendoscopic discectomy, and Group 2 (57 patients), with open (fenestration/ laminotomy) discectomy. Analysis of the outcomes of both procedures was based on the patient's self-evaluation before and after the operation through Oswestry scoring, and the patient's ability to return to a functional status. The patients were followed at one week, 6 weeks, 6months and for a minimum of one year postoperatively and the results were statistically analyzed.

Paper Abstracts

Results: On the basis of the patient's preoperative and postoperative self-evaluation and the patient's ability to return to work or to normal activity, 53 patients (96 percent) in Group 1 and 54 patients (95 percent) in Group 2 were considered to have had a satisfactory outcome. The overall satisfaction score was statistically significantly higher after the endoscopic microdiscectomies than after the laminotomies and discectomies in immediate postoperative period (one and six weeks) as assessed through Oswestry scoring and became statistically insignificant at 6 months and one year.

Conclusion: The data from this randomized, prospective study suggest that better subjective outcome with MED is more significant in first 6 weeks and become insignificant at one year.

128. Thoracic Pedicle CT Classification for Free-hand Pedicle Screw Placement in Posterior Vertebral Column Resection Treating Severe Spinal Deformity

Jingming Xie; Ying Zhang; Zhi Zhao; Hong Chen; Yingsong Wang, MD; Ni Bi; Zhendong Yang; Tao Li

China

Summary: Posterior Vertebral Column(PVCR) is an effective alternative for severe rigid spinal deformity. However, successful pedicle screw placement , especially in the apical region, which was a crucial precondition of performing this treatment.Although morphologic evaluations of thoracic pedicles in AIS have been well reported, the results were lack of objective quantifying standard.

Introduction: The aim was this study is to explore the relevance between accurate placement of thoracic pedicle screws and the thoracic pedicle inner cortical width in the PVCR treatment of rigid and severe spinal deformity.

Methods: A consecutive series of 56 patients (1098 thoracic pedicles) who underwent PVCR at a single institution from 2004-2009 were reviewed.The thoracic pedicles were evaluated by pre- and postoperative CT Scan.The inner cortical width of the thoracic pedicle were measured. All the thoracic pedicles in this study were divided into four different groups according to the inner cortical width, including 1(0.0-1.0mm), 2(1.1-2.0mm), 3(2.1-3.0mm) and 4(large than 3.1mm). The success rate of screw placement of each type according to Lenke classification and the inner cortical width were calculated respectively. Statistical analysis was performed to determine the significance.

Results: The success rate of screw placement of each type according to Lenke pedicle morphologic classification were A:82.31%;B:83.40%;C:80.00% ;D:30.28%, respectively.There was a significant difference among D type and other types(P<0.008).The success rate of screw placements of 1,2,3,4 groups according to the inner cortical width was in turn 35.05%,65.34%,84.38%,and 92.02%,respectively.The significant difference was found between Group 1 and other groups (P<0.008),Group 2 and other groups (P<0.008). There was a significant difference among 1, 2 and 3+4 types(P<0.017), when 3 and 4 group were merged to analyze.

Conclusion: This study proposed a CT classification of thoracic pedicles characteristic quantization which indicates whether the pedicle has a cancellous channel and how the size of the channel was.It suggests that surgeons should be aware of the extremely low success rate of type 1 thoracic pedicles ,especialy in the apical region,when considering pedicle screw instrumentation in PVCR treatment.

Significance: This study proposed a CT classification of thoracic pedicles characteristic quantization.

129. Short Segment Anterior Fusion with Interbody Cages for Painful Scheuermann's Disease

Jwalant S. Mehta, FRCS (Orth); Kan Min, MD; Eldin E. Karaikovic, MD, PhD; Suken A. Shah, MD; Daniel Zarzycki, MD, PhD; Robert W. Gaines, MD

United Kingdom

Summary: Summary: We report on 40 patients with Scheuermann's disease with severe pain and a moderate deformity. The mean age was 20 years and the patients underwent an anterior short segment bone-on-cage instrumentation of a mean of 5.1 levels. We obtained and correction of the deformity from 70.9° to 47.3°. At the final follow-up of 34.5 months, the kyphosis measured 48.7°. All the patients reported a complete relief of pain by 4 months after the procedure. There were no mechanical or neurological complications.

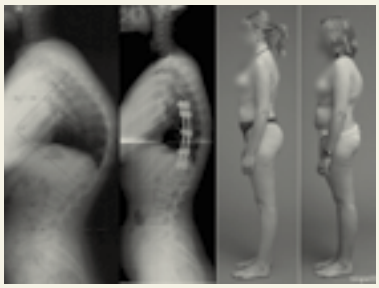
Introduction: The traditional approach towards treatment of Scheuermann's disease is to treat the kyphotic deformity, based on radiographic assessments. Natural history studies point towards a well defined population that present with severe pain over the apex despite a moderate kyphotic deformity. The MRI changes of loss of hydration in the apical thoracic discs support the theory of discopathy causing the pain. Rather than the traditional long fusion, we report on our experience with a short segment fusion of the affected discs with correction of the deformity.

Methods: We report the multi-centre outcomes on 40 patients treated by the short segment anterior inter-body fusion of the apical motion segments, after a failed conservative trial, for a lifestyle limited by pain and hyperkyphotic deformity. Outcomes are reported in terms of relief of pain and correction of the deformity. The mean age of the cohort was 20 years (range 14 - 34); and 33 were male.

Results: All the patients reported a complete relief in the pain and were off the narcotic analgesics by 4 months of the operation. The mean preop kyphosis was 70.9° (95% CI 66.6 - 75.3) with mean flexibility (hyper-extension radiographs) Cobb of 47.3°, a flexibility index of 33.7% (95% CI 43.8° - 50.8°). The mean correction was 48.7° after a fusion of 5.1 ± 0.1 levels. The correction was well maintained with a final mean measure of 51.3°, at a mean of 34.5 months (95% CI 26.2 - 42.8). An increase in kyphosis of 2.4° was noted in the instrumented segments and a loss of correction of -4.1%. The mean operation time was 462.3 minutes (95% CI 46 - 879) and the blood loss was 776.8 ml (95% CI 606 - 948). There were no mechanical or neurological complications.

Conclusion: This is a safe and effective approach in the treatment of severe Scheuermann's disease where pain is the predominant symptom and the deformity is moderate.

Significance: This method allows for a reduction of one half of the levels as posterior based approaches, with similar correction.



130. The Reliability of X-Ray Based Evaluation of Pedicle Screw Misplacement in Adolescent Spinal Deformity

Paul Haynes, MD; Beverly Thornhill, MD; Gordon E. Sims, BS; Jonathan J. Horn; Adam L. Wollowick, MD; Terry D. Amaral, MD; Preethi M. Kulkarni, MD; Vishal Sarwahi, MD

United States

Summary: X-ray-based evaluation of pedicle screw misplacement is severely limited in spine deformity patients and better evaluation methods need to be considered.

Introduction: Post-operative x-rays are routinely used to detect misplaced pedicle screws. Kim, et al. have defined radiographic criteria for evaluation of screw placement in spinal deformity. This study evaluates pedicle screw misplacement on x-ray using these criteria as well as anterior placement on lateral x-ray, and compared them to screw misplacements seen on post-operative CT scan.

Methods: Post-op x-rays and low dose CT scans of 104 adolescent spinal deformity patients who underwent PSF were reviewed. A blinded review of screw placement on x-ray was carried out 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 the vertebral body. On lateral x-ray, a screw was considered misplaced if: 1) an anterior breach was seen or 2) the length of the screw inside the vertebral body was ≥ 80% of the width of the vertebral body. Kappa analysis was used for overall agreement as well as agreement within specific regions of the curve.

Results: 2087 screws were evaluated on x-ray and CT. CT classified 1820 screws as acceptable, 143 lateral, 30 medial, and 94 anterior. X-ray had 908 acceptable, 304 lateral, 241 medial, and 634 anterior. X-ray correlated with CT Scan in 50% of acceptable screws, 213% of laterally placed screws, 803% of medially placed screws, and in 674% of anteriorly placed screws. X-ray overestimated the number of misplaced screws and had poor reliability for detecting properly placed screws. Overall agreement was 0.08, indicating poor correlation. 53 screws were identified by CT scan as concerning - either breeching the canal or lying adjacent to the aorta. Of these, only 35% were correctly classified on x-ray. Further review of these screws on x-ray was unable to identify any relationship to structures of concern.

Conclusion: X-ray evaluation of screw placement showed poor correlation with CT data. X-rays were found to be inadequate to evaluate screw misplacement or relationship to structures of concern.

Significance: Routine postoperative x-rays have significantly high false positive rates for screw misplacement. The practice of evaluating accuracy on x-ray needs to be examined. Low dose CT scan or intra-op image guidance should be considered.

131. The Role Closed Reduction under General Anesthesia in the Treatment of C1/C2 Rotatory Subluxation in Children

Lynn J. Letko, MD; Jurgen Harms, MD

Germany

Summary: Resistant and/or persistent C1/C2 rotatory subluxation may require attempted reduction. Closed reduction under general anesthesia and immobilization in a halo vest may provide

maintained reduction especially in cases treated within 3 months of rotatory subluxation

Introduction: Resistant and/or persistent C1/C2 rotatory subluxation may require attempted reduction. We report the results of 22 children treated with attempted closed reduction under general anesthesia utilizing the technique of Jezensky

Methods: Retrospective review 22 children (17 F, 5M) with C1/C2 rotatory subluxation who underwent attempted closed reduction under general anesthesia 10.93-1.08. Mean age at closed reduction was 8 + 1 years (4+3 - 11+1). Causes of the C1/C2 rotatory subluxation were 6 minor trauma, 5 Grisel's syndrome, 5 post-surgical, 3 unclear, and 3 moved wrong or suddenly. Mean time from rotatory subluxation to attempted reduction was 5 mos. (3 days - 16mo). Mean follow - up 16mo (1.5 - 54 mo)

Results: In 14 of the 22 patients, the C1/C2 rotatory subluxations was successfully reduced under anesthesia and maintained in a halo vest for 6 - 12 weeks (mean 9.8 weeks). 2 of the 14 patients re-subluxed after removal of the halo vest at 12 weeks. All of the patients who were reduced and maintained had a time from subluxation to reposition of < 3 mo. Of the 2 patients who re-subluxed, the time to reduction was 3 mo and 10 mo respectively. In 2/22 patients the reduction obtained was unstable and re -subluxed immediately. Reduction was not possible in 1/22 patients. Only a partial reduction was obtained in 5/22 patients. All except for 1 of these 8 patients had time from subluxation to attempted reduction of > 3 mo (3-16 mo). Those patients in whom maintained reduction was not possible, was partial or was lost after removal of the halo vest, underwent open reduction and instrumentation with or without definitive fusion.

Paper Abstracts

Conclusion: This technique may prevent the need for an open operative intervention particularly in patients with < 3 mo subluxation.

It may assist in determining the most appropriate treatment plan

In 12 of 22 cases (55%) closed reduction was obtained and maintained. All had a time from subluxation to reduction of < 3mo.

2(14%) patients initially reduced and treated in a halo vest lost correction and required operative intervention

Significance: Closed reduction under general anesthesia provides an additional tool in the armamentarium of treatment of C1/C2 rotatory subluxation in children

132. MRI is Unnecessary to Clear the Cervical Spine in Pediatric Trauma Patients: Ten-Year Experience of a Level One Pediatric Trauma Center

Jessie Gargas, MD; Burt Yaszay, MD; Peter Kruk, MD; Tracey Bastrom, MA; Sandeep Khanna, MD

United States

Summary: The results of this study suggest that outside of its appropriate application to patients with neurologic deficits, MRI is unlikely to uncover unstable C-spine injuries in pediatric patients when C-spine CT scan using modern imaging protocols is normal.

Introduction: The purpose of this study was to evaluate if a cervical spine (C-spine) magnetic resonance image (MRI) is necessary to clear pediatric trauma patients from C-spine precautions when computed tomography (CT) scan of the C-spine has been completed and is normal.

Methods: Retrospective chart review was conducted from 1/2000 through 2/2010 of patients who were seen by the trauma department at a Level 1 Children's hospital. Patients were <18 years of age, placed in C-spine precautions, had normal C-spine CT scan, and had C-spine MRI. Those with incomplete records or abnormal C-spine CT scans were excluded. Cohort was sub-divided into patients who underwent CT scans during the years 1/2000-7/31/2005 (early group) and 8/1/2005-2/2010 (late group) during which time the institution began utilizing a contemporaneous 64-slice CT scanner.

Results: 173 patients met inclusion criteria (10.1 ± 5 yrs age). Average time lapse between CT scan and MRI was 103.2 ± 177 hours (median 23.4 hours). While 100% of the patients had negative CT scans, 83% of MRI findings were negative (p<0.001). 29 patients (17%) demonstrated positive findings on MRI. 5 of the 29 (2.9%) required operative C-spine stabilization. 85 patients underwent CT scan in early group and 88 in late group. All 5 patients with unstable injuries missed on CT were from the early group, compared to none in the late group (p=0.027).

Conclusion: Our data suggests outside of its appropriate application to patients with neurologic deficits, MRI is unlikely to uncover unstable C-spine injuries in pediatric patients when C-spine CT scan using modern imaging protocols is normal.

Significance: Delay in ascertaining that the C-spine is injury-free is an important clinical care issue: it may interfere with airway management, central line placement, lead to multiple trips to the radiology suite for repeat radiographs, and cause delay in removing hard C-spine collars. MRI is expensive and increases hospital costs. MRI requires transporting the patient to a MRI suite, exposing the patient to multiple risks, as monitoring is limited. Our conclusions may help reduce the time pediatric patients remain in C-spine precautions and the number of C-spine MRIs done when a C-spine CT scan is normal.

133. Pulmonary Function Changes following Posterior Vertebral Column Resection in Pediatric and Adult Spinal Deformity Patients

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United States

Summary: Pediatric patients undergoing a posterior vertebral column resection for severe deformity demonstrated improvement in postoperative pulmonary function testing, while adult VCR patients did not demonstrate any significant change in PFTs. Pediatric PFT improvement was correlated with both deformity diagnosis as well as previous spinal surgery.

Introduction: Posterior vertebral column resection (PVCR) enables surgical correction of severe spinal deformity via a posterior-only approach, eliminating the need for a combined anterior/posterior (A/P) approach, which is known to have deleterious effects on pulmonary function. To our knowledge, no reports of pulmonary function test (PFT) changes after PVCR surgery are available.

Methods: PFTs in 20 pediatric/18 adult pts who underwent a PVCR at 1 institution were reviewed retrospectively with min 2yr followup (f/u). Mean age at surgery was 29.2yrs (range 8-72), and mean f/u was 2+6yrs (range 2-6). There were 24 females/14 males. Preop diagnoses were severe scoliosis (n=3), kyphoscoliosis (n=19), global kyphosis (n=9) and angular kyphosis (n=7). Thoracic PVCRs (T5-11) were performed in 25pts and thoracoabdominal PVCRs (T12-L5) in 13pts. Immediate preop and postop PFTs were obtained at regular f/u intervals. Comparison was made to PFTs from control groups of pediatric and adult pts who underwent combined A/P fusions for similar deformities.

Results: In pediatric pts, PVCR resulted in an increase of FVC from 2.12 to 2.42L (p=0.008) and FEV1 from 1.72 to 1.96L (p=0.01). However, there were no significant differences in % predicted values for FVC (71% to 69%, p=0.68) or FEV1 (66% to 64%, p=0.81). In adult pts, there were no significant changes in FVC (2.47 to 2.45L, p=0.87) or FEV1 (1.99 to 1.94L, p=0.61) after PVCR; also, changes in adult % predicted values for FVC (75% to 74%, p=0.96) and FEV1 (73% to 72%, p=0.86) were not significant. Comparison of changes in PFTs between the PVCR pts and control groups of pediatric and adult pts who

underwent combined A/P approach did not reveal significant differences. In the pediatric PVCR pts, improved PFTs correlated with diagnosis (angular kyphosis showed most improvement, p=0.001 for FVC, p=0.0001 for FEV1), as well as with no history of previous surgery (p=0.002 for FEV1).

Conclusion: In pediatric pts, PVCR resulted in a small but significant increase in postop FVC and FEV1. In adult pts, no significant change in PFTs was found. No significant differences in PFTs were seen when comparing PVCR pts to combined A/P pts. Improvement in pediatric PFTs correlated with diagnosis as well as absence of prior spine surgery.

134. Bilateral Rib-Based Distraction to the Pelvis for the Management of Congenital Gibbus Deformity in the Growing Child

John T. Smith, MD; Jennie B. Mickelson, BS

United States

Summary: This is a retrospective review of a single institution experience of using a rib to pelvis distraction technique for severe gibbus deformities that avoids kyphectomy and fusion in young children while preserving growth.

Introduction: Congenital gibbus deformity of the spine associated with Myelodysplasia is a challenging problem in the growing child, and is commonly associated with skin breakdown and chronic infection. Surgical solutions including kyphectomy, skin flaps, neonatal resection are all associated with a high rate of complications and ultimately, a short trunk. The purpose of this paper is to describe our early results in using a rib-based distraction to the pelvis without vertebral resection and fusion to manage this deformity.

Methods: This is an IRB approved retrospective review of a consecutive single surgeon series of using the rib to pelvis distraction technique in congenital gibbus deformity. There were four patients (2 males, 2 females) with an average age of 20 months (16-25 months). The diagnosis was myelomengocele (2), congenital kyphosis (1) and congenital kyphoscoliosis (1). All patients were managed with bilateral rib to pelvis distraction using the VEPTR device.

Results: The average pre-op gibbus deformity measured 114 degrees (108-154). The average post-op gibbus measured 52 degrees (36-80). The average length of follow-up is 26.2months (range 10-48 months) There were 3 complications; a dural leak during device expansion, rib hook migration at 48 months, and one post op infection after initial implant that resolved with irrigation, debridement and IV antibiotics. One patient had skin expanders placed preoperatively to facilitate skin coverage. No patient has required vertebral resection to achieve correction of the deformity. No patient has had subsequent skin breakdown over the residual gibbus.

Conclusion: This minimally invasive technique effectively corrects gibbus deformity in the growing child without early vertebral column resection and fusion. Our practice is to intervene early while the gibbus is flexible and prior to skin breakdown over the deformity. These early results are encouraging, but further long-term follow-up is needed to confirm the benefits of this technique over traditional methods.

Significance: This technique represents a new paradigm in the management of this challenging deformity in the growing child.

135. A New Technique for Surgical Correction of Severe Kyphosis

Hong Zhang, MD; Daniel J. Sucato, MD, MS; David Ross, MFA; William Pierce, BS; Karen D. Standefer, BS

United States

Summary: A new mode has been proposed for surgical correction of severe kyphosis. The mode involves extended repair of the vertebral column by a provisional rod link reducer, supplemented by the use of a novel pedicle screw final rod construct. The assessment of this implant system was performed using a plastic severe kyphosis model in-vitro. The provisional rod link reducer effectively elongated the anterior column (32%) and shortened the posterior column (21%) at the apex to correct the severe kyphosis from 90° to 35°. Using this implant device for the most severe kyphosis may enable a shorter and less aggressive surgery to reach good correction.

Introduction: The principles of surgical correction of kyphosis have included elongating the anterior column and shortening the posterior column of the spine. Current implant strategies are not ideal for severe cases since they fetter the correction forces for the apical vertebrae of the curve. A new technique involves a provisional rod link reducer / pedicle screws which allows for very controlled correction of the severe kyphosis at the apex. The purpose of this study was to assess the instrumentation using a plastic severe kyphosis model in-vitro.

Methods: This implant system consists of: 1) pedicle screw with a screw head that can receive provisional and final rods with a breakaway mechanism between the two rod receivers; 2) the rod link reducer rigidly links the provisional rods at the apex allowing the apical vertebrae free for correction. While the deformity was corrected using the provisional rod link reducer, the final rod is fixed and then the provisional ones are removed (Fig.). A 90° plastic thoracic kyphosis model was instrumented to verify the apical vertebral correction. The anterior and posterior column lengths at the apex were measured at the pre- and post-correction. The percentages of anterior column lengthening and posterior column shortening were calculated.

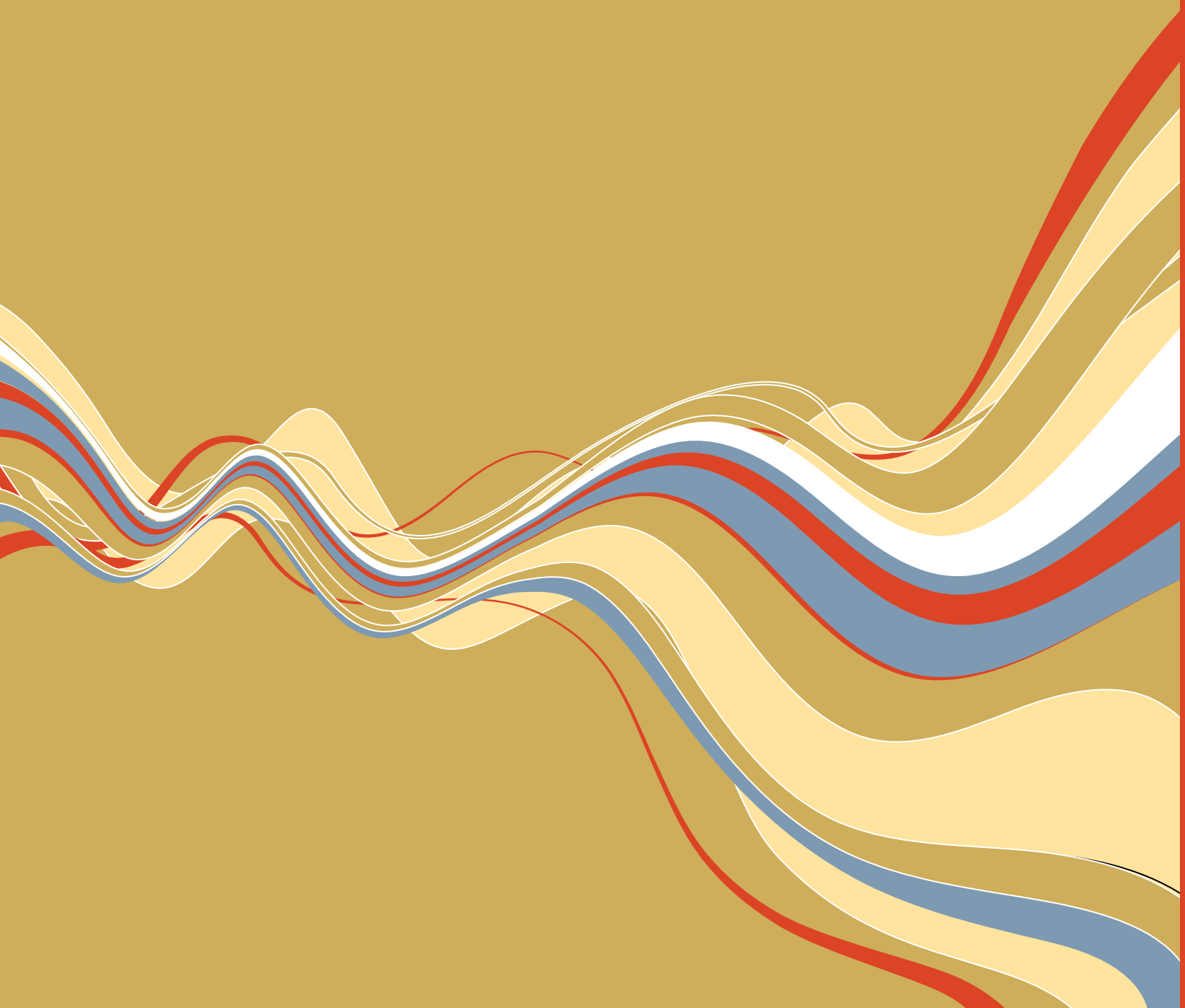
Results: The correction maneuver included the provisional rod link compression which allows the surgeon complete, precise control to effectively correct the apical kyphosis without the danger of translation or distraction of the spinal cord. While the deformity was corrected from 90° to 35°, the anterior column at the apex was lengthened by 32% and the posterior column was shortened 21%. The entire spine height was increased by 41%.

Conclusion: This new instrumentation system effectively elongated the anterior column and shortened the posterior column at the apex to correct severe kyphosis. This system may offer a safer, easier and improved deformity correction, as well as shorter surgical time for the surgical correction of severe kyphosis.

Paper Abstracts

Significance: Using this implant device for the most severe kyphosis may enable a shorter and less aggressive surgery to reach good correction.

E-Poster Index



The Scoliosis Research Society gratefully acknowledges Synthes Spine for their overall IMAST support.

E-Poster Index

This index includes all accepted E-Posters whose authors confirmed participation prior to publication. If provided by the author, E-Posters are available for viewing at the computer kiosks in the Exhibit Hall and on the CD-ROM provided with your registration materials.

#201: Cervical Total Disc Replacement vs. Anterior Cervical Fusion: Data from Four Prospective, Randomized, Multicenter Trials

Richard D. Guyer, MD; Yigal Samocha, MD; Donna Ohnmeiss, MD; Scott L. Blumenthal; Jack E. Zigler, MD
United States

#202: Treatment of Cervical Myeloradiculopathy with PCM Total Disc Arthroplasty Compared to ACDF in a Prospective Randomized Clinical Trial

Christopher Chaput, MD; Frank M. Phillips, MD; Fred H. Geisler, MD, PhD; Andrew Cappuccino, MD, BES; John G. DeVine, MD; Christopher J. Reah, PhD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA
United States

#205: Night-Time Detorsion Brace for the Treatment of Idiopathic Scoliosis in Children under Six Years Old

Brice Ilharreborde, MD; Sebastien Moreau; Georges-François Penneçot; Keyvan Mazda
France

#206: Comparing Effects of Kyphoplasty, Vertebroplasty, and Non-Surgical Management in a Meta-Analysis of Level I and II Studies

Frank D. Vrionis, MD, PhD; Ioannis Papanastassiou, MD; James R. Berenson, MD; Jan K. Van Meirhaeghe; Gunnar Andersson; Kamran Aghayev; Mohammed Eleraky, MD; Frank M. Phillips, MD
United States

#210: The Superior Articular Process as an External Landmark for Determining Transverse Plane Angulation of Thoracic Pedicles

Kathryn Pade, BS; John T. Anderson, MD; Darrell S. Hanson; Andrea Long; Daniel G. Hoernschemeyer, MD
United States

#212: Recidivism Rates after Smoking Cessation Prior to Spinal Fusion

Brandon B. Carlson, BS; Douglas C. Burton, MD; Robert S. Jackson, MD; Stephanie Robinson, MS
United States

#213: In-Vivo Evaluation of Bone Micro-Architectures in Adolescent Idiopathic Scoliosis Using High Resolution pQCT

Tsz-ping Lam, MB,BS; Fish WS Yu, BS; Hiu Yan Yeung; Bobby KW Ng, MD; Kwong-Man Lee, PhD; Jack C. Cheng, MD
Hong Kong

#215: Analysis of the Several Factors that May Affect the Radiological and Clinical Outcome in Cervical Arthroplasty

Chul-Woo Lee, MD; Kang-Jun Yoon; Sang-Soo Ha; Sang-Ho Lee, MD
Republic of Korea

#216: Clinical Success Predictors for Neck and Arm Pain in Patients Undergoing ACDF or Cervical Total Disc Replacement

Thomas D. Cha, MD, MBA; Frank M. Phillips, MD; Andrew Cappuccino, MD, BES; Fred H. Geisler, MD, PhD; Christopher Chaput, MD; John G. DeVine, MD; Kye Gilder, PhD; Kelli M. Howell, MS; Paul C. McAfee, MD, MBA
United States

#217: Discriminative Properties of the SF-6D Compared to the SF-36 and ODI

Leah Y. Carreon, MD, MSc; Sigurd H. Berven, MD; Mladen Djurasovic, MD; Kelly R. Bratcher, RN, CCRP; Steven D. Glassman, MD
United States

E-Poster Index

#218: A Research on Safety and Effectiveness of Using Large Dose of Tranexamic Acid to Control the Bleeding during the Spine Correction Surgery
Jingming Xie; Tao Li; Yingsong Wang, MD; Zhi Zhao; Ying Zhang; Zhendong Yang, master; Ni Bi; Hong Chen
China

#219: Direct Repair of Lumbar Spondylolysis by Segmental Pedicle Screw-Infralaminar Hook Construct
Meric Enercan; Cagatay Ozturk, MD; Mercan Sarier; Selhan Karadereler; Fatih Korkmaz; Azmi Hamzaoglu, MD
Turkey

#221: Biomechanics of Two Fusionless Scoliosis Correction Techniques-Rigid Staple vs. Flexible Tether
Diana A. Glaser, PhD; Chaitanya Nandipati, BSE; Thomas Nunn; Peter O. Newton, MD
United States

#222: Medium Term Results of Microscopic Selective Laminoplasty for Cervical Spondylotic Myelopathy
Naoyuki Shizu; Sadaaki Nakai; Tateru Shiraishi
Japan

#223: Minimally Invasive Surgical (MIS) Method for Sacroiliac Joint Arthrodesis – A Case Series of Long-Term Follow-Up Patients
Leonard Rudolf, MD; Mark Reiley, MD
United States

#224: Outcomes of MIS Spinal Fusion: 12 and 24 Months
William B. Rodgers, MD; Edward J. Gerber, PA-C; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS
United States

#225: Is Pre-Operative PFT Assessment Worthwhile in SK?
Baron S. Lonner; Jamie S. Terran, BS; Peter O. Newton, MD; Tracey Bastrom, MA; Suken A. Shah, MD; Harry L. Shufflebarger, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Paul Sponseller
United States

#226: Analysis of Sagittal Alignment Correction in Ankylosing Spondylitis Using Three Different Osteotomy Techniques
Hossein Mehdian, MD, MS(Orth) FRCS(Ed); David P. Copas, BMedSci, BMBS, MRCS; J. S. Mehta, FRCS(Orth)
United Kingdom

#227: Sagittal Spino-Pelvic Parameters in Scheuermann's Kyphosis A Preliminary Study
Baron S. Lonner; Patrick J. Cahill, MD; Peter O. Newton, MD; Jamie S. Terran, BS; Suken A. Shah, MD; Paul Sponseller; Harry L. Shufflebarger, MD
United States

#228: Post-Operative Trunk Imbalance following Posterior Spinal Fusion is Associated with Progressive Subjacent Disc Wedging in Adolescent Idiopathic Scoliosis
Ying-Chuan Zhao; Ming Li
China

#229: Discriminative Properties of the SAQ Compared to the SRS22R
Leah Y. Carreon, MD, MSc; James O. Sanders, MD; Beverly E. Diamond, PhD; Daniel J. Sucato, MD, MS
United States

E-Poster Index

#230: Establishing Parameters for T12 as the Lowest Instrumented Vertebra (LIV) in Selective Thoracic Fusions

Jahangir Asghar, MD; Harry L. Shufflebarger, MD; Dianna C. Morales, BA; Tracey Bastrom, MA
United States

#231: Adolescents with Idiopathic Scoliosis Spinal Range of Motion Pre and Post- Spinal Fusion Compared to Age-Matched Controls

Adam Graf; Peter Sturm, MD; Kim W. Hammerberg, MD; Purnendu Gupta, MD; Mary Riordan, Bachelor of Arts; Sahar Hassani, MS; Joseph Krzak, PT; Gerald F. Harris, PhD
United States

#232: Does Fusion into the Upper Thoracic Spine Cause a Reduction of Pulmonary Function in AIS?

Satoru Demura, MD; Peter O. Newton, MD; Burt Yaszay, MD; Tracey Bastrom, MA; John Schlechter, DO; Harms Study Group
Japan

#234: Baseline Data Variability in Prospective Multi-Center Databases: How Comparable is the Data between Different Centers?

Firoz Miyanji, MD, FRCSC; Michelle C. Marks, PT, MA; Kishore Mulpuri, MBBS, MS, MHSc; Amer F. Samdani, MD; Suken A. Shah, MD; Harry L. Shufflebarger, MD; Randal R. Betz, MD; Peter O. Newton, MD
Canada

#235: Infection Rates for Spine Surgery in Underserved and Underdeveloped Nations: A Review of a Consecutive Series in a SRS Global Outreach Program in Africa

Han Jo Kim, MD; Matthew E. Cunningham, MD, PhD; Jerome Boatey, MD; Bettye Wright, RN, PA; Michael J. Mendelow, MD; W. F. Hess, MD; Kenneth J. Paonessa, MD; Akilah B. King, BA; Mitsuru Yagi, MD,PhD; Oheneba Boachie-Adjei, MD; Complex Spine Study Group; Focos Organization
United States

#236: Analysis of Dural Sac Thickness in Human Spine -Cadaver Study with Confocal Infrared Laser Microscope

Jae-Young Hong, MD; Seung-Woo Suh, MD, PhD; Hitesh N. Modi, MS, PhD
Republic of Korea

#237: Preclinical Study of Human Allograft Amniotic Membrane as a Barrier to Epidural Fibrosis in the Early Wound of a Postlaminectomy Rat Model

R. Todd Allen, MD, PhD; Andrew T. Mahar, MS; Jennie Massie, MS; Frank M. Phillips, MD
United States

#238: Incidence of Complete Spinal Instrumentation Removal Following Deformity Surgery: A 16 Year Retrospective Review

Christina Hardesty, MD; Connie Poe-Kochert, BSN; Jochen P. Son-Hing, MD, FRCSC; George H. Thompson, MD
United States

#239: Titanium Concentrations in the Serum and Hair of Scoliosis Patients who Underwent Posterior Surgeries using with Titanium Implants

Ruriko Uchimura; Hideki Murakami; Ken Yamazaki, MD; Satoshi Yoshida; Tadashi Shimamura
Japan

#240: Complications after Nine Years Follow-Up in Three Different Nucleus Replacement Devices

Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

E-Poster Index

#241: Reliability of SterEOS Imaging Software in AIS Curves Greater Than 50 Degrees
Joseph H. Carreau, MD; Tracey Bastrom, MA; Maty Petcharaporn, BS; Caitlin Schulte, BA; Michelle C. Marks, PT, MA; Peter O. Newton, MD
United States

#242: Is Disability Status a Predictor of Outcome for Lumbar Fusion?
Jeffrey L. Gum, MD; Steven D. Glassman, MD; Leah Y. Carreon, MD, MSc
United States

#243: Complication Rates in Pediatric Occipitocervical Fusions
Loyola V. Gressot, MD; Steven Hwang, MD; Jonathan Thomas, MD; Andrew Jea, MD
United States

#244: A Comparative Study between Anterior Lumbar Interbody Fusion with and without Pedicle Screw Fixation for Isthmic Spondylolisthesis. A Long -Term Follow-Up Study
Mohamed M. Mossaad, MD; Ahmed S. Mohamed, MD
Egypt

#245: Mid-Term Outcomes of Posterolateral Lumbar Fusions with Porous Hydroxyapatite and Local Autograft vs. Iliac Crest Bone Graft for Single Level Spinal Diseases
Jun Young Yang, MD, PhD; June Kyu Lee; Ho Sup Song; Soo Min Cha; Yong Bum Joo
Republic of Korea

#246: Translation of the Scoliosis Research Society Outcomes Instrument to Utility Scores for the Cost-Effectiveness Analysis of Spine Treatments for Adult Deformity
Shawn Richardson, BA; Sigurd H. Berven, MD; Leah Y. Carreon, MD, MSc; Steven D. Glassman, MD; Keith H. Bridwell, MD
United States

#247: Flat Back Syndrome: Is Pedicle Subtraction Osteotomy (PSO) the Best Choice?
Alfredo Cioni; Konstantinos Martikos; Francesco Lolli; Mario Di Silvestre, MD; Georgios Bakaloudis; Tiziana Greggi
Italy

#248: A Descriptive Analysis of Lateral Spondylolisthesis in Patients with Adult Scoliosis
Patrick Knott, PhD, PA-C; Samantha Thompson, BS; Steven M. Mardjetko, MD, FAAP
United States

#249: Functional Outcome and Complications Following Revision Surgery in Adult Spinal Deformity Stratified by Age; Younger vs. Older than 65 Years
Hamid Hassanzadeh, MD; Amit Jain; Richard L. Skolasky, ScD; Michael C. Ain, MD; Khaled Kebaish
United States

#250: Adult Spinal Deformity: A Two-Year Cost-Utility Analysis and Ten-Year Thought Experiment
Daniel T. Warren, MD; Baron S. Lonner; Christian Hoelscher, BS; Jamie S. Terran, BS; Frank Schwab, MD; Steven D. Glassman, MD; Keith H. Bridwell, MD; Thomas Errico; Virginie Lafage, PhD
United States

#251: Sagittal Plane Spinal Deformity: Correction Thresholds and Health Related Quality of Life at Two Years Follow Up
Frank Schwab, MD; Virginie Lafage, PhD; Benjamin Blondel, MD; Justin S. Smith, MD, PhD; Edward Chay; Keith H. Bridwell, MD; Steven D. Glassman, MD
United States

E-Poster Index

#252: Vertebral Column Resection (VCR) and Pedicle Subtraction Osteotomy in the Treatment of Spinal Deformity in Adult Patients 60 Years and Older: Outcome and Complications

Hamid Hassanzadeh, MD; Amit Jain; Mostafa H. El Dafrawy, MD; Richard L. Skolasky, ScD; Addisu Mesfin, MD; Michael C. Ain, MD; Khaled Kebaish
United States

#253: Radiographic and Clinical Outcomes of One Institution's Early Experience with Extreme Lateral Interbody Fusion (XLIF) in the Treatment of Degenerative Scoliosis

Kaveh Khajavi, MD, FACS
United States

#254: Radiographic Outcomes of Long Posterior Fusion using Iliac Screw Fixation in Adult Spinal Deformity

Naobumi Hosogane, MD; Kota Watanabe; Hitoshi Kono; Masashi Saito; Yoshiaki Toyama; Kazuhiro Chiba, MD, PhD; Morio Matsumoto, MD
Japan

#256: Novel, Semi-Rigid Lumbar Spinal Stabilization Lowers Pedicle Screw Pull-Out Risk in an Osteoporotic Spine when Compared with Titanium and PEEK Rods

Joshua D. Auerbach, MD; Pawel Hanulewicz, MD; Steve A. Rundell, MS
United States

#257: Investigating the Potential Effect of "Euphoric Bias" for the New Technology on Results of Randomized Lumbar Total Disc Replacement Trials

Richard D. Guyer, MD; Scott L. Blumenthal; Jack E. Zigler, MD; Donna Ohnmeiss, MD
United States

#258: Characterization of In Vivo Vertebral Growth Modulation by Shape Memory Alloy Staples in a Porcine Model

Yaroslav Wakula, MD; Stefan Parent, MD, PhD; Carl-Eric Aubin, PhD, PEng; Mark Driscoll, BEng; Isabelle Villemure, PhD
Canada

#259: Normal Values for the 3D Representation of the Planes of Maximum Curvatures (da Vinci representation) in Asymptomatic Adolescents

Stefan Parent, MD, PhD; Carl-Eric Aubin, PhD, P.Eng; Peter O. Newton, MD; Lawrence G. Lenke, MD; Roger P. Jackson, MD; Xavier Jodoin-Fontaine, MD; Jérémie Thériault, MSc.; Hubert Labelle, MD
Canada

#260: Atlantoaxial Fixation using the Polyaxial Screw-Rod System

Jan Stulik; Jan Kryl; Petr Nesnidal
Czech Republic

#261: Lumbar Spinal Canal and Foraminal Volume Changes Due to Indirect Decompression with Comparison to Lateral Cage Positions: A Radiographic Study

Andres F. Cabezas, BSCE; German Marulanda, MD; Ryan Murtagh, MD, MBA; Aniruddh Nayak, MS; Brandon G. Santoni, PhD; Antonio E. Castellvi, MD
United States

#262: A Novel Method of Screw Placement for Extremely Small Thoracic Pedicles in Scoliosis

Choon Sung Lee, MD, PhD; Soo-An Park, MD, PhD; Chang Ju Hwang, MD, PhD.; Dong-Ho Lee, MD, PhD
Republic of Korea

#263: The Ventral Lamina and Superior Facet Rule: The Key to Accurate Placement for Thoracic Pedicle Screws

Ronald A. Lehman, MD; Daniel G. Kang, MD; Lawrence G. Lenke, MD; Rachel E. Gaume, BS; Haines Paik, MD
United States

E-Poster Index

#264: Is Thoracic Hypokyphosis Unavoidable? How to Maintain Thoracic Kyphosis during the Correction of Scoliosis using a VCM Instrument
Taichi Tsuji; Noriaki Kawakami, MD; Kazuyoshi MIyasaka, MD; Tetsuya Ohara; Toshiki Saito; Ayato Nohara; Michiyoshi Sato; Kenyu Ito
Japan

#265: Pedicle Screw Placement in Adults Using Image-Guided Navigation is Safe and Accurate
Edward Rainier G. Santos, MD; Jonathan N. Sembrano, MD; A. Noelle Larson, MD; Sharon C. Yson, MD; Charles Gerald T. Ledonio, MD; David W. Polly, MD
United States

#266: An Inexpensive Computer Assisted Technique for Pedicle Screw Placement in Scoliosis Surgery
Yuichiro Abe, MD, PhD; Manabu Ito, MD, PhD; Kuniyoshi Abumi, MD; Yoshihisa Kotani, MD; Hideki Sudo; Ken Nagahama; Akira Iwata, MD; Akio Minami, MD, PhD
Japan

#267: Comparison Between Posterior-Only Correction and Combined Anterior/Posterior Fusion for Severe Scheuermann's Kyphosis
Yutaka Nakamura, MD,PhD.; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Yuan Ning; Guangxun Hu, MD; Woo-Kie Min, MD, PhD; Linda Koester, BS
Japan

#268: Comparison of Scheuermann's Kyphosis Correction by Posterior-Only Pedicle Screw Fixation with or without Ponté Osteotomy
Guangxun Hu, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Linda Koester, BS
United States

#269: Radiological Analysis of Pedicle Subtraction Osteotomies in Children: Where Does the Correction Occur?
J. Naresh-Babu, MD; Cheekatla Suresh; Ch V. Swamy
India

#270: Prevalence of Spinal Deformities in Prader-Willi Syndrome
Harold J. van Bosse, MD
United States

#271: Trunk Motion Improves over Time after Spinal Fusion for Adolescent Idiopathic Scoliosis
Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Maty Petcharaporn, BS; Randal R. Betz, MD; Harry L. Shufflebarger, MD; Baron S. Lonner; Suken A. Shah, MD; Peter O. Newton, MD
United States

#273: Surgical Technique Can Improve Patient Perception of Breast Asymmetry in AIS
Anna McClung, RN; Daniel J. Sucato, MD, MS; Beverly E. Diamond, PhD
United States

#275: Radiographic and Clinical Outcomes following Scoliosis Surgery in Adolescent Patients with Marfan Syndrome - Are They Different from Adolescent Idiopathic Scoliosis?
Woo-Kie Min, MD, PhD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Dong-Ho Lee, MD, PhD; Yutaka Nakamura, MD, PhD.; Moon Soo Park, PhD; Linda Koester, BS
United States

#276: Revision Surgery After Instrumentation and Fusion in Adolescent Idiopathic Scoliosis
Kelley Banagan; Peter Sturm, MD; Jessica Day; Anne Riordan, BA; Melanie Bland, BS; Kim W. Hammerberg, MD
United States

E-Poster Index

#277: Surgical Treatment of Sacrum Tuberculosis by Single-Stage Posterior Reconstruction and Anterior Debridement and Drainage

Ming Li; Yushu Bai
China

#278: Vertebral Body Stapling Plus an Expandable Hybrid Rod: Early Results of A Non-fusion Alternative in the Treatment of Skeletally Immature Children with Idiopathic Scoliosis and a High Risk of Progression

Joshua E. Heller, MD; Amer F. Samdani, MD; Jahangir Asghar, MD; David H. Clements, MD; Harsh Grewal, MD, FACS; Ross Chafetz; Randal R. Betz, MD; Patrick J. Cahill, MD
United States

#279: Comparison of Osteogenesis of an Early Differentiating Adult Stem Cell to Bone Marrow Aspirate and Pure Mesenchymal Stems Cells within a Demineralized Bone Scaffold in an Athymic Rat Model

Carl Lauryssen, MD; Andrew T. Mahar, MS; Sara Chastain, MS; Srilakshmi Vishnubhotla, MS; Sigurd H. Berven, MD; Jonathan N. Grauer, MD
United States

#280: Burying One's Head in the Sand: Are We Underestimating the Significance of Pedicle Screw Misplacement?

Vishal Sarwahi, MD; Jonathan J. Horn; Terry D. Amaral, MD; Beverly Thornhill, MD; Preethi M. Kulkarni, MD; Melanie Gambassi, NP; Adam L. Wollowick, MD
United States

#281: Radiolucency and Pseudoarthrosis after Four-Year Follow-Up on a Minimally Invasive Presacral Approach

Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#282: Complications on Lumbar Arthroplasty after Eight Years Follow Up - What Can be Done to Improve Results in Future?

Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#283: Surgical Treatment of Severe Scoliosis: Best Practices, Complications and Efficacy of Combined Anterior/Posterior vs. Posterior Procedures by A SRS Global Outreach Team

Oheneba Boachie-Adjei, MD; Han Jo Kim, MD; Munish C. Gupta, MD; Baron S. Lonner; W. F. Hess, MD; Carlos Villanueva, MD, PhD; Maria Cristina Sacramento Dominguez, MD, PhD; Michael J. Mendelow, MD; Kenneth J. Paonessa, MD; Francisco Javier Sánchez Pérez-Grueso; Jerome Boatey, MD; Matthew E. Cunningham, MD, PhD; Complex Spine Study Group; Focos Organization
United States

#284: Image-Guided Placement of Pedicle Screws in Congenital Spine Deformity

A. Noelle Larson, MD; David W. Polly, MD; Edward Rainier G. Santos, MD; Charles Gerald T. Ledonio, MD; Jonathan N. Sembrano, MD; Cary H. Mielke, MD; Kenneth J. Guidera, MD
United States

#285: Does Rib-Based Distraction Control Curve Progression and Prevent Parasol Deformity of the Chest in Scoliosis Associated with Congenital Myopathy?

John T. Smith, MD; Jennie B. Mickelson, BS; Charles R. d'Amato, MD, FRCSC; Robert M. Campbell, MD; Michael G. Vitale, MD, MPH
United States

#286: Growing Spine Profiler – A New Device in the Treatment of Progressive Spinal Deformities, Early Results

Daniel Zarzycki, MD, PhD; Tomasz Potaczek, MD; Slawomir Duda, MD; Maciej Tesiorowski, MD, PhD
Poland

E-Poster Index

#287: Resolution of Leg Pain after Surgical Decompression: Results with and without TLIF and RhBMP-2
Dennis Crandall, MD; Eric Huish, BS; Jason Patterson, MD; Jan Revella, RN; Jason Datta, MD; Michael S. Chang, MD; Terrence Crowder, MD; Ryan McLemore, PhD
United States

#288: Prospective, Randomized Trial of Pedicle Drilling Probe That Measures Electrical Conductivity and Reduces Radiation Exposure
Christopher Chaput, MD; Keri George, RN; Amer F. Samdani, MD; John Gaughan; Randal R. Betz, MD
United States

#289: The Prevalence and Potential Impact of Lumbar Facet Replacement in Patients Undergoing Lumbar Spinal Surgery
Kai Zhang; Darren R. Lebl, MD; Fred Mo, MD; Matthias Pumberger, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD
United States

#290: Direct Repair of Multiple Level Lumbar Spondylolysis by a Cable Screw Construct
Yasser ElMiligui, MD, FRCS; Wael Koptan, MD; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa
Egypt

#291: The Treatment of Thoracic Osteomyelitis in Elderly Patients by Modified Posterior Vertebral Column Resection
Emre Karadeniz; Meric Enercan; Cagatay Ozturk, MD; Ahmet Alanay; Mehmet Tezer; Azmi Hamzaoglu, MD
Turkey

#292: Role of 'Low Cost Indian Implants' in our Practice: Our Experience with 1,572 Pedicle Screws
Saurabh Rawall; Abhay Nene
India

#293: Neck-Shoulder Crossover: How Often Do Neck and Shoulder Pathology Masquerade as the Other?
Jonathan N. Sembrano, MD; Sharon C. Yson, MD; Okezika Kanu, BS; Edward Rainier G. Santos, MD; Alicia Harrison; David W. Polly, MD; Jonathan P. Braman, MD
United States

#294: Impact of Diabetes on Symptoms and Treatment Outcomes in Patients with Cervical Spondylotic Myelopathy. The Results of the AOSpine North America Multi-Center Prospective Study
Paul Arnold; Michael Fehlings, MD, PhD, FRCSC; Branko Kopjar; S. Tim Yoon; Alexander R. Vaccaro, MD, PhD; Darrel S. Brodke, MD; Christopher I. Shaffrey, MD; Eric J. Woodard, MD; Robert Banco; Jens R. Chapman, MD; Michael Janssen, DO; Rick C. Sasso, MD; Christopher Bono; Mark B. Dekutoski, MD; Ziya L. Gokaslan, MD
United States

#295: Association of Estrogen Receptor Gene Polymorphism in Patients with Degenerative Lumbar Spondylolisthesis
Jung Sub Lee, MD, PhD; Jong Min Lim; Tae Sik Goh
Republic of Korea

#296: Incidence/Association of Spondylolisthesis and Adolescent Idiopathic Scoliosis (AIS)
Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Kathy Blanke, RN; Ensor E. Transfeldt, MD; Hubert Labelle, MD; Stefan Parent, MD, PhD; Jean-Marc Mac-Thiong, MD, PhD
United States

#297: Post-Operative Trunk Mobility is Better With the Anterior Approach vs. Posterior in Thoracolumbar Scoliosis
Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Maty Petcharaporn, BS; Randal R. Betz, MD; Harry L. Shufflebarger, MD; Baron S. Lonner; Suken A. Shah, MD; Peter O. Newton, MD
United States

E-Poster Index

#298: CT-Based Evaluation of 8,661 Pedicles: What Patient and Curve Characteristics are Associated with Abnormal Morphology?

Terry D. Amaral, MD; Beverly Thornhill, MD; Adam L. Wollowick, MD; Joshua Grossman; Jonathan J. Horn; Etan P. Sugarman, MSIV; Preethi M. Kulkarni, MD; Vishal Sarwahi, MD
United States

#299: Is it OK to Stop at the Lowest Instrumented Vertebra without Touching by Center Sacral Line for Thoracic Adolescent Idiopathic Scoliosis?

Yongjung J. Kim, MD; Charla R. Fischer, MD; Oheneba Boachie-Adjei, MD; Jean-Luc Clement, MD; Munish C. Gupta, MD
United States

#300: Treatment of Adolescent Idiopathic Scoliosis with All Pedicle Screw Constructs with Minimum Five Year Follow-up

Amer F. Samdani, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Patrick J. Cahill, MD; Hitesh Garg, MD; Baron S. Lonner; Suken A. Shah, MD; Firoz Miyanji, MD, FRCSC; Harry L. Shufflebarger, MD; Peter O. Newton, MD; Randal R. Betz, MD
United States

#301: Analysis of Minimum Three-Year Follow-Up of Posterior Pedicle Screw-Only Constructs in Surgical Treatment of Adolescent Idiopathic Scoliosis

Ming Li; Ying-Chuan Zhao; Zi-Qiang Chen, MD
China

#302: Postoperative Left Shoulder Elevation (LSE) In Patients With Non-Structural Proximal Thoracic Curves (PT): Can It Be Prevented?

Ahmet Alanay; Meric Enercan; Cagatay Ozturk, MD; Mehmet Tezer; Mehmet Aydogan; Azmi Hamzaoglu, MD
Turkey

#303: New Proximal Thoracic Curve Occurrence after Posterior Correction in Adolescent Idiopathic Scoliosis

Yipeng Wang, MD; Bin Yu, MD; Guixing Qiu
China

#304: Thoracoplasty in the Surgical Treatment of Adolescent Idiopathic Scoliosis

Tiziana Greggi, Head; Georgios Bakaloudis; Mario Di Silvestre, MD; Konstantinos Martikos; Francesco Lolli; Francesco Vommaro; Elena Maredi
Italy

#305: Repeat Surgical Intervention Following Definitive Instrumentation for Idiopathic Scoliosis – Five-Year Update on a Previously Published Cohort

Brandon A. Ramo, MD; B. Stephens Richards, MD
United States

#306: Clinically Oriented Classification for the Surgical Treatment of Adolescent Idiopathic Scoliosis

Zaher Dannawi, FRCS (Tr & Orth); Mohannad Al-Mukhtar, MB, ChB, MRCS; Julian J. Leong, MA, MBBS, MRCS, PhD, DIC; M. Shaw, FRCS; Alex Gibson; Hazem B. Elsebaie, FRCS, MD; Hilali H. Noordeen, FRCS
United Kingdom

#307: Establishment and Validation of 3-Dimensional Finite Element Model of Lenke1BN Idiopathic Scoliosis

Hongqi Zhang, MD; Chaofeng Guo
China

E-Poster Index

#308: Correlation between Curve Flexibility and Respiratory Functions Pre and Post Surgical Correction of Idiopathic Scoliosis
Abla Hamed; Youssry El Hawary
Egypt

#309: The Relationship between the Position of Aorta and Left Thoracic Pedicle in Adolescent Idiopathic Scoliosis
Jianxiong Shen, MD; Jiaming Liu, MD
China

#310: Radiographic and Clinical Outcomes of Posterior Spinal Fusion for Idiopathic Scoliosis in African Patients: A Comparison of All Pedicle Screw vs. Hybrid Instrumentation
Han Jo Kim, MD; Oheneba Boachie-Adjei, MD; Francisco Javier Sánchez Pérez-Grueso; Baron S. Lonner; Kenneth J. Paonessa, MD; W. F. Hess, MD; Maria Cristina Sacramento Dominguez, MD, PhD; Ferran Pellise, MD; Juan Bago, MD; Munish C. Gupta, MD; Matthew E. Cunningham, MD, PhD; Complex Spine Study Group; Focos Organization
United States

#311: Staging Regimen in Adult Spinal Deformity Surgery Significantly Impact Functional Outcome, Complications & Total Hospital Days
Hamid Hassanzadeh, MD; Joseph P. Gjolaj, MD; Mostafa H. El Dafrawy, MD; Amit Jain; David B. Cohen, MD; Khaled Kebaish
United States

#312: Complications and Revision Rates for Long Fusions Terminating at L5 vs. the Sacrum in Adult Spine Deformity
John Caridi, MD; Jaspaul Gogia, MD; Oheneba Boachie-Adjei, MD; Matthias Pumberger, MD; Thomas Ross, MS, RN; Complex Spine Study Group
United States

#313: Analysis of Perioperative Factors Contributing to Extended Length of Stay
Jamie S. Terran, BS; Christian Hoelscher, BS; Baron S. Lonner; Antonio Valdevit, PhD; Frank Schwab, MD; Virginie Lafage, PhD; Thomas Errico
United States

#314: Unilateral vs. Bilateral Iliac Screw Fixation: Outcomes and Complications
Michael S. Chang, MD; Dennis Crandall, MD; Jan Revella, RN; Yu-Hui H. Chang, MPH, MS, PhD
United States

#315: Anterior Elongation Instead of Posterior Osteotomies - Lateral Interbody Fusion
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#316: Radiographic and Clinical outcomes of Posterior Column Osteotomies in Spinal Deformity Correction: Analysis of 128 Patients
Ian G. Dorward, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Woojin Cho, MD, PhD; Linda Koester, BS; Brenda A. Sides, MA
United States

#317: Recovery Rates after Corrective Surgery for Adult Scoliosis
Michael H. Weber, MD, PhD; Steven Takemoto, PhD; Sigurd H. Berven, MD
United States

#318: The Limited Benefit of Coronal Cobb Angle Correction in the Setting of Adult Spinal Deformity: a Health Related Quality of Life Assessment on Two Year Outcomes
Virginie Lafage, PhD; Frank Schwab, MD; Benjamin Blondel, MD; Justin S. Smith, MD, PhD; Jason Demakakos; Keith H. Bridwell, MD; Steven D. Glassman, MD
United States

E-Poster Index

#319: The Utility and Limitations of XLIF for Adult Scoliosis

Vedat Deviren, MD; Sassan Keshavarzi; Gregory M. Mundis, MD; Murat Pekmezci, MD; Behrooz A. Akbarnia, MD; Michael H. Weber, MD, PhD; Christopher P. Ames, MD

United States

#320: The Effect of Prophylactic Vertebroplasty on the Incidence of Proximal Junctional Kyphosis Following Long Posterior Spinal Fusion in Adult Spinal Deformity: A Case Control Study

Khaled Kebaish; Oheneba Boachie-Adjei, MD; Akilah B. King, BA; Mitsuru Yagi, MD,PhD; Richard L. Skolasky, ScD; John P. Kostuik, MD; Complex Spine Study Group

United States

#321: Conservative Care vs. Radiofrequency Kyphoplasty: A Comparative Effectiveness Study on the Treatment of Vertebral Body Fractures

Robert Pflugmacher

Germany

#322: 3-D Analysis of the Porcine Scoliosis Model: Impact of a Corrective Tether

Jason Demakakos; Frank Schwab, MD; Bertrand Moal, MS; Benjamin Ungar; Renaud Lafage; Paul Riviere; Virginie Lafage, PhD

United States

#324: Pedicle Length is Associated with the Interpedicular Distance in the Cervical and Lumbar Spine: An Anatomic study of 410 Human Cadaveric Spines

Navkirat S. Bajwa; Jason O. Toy, MD; Nicholas U. Ahn, MD

United States

#325: Can Infection Following Scoliosis Instrumentation Surgery Be a 'Never Event'?: Dramatic Reduction in Infection Rates at One Institution after Implementation of a Multimodal Prevention Protocol

Michael P. Horan, MD, MS; Brendan A. Williams, AB; W.G. Stuart Mackenzie, BS, MS II; Hiroko Matsumoto, MA; Lisa Saiman, MD, MPH; Lisa Covington, RN, MPH; Benjamin D. Roye, MD, MPH; Joshua E. Hyman, MD; David P. Roye, MD; Michael G. Vitale, MD, MPH

United States

#326: Early and One Year Complication Rates in Scheuermann's Kyphosis: Are the Surgical Challenges Different from Adolescent Idiopathic Scoliosis

Baron S. Lonner; Burt Yaszay, MD; Jamie S. Terran, BS; Peter O. Newton, MD; Suken A. Shah, MD; Paul Sponseller; Amer F. Samdani, MD; Randal R. Betz, MD; Harry L. Shufflebarger, MD

United States

#327: Management of Craniovertebral Tuberculosis - Retrospective Review of 52 Cases

Kshitij S. Chaudhary, MS DNB; Prabodhan P. Potdar, MS; Mihir R. Bapat, MS DNB; Vinod Laheri, MS

India

#328: Does Resection of the Posterior Longitudinal Ligament Impact the Incidence of C5 Palsy after Cervical Corpectomy Procedures? A Review of 459 Consecutive Cases

Ahmad Nassr, MD; Jason C. Eck, DO, MS; Barrett I. Woods, MD; Ravi K. Ponnappan, MD; William F. Donaldson, MD; James D. Kang, MD

United States

#329: The Long-Term Outcome of Pediatric Vertebral Column Resection (VCR)

Ravi S. Bains, MD; Nicholas Pirnia, MD

United States

#330: The Prevalence of Lumbosacral Transitional Vertebrae in an American Population

Pedro A. Ricart-Hoffiz, MD; Alexios Apazidis, MD, MBA; Christopher Diefenbach, BS; Jeffrey M. Spivak, MD

United States

E-Poster Index

#331: One-Stage Posterior Hemivertebra Resection Combined with Transpedicular Instrumentation for the Surgical Treatment of Congenital Scoliosis in Young Children (One to Three Years-Old)
Hongwen Xu; Denghui Xie, MD; Zhao-Min Zheng, MD
China

#332: Clinical and Radiographic Outcomes on a Series of 171 Patients Treated With Single Level Baguera C Cervical Disc Replacement at Two-Year Follow-Up
Patrick Tropiano, MD; Benjamin Blondel, MD; Patrick Fransen, MD; Gianluca Maestretti
Belgium

#333: The Future of Lumbar Arthroplasty: Elastomeric Lumbar Disc Replacement Improving Load Absorption 36 Months after Surgery
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#334: Lumbar Total Disc Replacement vs. Fusion: Analysis of Cost Comparison Studies
Richard D. Guyer, MD; Ashraf Darwish, MD; Scott L. Blumenthal; Jack E. Zigler, MD; Donna Ohnmeiss, MD
United States

#335: Outcomes of Growing Rod Techniques in Early Onset Scoliosis: Multicenter Study in Japan
Kota Watanabe; Morio Matsumoto, MD; Koki Uno, MD, PhD; Noriaki Kawakami, M D; Taichi Tsuji, MD; Haruhisa Yanagida, MD; Manabu Ito, MD, PhD; Toru Hirano; Ken Yamazaki, MD; Shohei Minami; Hiroshi Taneichi, MD; Shiro Imagama, MD; Katsushi Takeshita; Takuya Yamamoto
Japan

#336: Post-Operative Wound Infection in Growing Rod Surgery for Early-Onset Scoliosis
Behrooz A. Akbarnia, MD; Nima Kabirian, MD; Jeff Pawelek; Milad Alam, BS; Gregory M. Mundis, MD; Ricardo Acacio, MD; George H. Thompson, MD; David S. Marks, FRCS; Adrian Gardner, BM MRCS FRCS (T&O); David L. Skaggs, MD; Growing Spine Study Group
United States

#337: Radiographic Results of Expansion Thoracoplasty with VEPTR in Jeune Syndrome
Davin Cordell, MD; Ambadas Kathare; Ajeya P. Joshi, MD; James W. Simmons, DO; Robert M. Campbell, MD
United States

#338: More Experienced Surgeons Less Likely To Fuse: A Focus Group Review of 315 Hypothetical EOS Cases
Jahangir Asghar, MD; Brendan A. Williams, AB; Hiroko Matsumoto, MA; David P. Roye, MD; John M. Flynn, MD; Michael G. Vitale, MD, MPH
United States

#339: The Value of Flexibility Radiographs in Predicting Coronal Curve Correction Following Growing Rod Surgery
Burt Yaszay, MD; Jeff Pawelek; Nima Kabirian, MD; Tracey Bastrom, MA; John B. Emans, MD; George H. Thompson, MD; Richard E. McCarthy; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD; Growing Spine Study Group
United States

#340: Complications in Patients with VEPTR Instrumentation are Strongly Associated with Basic Diagnosis
Krister Kyllönen; Olli T. Pajulo, MD, PhD; Jari Peltonen; Ilkka Helenius, MD, PhD
Finland

#341: An Analysis of Upright Biplanar Scanning Low Dose Digital Scoliosis X-Rays
Joseph H. Carreau, MD; Tracey Bastrom, MA; Carrie E. Bartley, MA; Burt Yaszay, MD; Peter O. Newton, MD
United States

E-Poster Index

#342: High Dose Tranexamic Acid (TXA) Reduces Blood Loss in Complex Pediatric Deformity Spine Surgery
Ra'Kerry K. Rahman, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Scott J. Luhmann, MD; Brenda A. Sides, MA
United States

#343: Enhance Method of Pedicle-Screw Insertion for Pedicles without Cancellous Channel
Koki Uno, MD, PhD; Teppei Suzuki; Hiroshi Miyamoto, MD; Yoshihiro Inui
Japan

#344: Outcomes of the Trans-Psoas Lateral Approach for Lumbar Interbody Fusions
Michael R. Briseno, MD; Joshua H. Abrams; Sanjum P. Samagh, M.Sc.; Ivan Cheng, MD
United States

#345: Percutaneous Pedicle Screw Placement Using Image-Guided Navigation is Safe and Accurate
Edward Rainier G. Santos, MD; Jonathan N. Sembrano, MD; A. Noelle Larson, MD; Sharon C. Yson, MD; Charles Gerald T. Ledonio, MD; David W. Polly, MD
United States

#346: Posterior Reamed Lumbosacral Interbody Fusion by a Transacral Approach - Early Clinical and Radiographic Results
Darren R. Lebl, MD; Andrew A. Sama, MD; Matthias Pumberger, MD; Suhel Kotwal, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD
United States

#347: Minimally Invasive Transforaminal Lumbar Interbody Fusion: The Surgical Learning Curve
Kern Singh, MD; Jonathan A. Hoskins, MD
United States

#348: Pulmonary Function Comparison following Adult Spinal Deformity Surgery: Minimum Two-Year Follow-Up
Lawrence G. Lenke, MD; Jeremy J. Stallbaumer, MD; Keith H. Bridwell, MD; Jie Zheng, MS; Linda Koester, BS
United States

#350: Polysegmental SPO for Correction of Kyphosis secondary to Ankylosing Spondylitis
Yong Hai, MD
China

#351: Outcomes of Anterior Lumbar Interbody Fusion and Plating vs. Anterior Lumbar Interbody Fusion Alone
Laura Snyder; Samuel Kalb; Udaya K. Kakarla, MD; Nicholas Theodore, MD, FACS
United States

#352: Subsidence of PEEK Lumbar Interbody Grafts Placed via a Minimally Invasive Lateral Retroperitoneal Trnspsoas Aproach
Clinton Burkett, MD; Gisela Murray, MD; Elias Dakwar, MD; Ali A. Baaj; Fernando L. Vale, MD; Donald A. Smith, MD; Juan S. Uribe, MD
United States

#354: Return to Golf Following Spinal Surgery: A Preliminary Basis for Setting Expectations
Matthew Nugent, MD; Dennis Crandall, MD; Jan Revella, RN; Jason Datta, MD; Michael S. Chang, MD; Terrence Crowder, MD; Ryan McLemore, PhD
United States

#355: Clinical Results of Unilateral Partial Vertebroplasty(UPVP)in Osteoporotic Vertebral Fracture
Jun Young Yang, MD, PhD; Soo Min Cha; Yong Bum Joo; June Kyu Lee
Republic of Korea

E-Poster Index

#356: Comparative Analysis of Sagittal Lumbar & Pelvic Parameters between Young & Old Aged Groups
Youngbae B. Kim, MD, PhD; Yongjung J. Kim, MD; Young-Jun Ahn, MD; Kyu-Bok Kang, MD; Eui-Dong Yeo, MD; Seung-Won Lee, MD
Republic of Korea

#357: Effect of Minimally Invasive Lumbar Posterolateral Fusion using Percutaneous Pedicle Screw on Paravertebral Muscle Change and Postoperative Residual Low Back Pain
Yoshihisa Kotani, MD; Kuniyoshi Abumi, MD; Hideki Sudo; Manabu Ito, MD, PhD; Ken Nagahama; Akira Iwata, MD; Akio Minami, MD, PhD
Japan

#358: Clinical Outcomes Following Repair of the Pars Interarticularis
Travis Clegg, MD; Leah Y. Carreon, MD, MSc; Ian Mutchnick, MD; Rolando M. Puno, MD
United States

#359: Meta- Analysis of Lumbar Total Disc Replacement FDA-regulaed Trials: A Missed Opportunity
Zeshan Hyder, DO; Richard D. Guyer, MD; Donna Ohnmeiss, MD; Scott L. Blumenthal; Jack E. Zigler, MD
United States

#360: Surgical Outcome of Spinal Deformities Associated with Neurofibromatosis
Chizuo Iwai; Hiroshi Taneichi, MD; Satoshi Inami; Takashi Namikawa, MD, PhD; Daisaku Takeuchi; Nakayuki Kato; Yutaka Nohara, MD
Japan

#361: Combat Burst Fracture - A Military Specific Injury Mechanism
Brett A. Freedman, MD; Brian Cameron, MD; Chris J. Neal; Keith L. Jackson, MD; Rosemary Wells
United States

#362: Does Iliac Crest Harvesting Affect Outcomes Following Posterior Fusions for Adolescent Idiopathic Scoliosis?
Charles H. Crawford, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; Leah Y. Carreon, MD, MSc
United States

#364: Does the Curve Pattern Change during Brace Treatment of Adolescent Idiopathic Scoliosis?
Xin Zhen; Xu Sun, MD, PhD; Tao Wu; Bangping Qian; Zezhang Zhu, MD; Bin Wang, MD; Yong Qiu, MD
China

#365: Spine-Related Symptoms in Young Adults after Surgical Treatment of Adolescent Idiopathic Scoliosis
Jonathon M. Spanyer, MD; Charles H. Crawford, MD; Chelsea E. Canan, BA; Lauren O. Burke, BS; Leah Y. Carreon, MD, MSc
United States

#366: Lack of Agreement on Performing Selective Thoracic Fusions for Lenke 1C AIS Curve Patterns: Evaluation of 57 SRS Members
Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; Keith H. Bridwell, MD
United States

#368: Pediatric Sagittal Alignment - Different with Scoliosis and Unchanged with Surgery
Sergio A. Mendoza-Lattes, MD; Stuart L. Weinstein, MD; Gnanapragasam Gnanapradeep, MD; Zachary Ries, BSc; Rachel C. Nash; Yubo Gao
United States

#369: Does Insurance Status Influence Surgical Outcome for Pediatric Patients with Idiopathic Scoliosis?
Samuel K. Cho, MD; Natalia N. Egorova, PhD, MPH; Andrew C. Hecht; Sheeraz A. Qureshi, MD, MBA; Abigail Allen, MD; Alan Moskowitz, MD
United States

E-Poster Index

#370: Lung Thoracic Compliance Changes after Correcting Idiopathic Scoliosis under General Anesthesia
Toshiaki Kotani; Shohei Minami; Tsutomu Akazawa, MD; Toshiro Shitara; Noriaki Kawakami, M D; Taichi Tsuji, MD; Morio Matsumoto, MD; Kota Watanabe; Koki Uno, MD, PhD; Teppei Suzuki
Japan

#372: Patient Perception of Breast Asymmetry in Adolescent Idiopathic Scoliosis (AIS)
Jeannie Huh, MD; Anna McClung, RN; Kristina Walick, MD; Daniel J. Sucato, MD, MS
United States

#373: Evolution of Treatment Trends in AIS Surgery Across Implant Eras: How has our Practice Changed?
Jahangir Asghar, MD; Tracey Bastrom, MA; Michelle C. Marks, PT, MA; Amer F. Samdani, MD; Harry L. Shufflebarger, MD; Dianna C. Morales, BA
United States

#374: Ventral Derotation Spondylodesis for Treatment of Idiopathic Scoliosis with Special Emphasis on Cosmetical Aspects
Stefan Krebs; Andreas M. Robert, MD; Bernhard F. Greiner, MD; Christoph R. Schätz, MD
Germany

#375: Bone Debris Collected during Surgical Decompression: A Suitable Autograft for Spinal Fusion?
Claudia Eder, MD, PhD; Albert Chavanne; Jochen Meissner; Wolfgang Bretschneider; Alexander Tuschel; Philipp Becker; Michael Ogon
Austria

#376: Distinction of Acute and Chronic Spinal Cord Injury in Mammals based on Genetic Change
Jun Young Yang, MD, PhD; June Kyu Lee; Yong Bum Joo; Soo Min Cha
Republic of Korea

#377: Hemivertebrae Resection in the Treatment of Congenital Lumbosacral Scoliosis
Keyi Yu, MD; Zhang Jianguo, MD; Jianxiong Shen, MD; Qiu Guixing
China

#378: Does Pedicle Morphology Change with Age - A Study of 8,042 Pedicles in Normal Subjects
Terry D. Amaral, MD; Beverly Thornhill, MD; Eric Shulman; Adam L. Wollowick, MD; Jonathan J. Horn; Etan P. Sugarman, MSIV; Preethi M. Kulkarni, MD; Vishal Sarwahi, MD
United States

#380: Analysis of Mineralization Distribution in the Vertebral Endplates in Adolescent Idiopathic Scoliosis Patients using CT Osteoabsorptmetry
Yuichiro Abe, MD, PhD; Manabu Ito, MD, PhD; Kuniyoshi Abumi, MD; Yoshihisa Kotani, MD; Hideki Sudo; Ken Nagahama; Akira Iwata, MD; Norimasa Iwasaki, MD, PhD; Shigeru Tadano, PhD; Akio Minami, MD, PhD
Japan

#381: Effect of Strategic Cage Implantation on Sagittal Balance and Clinical Outcome in Lateral Lumbar Inter-Body Fusion
Suhel Kotwal, MD; Matthias Pumberger, MD; Ignacio Merino; Darren R. Lebl, MD; Andrew A. Sama, MD; Federico P. Girardi, MD; Frank P. Cammisa, MD
United States

#383: The Effect of TLIF Cage Position on Segmental and Regional Lordosis
Dennis Crandall, MD; Melissa Gebhardt, PA-C; Jan Revella, RN; Michael S. Chang, MD; Jason Datta, MD; Terrence Crowder, MD; Ryan McLemore, PhD
United States

E-Poster Index

#384: Transforaminal Lumbar Interbody Fusion: Which Construct Configuration Provides the Optimal Biomechanical Stability?
Divya V. Ambati, MS; Anton E. Dmitriev, PhD; Ronald A. Lehman, MD
United States

#386: Midsagittal Diameter Does Not Correlate with Functional Status or Disability in Lumbar Spinal Stenosis
Jeffrey Lange, MD; Benjamin J. Archer, BS; Mark S. Eskander, MD; Natalie Egge, MD; Patricia Franklin, MD, MBA, MPH; Patrick J. Connolly, md; Jason C. Eck, DO, MS
United States

#387: Timing to Diagnosis and Neurological Outcomes in 48 Consecutive Craniocervical Dissociation Patients
Richard J. Bransford, MD; Abiliio A. Reis, MD; Jens R. Chapman, MD; Julie Agel; Michael J. Lee, MD; Carlo Bellabarba, MD
United States

#388: A Definition for Congenital Stenosis of the Lumbar Spine: An Anatomic Study of 410 Postmortem Specimens
Navkirat S. Bajwa; Jason O. Toy, MD; Nicholas U. Ahn, MD
United States

#389: Shh Released from the Nucleus Pulposus Controls Growth and Differentiation of the Postnatal Mouse Disc
Chitra L. Dahia, PhD; Eric Mahoney; Christopher Wylie
United States

#390: The Feasibility of Translaminar Screws in the Subaxial Cervical Spine
Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; Michael Iwanik, PhD; John Glaser, MD; Joshua E. Heller, MD; Kai-Ming Fu, MD, PhD; Francis H. Shen, MD
United States

#391: Occipitocervical Fixation: Long-Term Follow-up in 57 Patients
Jan Stulik; Zdenek Klezl, MD; Jan Kryl; Petr Nesnidal
Czech Republic

#392: The Influence of Occipital Plate Screw Length on the Pullout Resistance of Assembled Screw-Plate Constructs: A Biomechanical Cadaver Study
Heiko Koller, MD; Juliane Zenner, MD; Michael Mayer, MD; Gundobert Korn, MD; Herbert Resch
Germany

#393: Posterior Hemivertebra Resection and Internal Fixation for Congenital Cervicothoracic Deformity
Zhang Jianguo, MD; Wu Sun, MD
China

#394: A Multidisciplinary Adult Spinal Deformity Preoperative Conference Leads to a Significant Rejection Rate
Rajiv K. Sethi, MD; Stephen J. Olivar, MD; Steve Lavine; Jean-Christophe Leveque, MD; Pamela Girres, MD, MPH; Chong C. Lee, MD, PhD; Vishal Gala, MD MPH; Joan Poochoon; Kyle Kim, MD, PhD; Sarah Hipps; Steve Rupp, MD
United States

#395: The Accuracy of Pedicle Screw Insertion Using Intraoperative Three-Dimensional Image Guidance
Edward Rainier G. Santos, MD; Jonathan N. Sembrano, MD; A. Noelle Larson, MD; Sharon C. Yson, MD; Charles Gerald T. Ledonio, MD; David W. Polly, MD
United States

E-Poster Index

#396: The Insertion Technique of Translaminar Screws in the Thoracic Spine: CT and Cadaveric Validation

Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; Michael Iwanik, PhD; John Glaser, MD; Kai-Ming Fu, MD, PhD; Joshua E. Heller, MD; Francis H. Shen, MD

United States

#398: Economic Impact of Minimally Invasive Spine Surgery Open vs. MIS Spinal Fusion Costs in the Perioperative Period (First 45 Days

William B. Rodgers, MD; Brent Vanconia, MS, MB; John Lucio, DO; Kevin J. Deluzio, PhD; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS

United States

#399: Minimally Invasive Lumbar Fusion (XLIF) using a TCP-HA Bone Graft Substitute: Fusion Rates out to Two Years

William B. Rodgers, MD; Edward J. Gerber, PA-C; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS

United States

#400: Surgical Management of Thoracolumbar Posttraumatic Kyphosis (PTK): A Consecutive Case Series Of 27 Patients

Fatih Korkmaz; Ahmet Alanay; Cagatay Ozturk, MD; Meric Enercan; Mehmet Aydogan; Azmi Hamzaoglu, MD

Turkey

#401: Are Thoracic Curves with a Low Apex (T11 or T11/12) Really Thoracic Curves?

Milad Alam, BS; Peter O. Newton, MD; Burt Yaszay, MD; Tracey Bastrom, MA; Harms Study Group

United States

#402: Surgical Treatment for Proximal Junctional Kyphosis after Adult Spinal Deformity Surgery. Minimum Two-Year Follow-Up Study

Eijiro Okada, MD; Sigurd H. Berven, MD; Serena S. Hu, MD; Shane Burch, MD; Vedat Deviren, MD; Bobby Tay, MD

United States

#403: Foraminal Dimensions in Adult Patients with Scoliosis and Radiculopathy

Sergio A. Mendoza-Lattes, MD; Andrew Pugely; Gnanapragasam Gnanapradeep, MD; Rachel C. Nash; Yubo Gao

United States

#404: Concomitance of Cervical Myelopathy and Scoliosis: A PearlDiver Study

Chang Hwa Hong; Steven Takemoto, PhD; Michael H. Weber, MD, PhD; Benjamin Young, BS; Serena S. Hu, MD

Republic of Korea

#405: An Analysis of Outcomes after Posterior Corpectomy and Expandable Cage Placement

Vishal C. Patel, Doctor of Medicine; Andrew W. Moulton, MD; Santiago A. Lozano-Calderon, MD, PhD

United States

#406: A Comparison of Female and Male Adult Revision Spinal Deformity Surgeries: Reasons for Revision and Risk Factors For Complications

Michael P. Kelly, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Jacob M. Buchowski, MD, MS; Lukas P. Zebala, MD; Linda Koester, BS

United States

#407: Safety and Efficacy of Transsacral Axial Interbody Fixation and Arthrodesis at the End of Long Spinal Fusion Constructs

Paul Issack; Oheneba Boachie-Adjei, MD; Akilah B. King, BA

United States

E-Poster Index

#408: Functional Outcome following Staged Adult Spinal Deformity Surgery: Benchmark for Improvement in Patient Reported Outcomes
Richard L. Skolasky, ScD; Hamid Hassanzadeh, MD; Khaled Kebaish
United States

#409: Use of a Central Compression Rod to Reduce Thoracic Level Spinal Osteotomies
Stephen Lewis; Andrew W. Bodrogi, BSc; Sergey Goldstein, MD; Sofia Magana, BSc
Canada

#410: The Surgical Treatment of Charcot Spinal Arthropathy
Richard J. Bransford, MD; Carlo Bellabarba, MD; Jens R. Chapman, MD
United States

#412: MRI Compatibility and Clinical Success of the Image Friendly Peek-Ceramic Cervical Total Disc Replacement: One Year Experience
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#413: Bailout Screw Placement Option for the Subaxial Cervical Spine (C3 to C6): A Biomechanical Study of Posterior Cervical Spinolaminar Screw Placement
Craig Kuhns, MD; Tyler Jenkins, BS; Ferris M. Pfeiffer, PhD; Joel T. Jeffries, MD; Theodore J. Choma, MD
United States

#414: Bone Fusion Rate Following Osteoplastic Laminoplasty of the Thoracic and Lumbar Spine Using Translaminar Screws
Chi Heon Kim, MD, PhD; Chun Kee Chung, professor; Tae-Ahn Jahng, MD, PhD; Soo Eun Lee, MD
Republic of Korea

#415: Disk Degeneration is Associated with Decreased Interpedicular Distance and Decreased Canal Size in the Lumbar Spine: An Analysis of 200 Cadaveric Human Spines
Navkirat S. Bajwa; Jason O. Toy, MD; Nicholas U. Ahn, MD
United States

#416: The Effect of Spinal Instrumentation on Seating Balance in Neuromuscular Scoliosis
Michelle Urban, MS; Isaac L. Moss, MDCM, FRCSC; Sahar Hassani, MS; Steven M. Mardjetko, MD, FAAP; Kim W. Hammerberg, MD; Peter Sturm, MD
United States

#417: Single vs. Multiple-screw Spino-Pelvic Fixation in Scoliotic Curves with Pelvic Tilt Undergoing Long Posterior Fusions
Eduardo Hevia, Dr; Jesús J Burgos Flores, PhD; Carlos Barrios; Pedro Domenech, MD; Alberto Caballero, MD; Gabriel Piza Vallespir, MD, PhD; Ignacio Sanpera, MD, PhD; Daniel Jiménez; Maria Soledad del Cura
Spain

#418: Correlation between Shunt Series and Scoliosis Radiographs: Can Shunt Series Radiographs be Used to Reliably Screen for Scoliosis?
Steven Hwang, MD; Todd Blumberg, MD; Jonathan Thomas; Andrew Jea, MD
United States

#419: One-Stage Posterior Piecemeal Excision and Composite Fixation of Spinal Metastasis
Mohammad M. El-Sharkawi, MD; Wael Koptan, MD; Yasser ElMiligui, MD, FRCS; Galal Z. Said, MD
Egypt

E-Poster Index

#420: Posterior Column Reconstruction after Total Spondylectomy for Spinal Tumor

Jae-Yoon Chung, MD; Hyoung-Yeon Seo, MD; Whoan Jeang Kim; Sung-Kyu Kim
Republic of Korea

#421: Spinal Cauda Compression by Metastatic Tumors of the Lumbo-Sacral Junction and Sacral Spine

Nasir A. Quraishi, FRCS; Kyriakos E. Giannoulis, PhD
United Kingdom

#422: Investigation of Thoracic Pedicle Screw Perforation Rates in Computer-Assisted Posterior Fusion for Adolescent Idiopathic Scoliosis

Hiroyuki Oshiba; Jun Takahashi, MD; Hiroki Hirabayashi; Hiroyuki Hashidate; Nobuhide Ogihara; Keijiro Mukaiyama; Hiroyuki Kato, MD, PhD
Japan

#423: Inter-Observer Reliability of Measurements for Clinical Indicators of Spinal Deformity in Preoperative Adolescent Idiopathic Scoliosis

Anna McClung, RN; Daniel J. Sucato, MD, MS; Jeffrey Hopkins, MSN, RN; Sumeet Garg, MD
United States

#424: A Four to Nine Year Review of 196 Post-instrumented Adolescent Idiopathic Scoliosis Patients

Jereme B. Atupan; Gabriel Liu, MSc. FRCSED(orth); Emelito V. Ritumalta, MD; Jian Wei Zhou; Yiong Huak Chan; Hwan Tak Hee, MD; Hee-Kit Wong
Singapore

#425: A Review of 287 Consecutive Spinal Instrumentation and Fusion in Adolescent Idiopathic Scoliosis Patients: Risk Factor Analysis for Early vs. Late & Minor vs. Major Complications

Jereme B. Atupan; Gabriel Liu, MSc. FRCSED(orth); Emelito V. Ritumalta, MD; Jian Wei Zhou; Yiong Huak Chan; Hwan Tak Hee, MD; Hee-Kit Wong
Singapore

#426: Radiographic Evaluation of Shoulder Imbalance in Idiopathic Scoliosis Patients: Risk Factor and Post-Operative Compensation of Shoulder Imbalance

Takuto Kurakawa; Koki Uno, MD, PhD; Teppei Suzuki; Hiroshi Miyamoto, MD; Yoshihiro Inui; Kotaro Nishida, MD, PhD; Kenichiro Kakutani, MD
Japan

#427: The Relevance of Thoracic Lordosis in Adolescent Idiopathic Scoliosis

Steven D. Glassman, MD; Leah Y. Carreon, MD, MSc; Lawrence G. Lenke, MD; James O. Sanders, MD; Michael G. Vitale, MD; Daniel J. Sucato, MD, MS
United States

#428: Anterior Chest Hump in Adolescent Idiopathic Scoliosis - Questionnaire Evaluation

Kota Watanabe; Naobumi Hosogane, MD; Yoshiaki Toyama; Kazuhiro Chiba, MD, PhD; Morio Matsumoto, MD
Japan

#429: Analysis of Factors that Affect Shoulder Balance after Correction Surgery in Adolescent Idiopathic Scoliosis

Jae-Young Hong, MD; Seung-Woo Suh, MD, PhD; Hitesh N. Modi, MS, PhD
Republic of Korea

#430: Is Waiting Justified before Operating Idiopathic Scoliosis? - A Case-Control Study between Skeletally Mature and Immature Scoliosis Surgery on a Prospective Cohort

Hitesh N. Modi, MS, PhD; Seung-Woo Suh, MD, PhD; Jae-Young Hong, MD; Jae Hyuk Yang, MD
Canada

E-Poster Index

#431: Adolescent Idiopathic Scoliosis : Does Disease Severity Vary by Country?
Baron S. Lonner; Jamie S. Terran, BS; Harry L. Shufflebarger, MD; Dianna C. Morales, BA; Ferran Pellise, MD; Akil Fazal, MD; Mohamed O. Ramadan, MD, MSc; Yasser ElMiligui, MD, FRCS; Wael Koptan, MD; Akilah B. King, BA; Han Jo Kim, MD; Oheneba Boachie-Adjei, MD
United States

#432: Are Patients with Thoracic Scoliosis More Likely to Develop Non-Specific Neck Pain?
Zi-Qiang Chen, MD; Ming Li
China

#433: No Long-Term Changes in the Position of the Spinal Cord inside the Canal after Surgical Correction of Scoliosis
Daniel Jiménez; Jesús J Burgos Flores, PhD; Elena Montes; Jose Ignacio Gallego Rivera; Gema De Blas, MD, PhD; Carlos Barrios; Eduardo Hevia; Maria Soledad del Cura; Jose I. Maruenda
Spain

#435: Thoracic Kyphogenic Posterior Segmental Spinal Instrumented Fusion Techniques in Adolescent Idiopathic Scoliosis: Sub-Laminar Wiring vs. Dual Rods Rotation Techniques
Yongjung J. Kim, MD; Oheneba Boachie-Adjei, MD; Jean-Luc Clement, MD
United States

#437: Analysis of Two Methods of Evaluation of the Apical Vertebral Rotation in Adolescent Idiopathic Scoliosis
Jean-Luc Clement, MD; Anne M. Geoffray, MD; Alain Coussement; Fatima Yagoubi, MSc
France

#438: Implant Density in the Surgical Treatment of Late Onset Idiopathic Scoliosis: Is More Necessarily Better?
Michael Grevitt, FRCS(Orth); Ashley A. Cole, DM, FRCS (Tr & Orth)
United Kingdom

#439: Correction of Sagittal Malalignment Following Pedicle Subtraction Osteotomy Improves Cervical Lordosis
Justin S. Smith, MD, PhD; Virginie Lafage, PhD; Eric Klineberg, MD; Christopher I. Shaffrey, MD; Frank Schwab, MD; Gregory M. Mundis, MD; Robert A. Hart, MD; Shay Bess, MD; Richard Hostin, MD; Douglas C. Burton, MD; Munish C. Gupta, MD; Vedat Deviren, MD; Christopher P. Ames, MD; International Spine Study Group
United States

#440: Can Different Surgical Strategies Result in Satisfactory Post-Operative Sagittal Alignment?
Virginie Lafage, PhD; Frank Schwab, MD; Christopher P. Ames, MD; Richard Hostin, MD; Robert A. Hart, MD; Vedat Deviren, MD; Behrooz A. Akbarnia, MD; Jason Demakakos; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Khaled Kebaish; Douglas C. Burton, MD; Shay Bess, MD; International Spine Study Group
United States

#441: Risk Factors for Surgical Site Infection after Spinal Surgery: Clinical Application of Administrative Claims Data
Amir Abdul-Jabbar; Michael H. Weber, MD, PhD; Serena S. Hu, MD; Shane Burch, MD; Vedat Deviren, MD; Christopher P. Ames, MD; Praveen V. Mummaneni, MD; Dean Chou, MD; Anthony Kakis, DPM, CIC; Eijiro Okada, MD; Amy D. Nichols, RN, MBA, CIC; Bobby Tay, MD; Catherine Liu, MD; Steven Takemoto, PhD; Sigurd H. Berven, MD
United States

#442: Cerebrospinal Fluid Pressure Distribution Responds to Compression and Decompression After Acute Spinal Cord Injury in an Animal Model
Claire F. Jones, MSc; Robyn Newell, MASc; Jae H. Lee, MSc; Peter A. Cripton, PhD; Brian K. Kwon, MD, PhD, FRCSC
Canada

E-Poster Index

#443: Dual Growing Rod Technique: Effects of Posterior Distraction Forces on Anterior Column Intradiscal Pressure

Andrew T. Mahar, MS; Behrooz A. Akbarnia, MD; Michael Flippin, MD; Tucker Tomlinson, MS; Pat Kostial, BSN; Ramin Bagheri, MD
United States

#445: Treatment of Severe Proximal Junctional Kyphosis Following Long Posterior Fusion of Thoraco-Lumbar Scoliosis

Jesús J Burgos Flores, PhD; Carlos Barrios; Gabriel Piza Vallespir, MD, PhD; Eduardo Hevia, Dr; Pedro Domenech, MD; Ignacio Sanpera, MD, PhD; Oscar Riquelme-García, MD, PhD; Jose I. Maruenda
Spain

#446: Response to Critical Intraoperative Neuromonitoring Changes in Spinal Deformity Surgery: A Poll of Spinal Deformity Surgeons Reviewing Pediatric/Adolescent Cases

Daniel J. Sucato, MD, MS; Lawrence G. Lenke, MD; Kathy Blanke, RN; Anna McClung, RN
United States

#447: Prophylactic Antibiotic Administration in Spinal Surgery for Patients with Risk Factors for Surgical Site Infection

Kota Watanabe; Naobumi Hosogane, MD; Takashi Tsuji; Ken Ishii, MD, PhD; Masaya Nakamura; Yoshiaki Toyama; Kazuhiro Chiba, MD, PhD; Morio Matsumoto, MD
Japan

#448: Is the Rate of Pedicle Screw Misplacement Higher in AIS or Non-AIS Deformity Patients?: A CT-Based Study of 2,176 Pedicle Screws

Terry D. Amaral, MD; Beverly Thornhill, MD; Adam L. Wollowick, MD; Jonathan J. Horn; Etan P. Sugarman, MSIV; Preethi M. Kulkarni, MD; Vishal Sarwahi, MD
United States

#449: Transforaminal Lumbar Interbody Fusion for Resistant Tuberculous Spondylodiscitis of the Lumbosacral Spine

Wael Koptan, MD; Yasser ElMiligui, MD, FRCS; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa; Fady S. Shafik
Egypt

#450: Wiltse vs. Midline Approach for Fusion of the Degenerative Lumbar Spine. A Prospective Case Controlled Study

John Street, MD, PhD; Zhi Wang, MD, MSc.; Christian P. DiPaola, MD; Michael Boyd, MD; Brian K. Kwon, MD, PhD, FRCSC; Scott Paquette, MD; Marcel F. Dvorak, MD; Charles G. Fisher, MD, MHSc, FRCSC
Canada

#451: Curve Characteristics of Preoperative Idiopathic Early Onset Scoliosis

Mark McElroy, MS; Paul Sponseller; Muharrem Yazici, MD; Behrooz A. Akbarnia, MD; George H. Thompson, MD; David L. Skaggs, MD; John B. Emans, MD; Jeff Pawelek; Growing Spine Study Group
United States

#452: Surgical Treatment of Severe Progressive Scoliosis in Neurofibromatosis in Pediatric Age

Tiziana Greggi; Konstantinos Martikos; Mario Di Silvestre, MD; Francesco Lolli; Georgios Bakaloudis; Elena Maredi; Francesco Vommaro
Italy

#453: Sagittal Spinopelvic Parameters Help Predict the Risk of Proximal Junctional Kyphosis for Children Treated with Posterior Distraction Based Implants

Ron El-Hawary, MD; Peter Sturm, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD; Michael G. Vitale, MD, MPH; Peter G. Gabos, MD; Nathan D. Bodin, MD; Colin Harris; Charles R. d'Amato, MD, FRCSC; John T. Smith, MD
Canada

E-Poster Index

#454: Surgical Management of Early Onset Scoliosis with Thoracic and Thoracolumbar Kyphosis by Four Rib Construct
AlaaEldin A. Ahmad, MD; Richard H. Gross, MD; Hai Yao, PhD
Palestine

#455: The Prevalence of Diffuse Idiopathic Skeletal Hyperostosis (DISH) in the Patients with Spinal Disorders
Hiromitsu Toyoda; Hidetomi Terai, MD, PhD; Akinobu Suzuki; Hiroaki Nakamura
Japan

#456: Meta-Analysis of Fusion Rates for Minimally Invasive Transforaminal Lumbar Interbody Fusion Performed without Posterolateral Bone Grafting
David E. Gwinn, MD; Ronald A. Lehman, MD; Daniel G. Kang, MD
United States

#457: Diagnostic Classification for Lumbar Spine Registry Development
Steven D. Glassman, MD; Leah Y. Carreon, MD, MSc; Paul A. Anderson, MD; Daniel K. Resnick, MD
United States

#458: Radiographic Comparison of Fixed Cage vs. Expandable Cage in TLIF
Dennis Crandall, MD; Eric Huish, BS; Sigurd H. Berven, MD; Neel Anand, MD; Murali P. Kadaba, PhD, MBA; Ryan McLemore, PhD
United States

#459: Adjacent Segment Degeneration: Analysis of L3/4 and L4/5 after PLIF L5/S1 - A Matched-Cohort Study
Alexander Tuschel, MD, MSc, MBA; Philipp Becker; Claudia Eder, MD, PhD; Michael Ogon
Austria

#460: Are Sublaminar Wires Really Safe? Analysis of 4,842 Sublaminar Wires
Gautam R. Prasad, MS; Shekhar Bhojraj, MS; Tarak Patel; Tushar Deore, DNB; Akshay Jain, MS
India

#461: Comparison of Current Trends in the Treatment of Neuromuscular Scoliosis: Results from the Canadian Pediatric Spinal Deformities Study Group
Ron El-Hawary, MD; Douglas Hedden, MD; Stephen Lewis; Reinhard D. Zeller, MD, FRCSC; Jason J. Howard, MD, FRCSC; Paul J. Moroz, MD, MSc, FRCSC; Peter Jarzem, MD
Canada

#462: Lumbosacral Dysplasia in Young Patients with Lumbosacral Spondylolisthesis
Abhijit Pawar, MD; Jean-Marc Mac-Thiong, MD, PhD; Hubert Labelle, MD
Canada

#463: Retrolisthesis and Lumbar Disc Herniation: A Postoperative Assessment of Patient Function
Kevin K. Kang, MD; Michael Shen, MD; Wenyan Zhao, MS; Jon D. Lurie, MD; Afshin E. Razi, MD
United States

#464: A Comparison of Short Form-12 Health-Related Quality of Life Improvements following coflex® Interlaminar Stabilization, Lumbar Spinal Fusion with and without Cages, and Total Joint Arthroplasty
Joshua D. Auerbach, MD; William R. Sears, MB, BS, FRACS
United States

E-Poster Index

#465: Analysis of 51 Cases of Anterior Screw Fixation in Odontoid Fractures Using Isocentric 3-Dimensional C-Arm Fluoroscopy and Biplanar Fluoroscopy

Nikolay Martirosyan; Samuel Kalb; Katharine Cronk, MD, PhD; Nicholas Theodore, MD, FACS
United States

#466: Percutaneous In Situ Contouring: A Novel Technique for Minimally Invasive Thoracolumbar Fracture Reduction

Yann Philippe Charles, MD; Sébastien Schuller; Axel Walter; Dakheel A. Aldakheel, MBBS, SSC(ortho), AFSA; Jean-Paul Steib, MD
France

#467: A Retrospective Radiographic Analysis of Subaxial Sagittal Alignment after Posterior C1-C2 Fusion

Tanaka Masato; Sugimoto Yoshihisa, PhD; Misawa Haruo, MD, PhD
Japan

#468: Improved Spine Fusion Outcomes with a Novel Ceramic-Polymer Composite

Kai Zhang; Matthew E. Cunningham, MD, PhD; Fred Mo, MD; Marjolein van der Meulen, PhD; Celeste Abjornson, PhD; Frank P. Cammisa, MD; Robert Harten, PhD
United States

#469: Spinal Cord Morphology After Surgical Decompression in a Large Animal Model of Traumatic Spinal Cord Injury

Claire F. Jones, MSc; Peter A. Cripton, PhD; Brian K. Kwon, MD, PhD, FRCSC
Canada

#470: The Effect of Nitinol Staples on Spinal Growth Modulation

Joseph H. Carreau, MD; Christine L. Farnsworth, MS; Diana A. Glaser, PhD; Josh Doan, MEng; Peter O. Newton, MD
United States

#471: Elevated RANTES Expression is Associated with Painful Disc Degeneration

Christopher K. Kepler, MD, MBA; Dessislava Z. Markova, PhD; Florian Dibra, BS; Sanjay Yadla, MD; Ravi K. Ponnappan, MD; Alexander R. Vaccaro, MD, PhD; Todd J. Albert, MD; D. Greg Anderson, MD
United States

#472: Biomechanical Effects of Different Supplemental Support Techniques on L4, L5 and S1 Screw Loading in a Long Posterior Fusion

Gary D. Fleischer, MD; Yongjung J. Kim, MD; Lisa Ferrara, PhD; Andrew L. Freeman, MS; Oheneba Boachie-Adjei, MD
United States

#473: Evaluation of Health-Related Quality of Life Before and After Surgical Reconstruction of Rheumatoid Cervical Spine using Euroqol (EQ-5D)

Masashi Uehara; Jun Takahashi, MD; Hiroki Hirabayashi; Hiroyuki Hashidate; Nobuhide Ogihara; Keijiro Mukaiyama; Hiroyuki Kato
Japan

#474: Anatomy of Lamina in the Subaxial Cervical Spine: CT and Cadaveric Analysis with Translaminar Screw Simulation

Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; Michael Iwanik, PhD; John Glaser, MD; Kai-Ming Fu, MD, PhD; Joshua E. Heller, MD; Francis H. Shen, MD
United States

#475: A Biomechanical Comparison of Two Revision Strategies for Failed C2-Pedicle Screws

Heiko Koller, MD; Juliane Zenner, MD; Herbert Resch; Wolfgang Hitzl, PhD; Michael Mayer, MD
Germany

E-Poster Index

#476: Standardized Traction Program and 3D-CT Evaluation for Initially-Irreducible Pediatric Atlantoaxial Rotator Subluxation
Kiyoshi Aono; Tetsuya Kobayashi, MD, PhD; Issei Senoo, MD; Takeo Matsuno
Japan

#477: Analysis of Postoperative Iliac Crest Bone Graft Harvest Site Pain in Instrumented Three and Four-Level Anterior Cervical Fusions. A Prospective Non-Randomized Comparison of the Efficacy of Intraoperative Local Administration of Ropivacain
Juliane Zenner, MD; Oliver Meier; Luis Ferraris, MD; Wolfgang Hitzl, PhD; Michael Mayer, MD; Heiko Koller, MD
Germany

#478: Posterior Cervical and Cervicothoracic Fusions with rhBMP-2: Complications and Fusion Rates at Minimum Two-Year Follow-Up
Ian G. Dorward, MD; Jacob M. Buchowski, MD, MS; Geoffrey E. Stoker, BS; Woojin Cho, MD, PhD; Lukas P. Zebala, MD
United States

#479: Cervical Laminoplasty vs. Posterior Laminectomy and Fusion: A Cost Analysis of Peri-Operative Care in Cervical Spondylotic Myelopathy
Pedro A. Ricart-Hoffiz, MD; Daniel T. Warren, MD; Christian Hoelscher, BS; Themistocles Protopsaltis, MD; John A. Bendo, MD
United States

#480: Beware the Risks of Instrumenting to the Pelvis in Ambulatory Early Onset Scoliosis Patients Treated with Growth Sparing Surgery
Burt Yaszay, MD; Nima Kabirian, MD; Jeff Pawelek; John B. Emans, MD; Charles E. Johnston, MD; Suken A. Shah, MD; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD; Growing Spine Study Group
United States

#481: Rigid Spinous Process System Fixation vs. Pedicle Screw Fixation in a Posterolateral Lumbar Arthrodesis Construct - Comparison of Fusion Rates
Michael Kapsokavathis, DO; Dana Ruehlman, DVM; Anthony S. Turner, Dipl.ACVS; Stewart Ryan, BVSc(Hons); Howard B. Seim, DVM; Mitchell Hardenbrook, MD
United States

#482: The Insertion Technique of Translaminar Screws in the Lumbar Spine: CT and Cadaveric Validation
Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; Michael Iwanik, PhD; John Glaser, MD; Kai-Ming Fu, MD, PhD; Joshua E. Heller, MD; Francis H. Shen, MD
United States

#483: Evaluating the Effective Radiation Dose Conferred to Patients by Intraoperative Cone-Beam CT in Thoraco-Lumbar Spinal Surgery
Jeffrey Lange, MD; Andrew Karellas, PhD; John Street, MD, PhD; Natalie Egge, MD; Jason C. Eck, DO, MS; Anthony S. Lapinsky, MD; Patrick J. Connolly, MD; Christian P. DiPaola, MD
United States

#484: The "All Posterior" Management of Lumbar Tumors: A Consecutive Series
Michael P. Kelly, MD; Jacob M. Buchowski, MD, MS; Geoffrey E. Stoker, BS; Addisu Mesfin, MD; Khaled Kebaish
United States

#485: Robotic-Assisted Pedicle Screw Placement in Complex Spinal Surgery: What Was Learned from the First 35 Consecutive Patients
Isador Lieberman; Donna Ohnmeiss, MD
United States

E-Poster Index

#486: Growth Sparing Spinal Deformity Surgery in Children < Ten Years of Age
Lynn J. Letko, MD; Michael Ruf, MD; Jurgen Harms, MD
Germany

#487: Minimally Invasive Thoracolumbar Corpectomy And Reconstruction: Early Results, Complications And Outcomes in 25 Patients
Safdar N. Khan, MD; Jonathan A. Hoskins, MD; Kern Singh, MD
United States

#488: Comparative Biomechanical Analysis of a New Midline Posterior Cervical Fixation System
Camilo A. Molina, BA; Ryan M. Kretzer, MD; Nianbin Hu, MD; Hidemasa Umekoji, MD; Hassan Serhan, PhD; Bryan W. Cunningham, MSc
United States

#489: Minimally Invasive Treatment of Adjacent Segment Degeneration via XLIF
William B. Rodgers, MD; Edward J. Gerber, PA-C; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS
United States

#490: Early Results of Scoliosis Correction with Shape Memory Alloy in Adolescent Idiopathic Scoliosis (AIS)
J. Bradley Williamson, FRCS; Francisco Javier Sánchez Pérez-Grueso; Michael Grevitt, FRCS(Orth); Bernd Wiedenhöfer, MD; Claus Carstens; Frank Spratt, Industrial Design; Klaas V. Klooster, MSc
United Kingdom

#491: Comparison of Clinical and Radiological Outcomes of Three Surgical Techniques in Scheuermann's Kyphosis
Hossein Mehdian, MD, MS(Orth) FRCS(Ed); Ranganathan Arun, FRCS(Tr&Orth),DM,MRCS; David P. Copas, BMedSci, BMBS, MRCS; Jwalant S. Mehta, FRCS (Orth)
United Kingdom

#495: Are Intraoperative Radiographs Necessary During the Surgical Treatment of Adolescent Idiopathic Scoliosis
Brice Ilharreborde, MD; Steffen Queinnec; Keyvan Mazda
France

#496: Return to Sports after Surgery to Correct Adolescent Idiopathic Scoliosis
Ronald A. Lehman, MD; Daniel G. Kang, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS
United States

#497: Using Precisely Controlled Bidirectional Orthopedic Forces to Assess Flexibility in Adolescent Idiopathic Scoliosis: Comparisons between Push-Traction Film, Supine Side Bending, Suspension and Fulcrum Bending Film
Ming Li; Zi-Qiang Chen, MD
China

#498: Is The Routine Use of Surgical Drain Necessary in Posterior Instrumented Adolescent Idiopathic Scoliosis Patients? A Review of Wound Complications in 193 cases
Jereme B. Atupan; Gabriel Liu, MSc. FRCSED(orth); Hee-Kit Wong
Singapore

#499: Three-Dimensional Finite Element Simulation of Posterior Surgical Correction of Lenke1BN Adolescent Idiopathic Scoliosis
Hongqi Zhang, MD; Chaofeng Guo
China

E-Poster Index

#500: Correction of Severe Scoliosis by Posterior-Only Approach with Smith-Petersen Osteotomies using Simultaneous Derotation and Pedicle Alignment Technique
Jane S. Hoashi, MD, MPH; Jesús J Burgos Flores, PhD; Pedro Domenech, MD; Carlos Barrios Pitarque; Gabriel Piza Vallespir, MD, PhD; Eduardo Hevia, MD; Jose I. Maruenda
Spain

#501: Comparison of Stainless Steel and Titanium Alloy Instruments for Posterior Correction and Fusion Surgery in Adolescent idiopathic Scoliosis. Minimum 2-Year Follow-Up Study
Eijiro Okada; Morio Matsumoto, MD; Kota Watanabe; Naobumi Hosogane; Kazuhiro Chiba, MD, PhD; Yoshiaki Toyama
Japan

#502: Self Reported Functional Limitations Due to Lumbar Stiffness Correlate with Age and SRS-22 Scores Among Asymptomatic Volunteers
Robert A. Hart, MD; Praveen V. Mummaneni, MD; Breton Line, BSME; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Oheneba Boachie-Adjei; Douglas C. Burton, MD; Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Virginie Lafage, PhD; Frank Schwab, MD; Christopher P. Ames, MD; Shay Bess, MD; Kirkham B. Wood, MD; International Spine Study Group
United States

#503: What Percent of Adult Deformity Patients Have Cancellous Pedicle Channels?
Lawrence G. Lenke, MD; Fernando E. Silva, MD
United States

#504: The Amount of Disc Removed: Is DLIF Really better than TLIF?
Jeff A. Lehmen, MD; Craig Kuhns, MD
United States

#505: Surgical Treatment for Moderate Sized Main Thoracic Scoliosis Demonstrates Similar Acute Perioperative Outcomes for Adolescent and Adult Idiopathic Scoliosis: A Prospective, Matched Cohort Evaluation
Shay Bess, MD; Burt Yaszay, MD; Breton Line, BSME; Munish C. Gupta, MD; Frank Schwab, MD; Baron S. Lonner; Virginie Lafage, PhD; Douglas C. Burton, MD; Behrooz A. Akbarnia, MD; Oheneba Boachie-Adjei; Robert A. Hart, MD; Richard Hostin, MD; Christopher I. Shaffrey, MD; International Spine Study Group
United States

#506: Clinical and Radiographic Outcomes of Trans-Sacral L5-S1 Fusions: Restoration of Lumbar-Sacral Lordosis and Disc Space Height
Stephen T. Enguidanos, MD; Gregory B. Archer; Jesse G. Eisler, MD, PhD
United States

#507: Radiological Outcomes of Segmental Pedicle Screw Fixation in Spinal Deformity Surgery
Hossein Mehdian, MD, MS(Orth) FRCS(Ed); David P. Copas, BMedSci,BMBS,MRCS; Jwalant S. Mehta, FRCS (Orth)
United Kingdom

#508: Does Prone Re-Positioning Prior to Posterior Fixation Produce Greater Lordosis in Lateral Lumbar Interbody Fusion (LLIF)?
Jonathan N. Sembrano, MD; Sharon C. Yson, MD; Jeffrey T. Luna, MD; Edward Rainier G. Santos, MD; David W. Polly, MD
United States

#509: Differences in Approach-Related Morbidity with Anterior Column Reconstruction in Thoracolumbar Fractures using Open and Video-Assisted Techniques. Results from a Two Center Matched-Pair Analysis
Juliane Zenner, MD; Heiko Koller, MD; Herbert Resch; Oliver Meier; Wolfgang Hitzl, PhD; Axel Hempfing, Consultant; Michael Mayer, MD
Germany

E-Poster Index

#510: Mineralized Collagen and Bone Marrow Aspirate in Anterior Interbody Carbon Fiber Cages Achieves High Fusion Rates in Multilevel Adult Spinal Deformity Surgery

Richard Hostin, MD; Eric Klineberg, MD; Shay Bess, MD; Munish C. Gupta, MD; International Spine Study Group
United States

#511: Early Outcomes of Decancellation Osteotomy for the Treatment of Fixed Sagittal Deformity

Darren R. Lebl, MD; Rahul D. Chaudhari, MD; Suhel Kotwal, MD; Matthias Pumberger, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD
United States

#512: The Impact of Thoracic and Thoracolumbar Angular Kyphosis on Pelvic Shape and Sagittal Alignment

Weishi Li; Zhongqiang Chen
China

#513: Prone Surgical Positioning May Impair Portal and Hepatic Blood Flow in Patients with Adolescent Idiopathic Scoliosis

Ron El-Hawary, MD; P. Christopher Cook, MD, FRCSC; John Trask, BSc.; Pierre Schmit, MD
Canada

#514: Biomaterial Impregnation with Bone Marrow Aspirate: Does it Live up to the Promise ?

Claudia Eder, MD, PhD; Erwin Falkner; Jochen Meissner; Alexander Tuschel; Philipp Becker; Michael Ogon
Austria

#515: Biomechanical Comparison of Rigid vs. Semi-Rigid Rods in Spinal Fusion Constructs

Missoum Moumene, PhD; Payman Afshari, PhD
United States

#516: In Vivo Forces on Pedicle Screws During Posterior Instrumentation Surgery for Adolescent Idiopathic Scoliosis

Manabu Ito, MD, PhD; Yuichiro Abe, MD, PhD; Kuniyoshi Abumi, MD; Kazuhiro Fujisaki; Shigeru Tadano, PhD; Yoshihisa Kotani, MD; Hideki Sudo; Ken Nagahama; Akira Iwata, MD
Japan

#517: Optimal Pedicle Screw Thread Design for use in Osteoporotic Bone

Khaled Kebaish; Oheneba Boachie-Adjei, MD; Jacob M. Buchowski, MD, MS; Mark D. Rahm, MD; Marilyn Gates, MD; Hani Mhaidli, MD, PhD; Donald A. Deinlein, MD; Kenneth J. Paonessa, MD; Gordon Donald, MD; Julie Reigrut, BS; Complex Spine Study Group
United States

#518: Do Stand-Alone Interbody Spacers with Integrated Screws Provide Adequate Segmental Stability for Multi-level Cervical Arthrodesis?

Mario J. Cardoso, MD, DC; Anton E. Dmitriev, PhD; Haines Paik, MD; Rachel E. Gaume, BS; Divya V. Ambati, MS; Ronald A. Lehman, MD
United States

#519: Unilateral Transforaminal Lumbar Interbody Fusion (TLIF) Using Antibiotic Impregnated Calcium Sulphate for Early Onset Post - Discectomy Spondylodiscitis

Wael Koptan, MD; Yasser ElMiligui, MD, FRCS; Mohammad M. El-Sharkawi, MD; Fady S. Shafik; AbdElMohsen Arafa
Egypt

#521: Posterior Only Vertebral Column Resection in Management of Severe Angular Spinal Deformity

Pankaj Kandwal; Upendra Bidre; Bhavuk Garg; Ankit Gupta; Arvind Jayaswal, MS (ortho)
India

E-Poster Index

#522: Are EOS 3D Reconstructions Reliable in Adolescent Idiopathic Scoliosis Treated by Posterior Instrumentation?
Brice Ilharreborde, MD; Jean-Sebastien Steffen, MSc; Jean-Marc Vital; Ibrahim Obeid; Keyvan Mazda; Wafa Skalli, PhD
France

#523: Comparison of Radiographic and Surface Topography Measurements in Adolescent Scoliosis
Patrick Knott, PhD, PA-C; Steven M. Mardjetko, MD, FAAP; Jason M. Frerich, MS; Kristen Hertzler, MS
United States

#524: Posterior Dynamic Stabilization as a Hybrid in Conjunction with Lumbar Fusion
Jorge E. Isaza, MD; Steve A. Guillory, PA-C
United States

#525: Dynamic Cervical Stabilization: A Novel, Motion-Preserving Alternative to Fusion and Articulating Total Disc Replacement
Joshua D. Auerbach, MD; Steve A. Rundell, MS
United States

#526: VEPTR Treatment of Patients with Cerebro-Costo-Mandibular Syndrome (CCMS)
Davin Cordell, MD; Ajeya P. Joshi, MD; James W. Simmons, DO; Robert M. Campbell, MD
United States

#527: Effect of Growing Screw Instrumentation on Spontaneous Spinal Fusion
Andriy Mezentsev, MD; Dmytro Petrenko; Andriy Mangov; Said Pardaev
Ukraine

#528: Single Incision XLIF: Is It Safe and Reproducible?
Jeffrey D. Coe, MD
United States

#529: C1-Lateral Mass Screw Fixation: Usage of a C1-Trocar Facilitates Screw Placement in Atlantoaxial Instabilities
Heiko Koller, MD; Luis Ferraris, MD; Oliver Meier; Juliane Zenner, MD
Germany

#530: Dynamic EMG Testing for the Placement of Lumbar Pedicle Screws
Antoine G. Tohmeh, MD; Robert B. Bazzano, PA-C
United States

#532: Long-Term Ability to Work after Primary vs. Revision Spine Surgery
Dennis Crandall, MD; Kenneth Schmidt, MD; Jan Revella, RN; Michael S. Chang, MD; Jason Datta, MD; Terrence Crowder, MD; Ryan McLemore, PhD
United States

#533: Health-Related Quality of Life: How Does Symptomatic Disc Degeneration and Its Treatment with Total Disc Replacement Compare to Other Medical Conditions?
Richard D. Guyer, MD; Issada Thongtrangan, MD; Donna Ohnmeiss, MD; Jack E. Zigler, MD; Amy Atanasov, PhD
United States

#534: Twelve Month Clinical and Radiographic Outcomes after Interlaminar Lumbar Instrumented Fusion (ILIF)
Justin Field, MD; Hyun Bae, MD
United States

E-Poster Index

#535: A Novel Approach to Anterior Fixation in and Anterior Lumbar Interbody Fusion Cage
Jeff Phelps, MD
United States

#536: Preventing Surgical Complications in Prader-Willi Syndrome
Harold J. van Bosse, MD; Stuart Hershman, MD; David S. Feldman, MD; Alice Chu, MD
United States

#537: A Review of Medicolegal Cases for Epidural Hematoma and Epidural Abscess: What Factors Lead to an Adverse Outcome for the Provider?
Keisha French, BS; Eldra W. Daniels, BS; Zachary L. Gordon, MD; Nicholas U. Ahn, MD
United States

#538: A Review of Medicolegal Cases for Cauda Equina Syndrome: What Factors Lead to an Adverse Outcome for the Provider?
Eldra W. Daniels, BS; Zachary L. Gordon, MD; Keisha French, BS; Nicholas U. Ahn, MD
United States

#539: Silicate-Substituted Calcium Phosphate Bone Graft
Vamsi V. Nagineni, MBBS; Andrew R. James, MBBS; Roger Hartl, MD; Christoph Hofstetter, MD
United States

#540: Validity of the Modified Japanese Orthopedic Association Score in Patients with Cervical Spondylotic Myelopathy. The AOSpine North America Multi-Center Prospective Study
Branko Kopjar; Michael Fehlings, MD, PhD, FRCSC; Beate Hanson
Canada

#541: The Prevalence of Abnormal Preoperative Neurologic Exam in Scheuermann's Kyphosis: Correlation with X-Ray, MRI, and Surgical Outcome
Woojin Cho, MD, PhD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Guangxun Hu, MD; Jacob M. Buchowski, MD, MS; Ian G. Dorward, MD; Joshua M. Pahys, MD; Samuel K. Cho, MD; Matthew M. Kang, MD; Lukas P. Zebala, MD; Linda Koester, BS
United States

#542: Neurologic Recovery after Anterior Cervical Discectomy and Fusion
Charles L. Lehmann, MD; Jacob M. Buchowski, MD, MS; Geoffrey E. Stoker, BS; K. Daniel Riew, MD
United States

#543: Radiographic Classification of Cerebral Palsy
Paul Sponseller; Joseph P. Gjolaj, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Peter O. Newton, MD; Patrick J. Cahill, MD; Unni G. Narayanan, MBBS, MSc, FRCS(C); Jahangir Asghar, MD; Tracey Bastrom, MA; Michelle C. Marks, PT, MA
United States

#544: Growing Segmental Spinal Instrumentation Without Fusion in Spinal Muscular Atrophy
Samuel R. Rosenfeld, MD; John Schlechter, DO; Afshin Aminian, MD
United States

#545: Could Universal Clamp Correct the Sagittal Profile in Neurological Scoliosis? A Single-Centre Experience
Guido La Rosa, MD; Giancarlo Giglio, MD; Leonardo Oggiano, MD
Italy

E-Poster Index

#546: Management of Burst Thoracic and Thoracolumbar Fractures with Thoracoscopically-Assisted Corpectomy and Posterior Percutaneous Stabilization
Ahmed Shawky; Heinrich Böhm
Germany

#547: The Demographics and Complications of Traumatic Dural Tears Associated with Unstable Spine Fractures
Richard J. Bransford, MD; Myles Luszczyk, DO; Gregory Blaisdell, MD; Brett P. Wiater, MD; Carlo Bellabarba, MD; Jens R. Chapman, MD
United States

#549: Outcome of Embolized Vascular Metastatic Spinal Tumours Causing Cord Compression
Nasir A. Quraishi, FRCS; Sanjay Purushothamdas, FRCS (Orth), MS (Orth); Michael Grevitt, FRCS(Orth)
United Kingdom

#550: The Role of Posterior Spinal Fusion In Healed Post-Tubercular Kyphosis In Children
Vikas Trivedi
India

#552: Shh Regulates Major Signaling Pathways in Postnatal Mouse Disc
Chitra L. Dahia, PhD; Eric Mahoney; Christopher Wylie
United States

#553: Ultrastructural Differences in Intervertebral Disc Cell Morphology in Idiopathic Scoliosis Patients
Ingrid Sitte, MD; Oliver Meier; Juliane Zenner, MD; Luis Ferraris, MD; Axel Hempfing, Consultant; Heiko Koller, MD
Austria

#554: Biomechanical Stability of Stand-Alone Interbody Spacers with Integrated Screws for Multi-Level Cervical Arthrodesis
Haines Paik, MD; Ronald A. Lehman, MD; Daniel G. Kang, MD; Mario J. Cardoso, MD, DC; Anton E. Dmitriev, PhD; Rachel E. Gaume, BS; Divya V. Ambati, MS; Michael Rosner, MD
United States

#555: Biomechanics of Lumbar Facet Screws and Interspinous Anchor
Dean G. Karahalios, MD; Felix Dominguez, MD; Phillip M. Reyes; Neil R. Crawford, PhD
United States

#556: Biomechanics of Lateral Plate vs. Pedicle Screw Construct in Lumbar Spine Instrumented at Two Levels with the XLIF® Cage
Aniruddh Nayak, MS; Brandon G. Santoni, PhD; Andres F. Cabezas, BSCE; Antonio E. Castellvi, MD
United States

#557: A Flitch-ELAP Technique for the Treatment of Cervical Canal Stenosis with Moderate Kyphosis
Tetsuya Kobayashi, MD, PhD
Japan

#558: A Novel Device for the Treatment of Cervical Radiculopathy: Clinical and Radiographic Outcomes at Six Months
Mario R. Ver, Medicine; Rafael C. Bundoc, MD; Jose Manuel Ignacio, MD; Edward F. Eyster, MD; Bruce McCormack, MD; Sigurd H. Berven, MD
United States

E-Poster Index

#559: Integrated Spinal Osteotomy Planning using Estimation of Post-Operative Balance
Jean-Sebastien Steffen, MSc; Wafa Skalli, PhD; Jean-Marc Vital; Olivier Hauger, MD, PhD; Jean Dubousset; Ibrahim Obeid
France

#560: Far-Lateral Interbody Fusion (FLIF): An Innovative Muscle Sparing Intermuscular Approach to Lumbar Decompression and Fusion for Spondylolisthesis
M. Darryl Antonacci, MD; Laury A. Cuddihy, MD; Joel Gorenstein, R-PAC; Caroline Erni, RNP
United States

#561: Comparative Study of Anterior Cervical Arthrodesis (ACDF) without Screws
Fernando G. Diaz, MD, PhD; Risa Tyo, PharmD; Christina Cook, PhD
United States

#562: INCA: Intermittent Neurogenic Claudication APERIUS ® Percutaneous Interspinous Spacer
Jan K. Van Meirhaeghe; Patrick Fransen, MD; Daniele Morelli; Niall J. Craig, MB;ChB, FRCS Ed (Tr & Orth); Frederic Collignon, MD, PhD; Gregor Godde
Belgium

#563: The Role of Posterior Spinal Fusion In Healed Post-Tubercular Lumbar Kyphosis In Children
Vikas Trivedi, MD
India

#564: The Evaluation of Pedicles in AIS from MPR CT and the Accuracy of Pedicle Screws using a Navigation System
Misawa Haruo, MD, PhD; Tanaka Masato; Sugimoto Yoshihisa, PhD; Yasuyuki Shiozaki; Tetsuro Mazaki; Toshifumi Ozaki, MD
Japan

#565: Cosmetic Issues Related to Scoliosis for Curves Less Than 50 Degrees
Sharon K. Mayberry, MD; Jennifer Hopton-Jones, BSN; John T. Killian, MD
United States

#566: Association Between Estrogen Receptor Gene Polymorphism and Back Pain Intensity in Female Patients with Degenerative Lumbar Spondylolisthesis
Jung Sub Lee, MD, PhD; Jong Min Lim; Tae Sik Goh
Republic of Korea

#567: The Evaluation of Scoliosis by Spinal Mouse System
Yutaka Sasao, MD, PhD; Jun Ueno; Atsushi Fujii; Shigeta Morioka; Yoshiaki Torii; Atsushi Kojima
Japan

#568: Utility of Bending Films in Preoperative Planning for Adolescent Idiopathic Scoliosis: When are They Necessary?
Daniel J. Sucato, MD, MS; Anna McClung, RN
United States

#569: High Heritability of a Large Chinese Adolescent Idiopathic Scoliosis Cohort
Hiu Yan Yeung, PhD; Nelson L S Tang; Vivian WY Hung; ChenDi Liao; Tsz-ping Lam, MB,BS; Kwong Man Lee; Bobby KW Ng, MD; Jack C. Cheng, MD
Hong Kong

#570: Benefit Of Perioperative Cell Salvage System For Posterior Spinal Fusion In Adolescent Idiopathic Scoliosis
Serkan Bilgic; Omer Ersen; Kenan Koca; Erbil Oguz; Ali Sehirlioglu
Turkey

E-Poster Index

#571: Comparison of Body Composition, Leptin and Soluble Leptin Receptor Levels between Girls with Adolescent Idiopathic Scoliosis and Normal Controls - A Cross Sectional Study
Elisa MS Tam, MSc; Hiu Yan Yeung, PhD; Tsz-ping Lam, MB,BS; Terry T. Ting, Msc. MBA; Kwong Man Lee; Yong Qiu; Jack C. Cheng, MD
Hong Kong

#572: Anterior Release and Posterior Osteotomies for Rigid Severe Scoliosis
Arvind Jayaswal, MS (ortho); Pankaj Kandwal; Upendra Bidre; Ankit Gupta; Bhavuk Garg
India

#573: The Value of Supine Traction Radiograms in Prediction of Curve Correction in Patients with Adolescent Idiopathic Scoliosis Lenke 1 Treated with "Bone-on-Bone" Anterior Spinal Fusion
Tomasz Potaczek, MD; Daniel Zarzycki, MD, PhD; Barbara M. Jasiewicz, MD, PhD; Maciej Tesiorowski, MD, PhD
Poland

#574: Anatomic Relation of the Thoracic Pedicle to the Spinal Cord in Patients with Adolescent Idiopathic Scoliosis
Takashi Ono, MD; Katsushi Takeshita; Hirotaka Chikuda, MD, PhD; Yasushi Oshima
Japan

#575: SRS-22 Outcomes Questionnaire for Adolescent Idiopathic Scoliosis Patients in Ghana, West Africa: A Correlative Study Between Normal and Scoliosis Populations
Han Jo Kim, MD; Bettye Wright, RN, PA; Akilah B. King, BA; Michael J. Mendelow, MD; Jerome Boatey, MD; Matthew E. Cunningham, MD, PhD; Oheneba Boachie-Adjei, MD; Complex Spine Study Group; Focos Organization
United States

#576: One-Year Results of Anterior vs. Posterior Surgery for Lenke 5 Adolescent Idiopathic Scoliosis: Clinical and Radiographic Outcomes
Darren R. Lebl, MD; Oheneba Boachie-Adjei, MD; Behrooz A. Akbarnia, MD; Jaspaul Gogia, MD; Joseph I. Krajbich, MD; Raymund Woo, MD; Mark D. Rahm, MD; Akilah B. King, BA; Matthew E. Cunningham, MD, PhD; Complex Spine Study Group
United States

#577: Correction Strategies in Treatment of Idiopathic Scoliosis Based on a 3D Mathematical Analysis of Scoliotic Curves
Joseph I. Krajbich, MD; Ian M. Krajbich, PhD
United States

#578: Combined Transplantation of Human Neuronal and Mesenchymal Stem Cells Following Spinal Cord Injury
Don Y. Park, MD; Robert E. Mayle, MD; Robert L. Smith, PhD; Ian Corcoran-Schwartz; Glen Kajiyama, BA; Ivan Cheng, MD
United States

#579: A Novel Large Animal Model of Acute Spinal Cord Injury - Establishing a Translational Intermediary for SCI Therapies
Jae H. Lee, MSc; Claire F. Jones, MSc; Elena B. Okon, PhD; Seth Tigchelaar; Tamara Godbey, DVM; Beverly Chua; Gordon T. Gray; Anthea M. Stammers; Peter A. Cripton, PhD; Wolfram Tetzlaff, MD, PhD; Brian K. Kwon, MD, PhD, FRCSC
Canada

#580: Developing Intervertebral Disc (IVD) Degeneration in the Rat Caudal Spine using Needle Puncture with and without Rotational Injury
Shayan Rahman, MD; Huina Zhang, MD, PhD; Khoi D. Than, MD; Frank La Marca, MD; Chia-Ying Lin, PhD
United States

E-Poster Index

#581: Delayed Quadraparesis after Posterior Spinal Fusion for Scoliosis: A Case Series
Jahangir Asghar, MD; Paul Sponseller; Dianna C. Morales, BA; Harry L. Shufflebarger, MD
United States

#582: Calibration Does Affect Radiographic Measurements: What is the Impact for Multicenter Studies?
Carl-Éric Aubin, PhD, PEng.; Christian Bellefleur; Stefan Parent, MD, PhD; Hubert Labelle, MD
Canada

#583: Use of Curved MPR Imaging to Analyze the Relationship of Thoracic Pedicles to Dura and Cord in Idiopathic Thoracic Scoliosis
Toshiaki Kotani; Tsutomu Akazawa, MD; Masaru Sonoda; Shigeyuki Nagaya; Jose Miguel T. Lumawig; Shohei Minami
Japan

#584: Morphological Evaluation of Thoracic Vertebrae for Safe Pedicle Screw Placement using Free-Hand Technique in Adolescent Idiopathic Scoliosis
Guanyu Cui; Morio Matsumoto, MD; Eijiro Okada; Kota Watanabe; Kazuhiro Chiba, MD, PhD; Yoshiaki Toyama
Japan

#585: Mechanical Factors are Responsible of Neurophysiologic Changes During Surgical Correction of Spinal Deformities. A Review of 359 Monitored Surgeries
Jesús J Burgos Flores, PhD; Gema De Blas, MD, PhD; Elena Montes; Carlos Barrios; Eduardo Hevia, Dr; Ignacio Regidor, MD, PhD
Spain

#586: Optimization of Radiation Exposure and Image Quality of the Cone-Beam O-Arm Intraoperative Imaging System in Spinal Surgery
Acke Ohlin, MD, PhD; Kasim Abul-Kasim; Marcus Söderberg
Sweden

#587: Clinical Uncertainty Defined: A Formal Evaluation of Equipoise among Treatment Options for Patients with Early Onset Scoliosis
David P. Roye, MD; Jacqueline Corona, MD; Daniel J. Miller, BS; Jennepher Downs, PhD; Brendan A. Williams, AB; Laurel C. Blakemore, MD; Randal R. Betz, MD; Charles E. Johnston, MD; David L. Skaggs, MD; Paul Sponseller; Peter Sturm, MD; George H. Thompson, MD; Muharrem Yazici, MD; Michael G. Vitale, MD, MPH
United States

#588: Surgical Treatment of Scoliosis in Patients with a Diagnosis of Prader Willis
Eduardo Galaretto, MD; Ida Alejandra Francheri Wilson, MD; Romina Corrado, MD; Carlos A. Tello, MD; Mariano A. Noel, MD; Ernesto Bersusky, MD
Argentina

#589: A Correlation Reasearch on the Changes of Cobb Angle in Each Segment to the Correction of the Major Curve in Patients Undergoing Posterior Vertebral Column Resection
Jingming Xie; Yingsong Wang, MD; Tao Li; Zhi Zhao; Ying Zhang; Zhendong Yang, master; Ni Bi; Hong Chen
China

#590: Early Clinical Outcomes of Multi-Level Posterior Cervical Foraminotomy for the Treatment of Unilateral Cervical Radiculopathy
Dong-Chan Lee, MD; Choonkeun Park; Jae Keon Kim; Dong Hwan Lim; Seung Ho Shin; Jung Hyun Shim; Dong Hyun Kim, Phd; Jang Hoe Hwang
Republic of Korea

E-Poster Index

#592: Direct vs. Indirect Decompression and Stabilization to Treat Spinal Stenosis and Low-Grade Degenerative Spondylolisthesis: A Comparison of Clinical Outcomes with coflex® Interlaminar Stabilization, Laminectomy and Spinal Fusion, and X STOP
Joshua D. Auerbach, MD; Andrew H. Milby, MD; Reginald J. Davis, MD
United States

#593: Incidence and Impact of Acute Adverse Events in Patients with Traumatic Spinal Cord Injury
John Street, MD, PhD; Vanessa Noonan, PhD, PT; Antoinette Cheung, BSc(Hons); Lydia Cartar; Marcel F. Dvorak, MD
Canada

#594: The Value of Non-Invasive Vascular Imaging to Identify Arterial Injury Following Blunt Cervical Spine Trauma in Children and Adolescents
Robert N. Hensinger; Frances A. Farley, MD; Kelly Vanderhave, MD; Michelle S. Caird, MD; Hugh Garton; Cormac O. Maher, MD; Stephen Tolhurst, MD
United States

#595: Radiological Evaluation on Risk Factors of Progression of Degenerative Lumbar Scoliosis
Hideki Murakami; Ken Yamazaki, MD; Ryuhei Kawamura; Satoshi Yoshida; Hitohiro Yoshino; Tadashi Shimamura
Japan

#596: A Comparative Study of Anterior Lumbar Surgical Approaches: Intra-Operative and Clinical Outcomes
Stephen T. Enguidanos, MD; Gregory B. Archer; Jesse G. Eisler, MD, PhD
United States

#597: The Characteristics of Symptomatic Spinal Stenosis in the Fractional Curve of De Novo Degenerative Lumbar Scoliosis Patients
Thomas D. Cha, MD, MBA; James T. Saunders, MSc, BA; Safdar N. Khan, MD; Howard S. An, MD
United States

#598: The Clinical Result of the Underwent Posterior Correction and Fusion without Laminectomy or Foraminotomy Treatment for Degenerative Adult Idiopathic Scoliosis Patients who had Neurological Deficit
Hongqi Zhang, MD; Qile Gao
China

#599: Laminoplasty using Myelo-CT Based Navigation System
Sugimoto Yoshihisa, PhD; Tanaka Masato; Misawa Haruo, MD, PhD
Japan

#600: Caregivers' Satisfaction After Spinal Fusion in Cerebral Palsy Patients With Scoliosis
Cunha A. Cunha, MD; Dulce H. Grimm, MD; Luiz E. Rocha, MD; Simone Tortato, MD
Brazil

#601: The Next Generation of Scoliosis Treatment: Apical Control with Motion Preservation
Suken A. Shah, MD; Steven J. Seme, MSME; John F. Otte, MSME; Andrew L. Freeman, MS; William J. Camisa; Behrooz A. Akbarnia, MD; Allen L. Carl, MD
United States

#602: Controlled Motion with the XL-TDR Lateral-Approach Lumbar Total Disc Replacement: In Vitro Kinematic Investigation
Luiz Pimenta, MD, PhD; Alexander W. Turner, PhD; G. Bryan Cornwall, PhD; Andrew Cappuccino, MD, BES
Brazil

E-Poster Index

#603: Silicated Calcium Phosphate Bone Graft Substitute in ACDF: Preliminary Results of an Ongoing Consecutive Series with an ICBG Control Cohort

Franco E. Vigna, MD; Dustin Ceratt, PAC; Barbara Y. Whiteside, PAC
United States

#604: Monitoring for Microemboli during Scoliosis Surgery in Children and Adolescents

Richard E. McCarthy; Michael L. Schmitz, MD; Carol Pierce, BSN; Pamela M. Killebrew, BSN, RNP; Edgar D. St. Amour, MSc; K. Poteet-Schwartz; Nischal K. Gautam, MD; Michael White, MD; Terry Fletcher, MD, PhD; Dale Harrison, PhD, MPH
United States

#605: Neuromonitoring is Required for Safety Utilizing Intraoperative Tong-Boot Traction

Vidyadhar V. Upasani, MD; Burt Yaszay, MD; Carrie E. Bartley, MA; Tracey Bastrom, MA; Peter O. Newton, MD
United States

#606: Prevention of Cage Extrusion in Transverse Lumbar Interbody Fusion (TLIF) using Computer Navigation

Fernando G. Diaz, MD, PhD; Christina Cook, PhD; Risa Tyo, PharmD
United States

#608: Navigated Percutaneous Lumbosacral Interbody Fusion: A Feasibility Study with 3D Surgical Simulations and Cadaveric Experiments

Yu Wang, MD, PhD; Cody E. Bunger
Denmark

#609: Initial Clinical Experience with a Novel Vertebral Augmentation System for Treatment of Symptomatic Vertebral Compression Fractures: A Case Series of 26 Consecutive Patients

Panagiotis Korovessis, MD, PhD; Thomas Repantis
Greece

#610: Extreme Lateral Interbody Fusion (XLIF) in the Morbidly Obese

William B. Rodgers, MD; Edward J. Gerber, PA-C; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS
United States

#611: A Multi-Center Evaluation of Percutaneous Lumbar Pedicle Screw Placement Aided by Fluoroscopy-Based Navigation

Benson P. Yang, MD; Melvin M. Wahl, MD; Cary Idler, MD
United States

#612: Endplate Anatomical Restoration May Reduce Adjacent Fracture Occurrence. Twelve Month Results after Using a New Cranio-Caudal Expandable Implant for Vertebral Compression Fracture Treatment

Joerg Beyerlein, MD; Nils Hansen-Algenstaedt, MD, PhD; David C. Noriega, MD
Germany

#613: Anterior Lengthening Does Occur in Pedicle Subtraction Osteotomy (PSO) at the Osteotomized Body as well as at the Discs Above and Below: Geometric Analysis

Woojin Cho, MD, PhD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Ian G. Dorward, MD; Lukas P. Zebala, MD; Joshua M. Pahys, MD; Samuel K. Cho, MD; Matthew M. Kang, MD; Linda Koester, BS
United States

#614: Staged Posterior Instrumentation, Bone Grafting and Anterior Debridment, Interbody Bone Grafting for the Treatment of Lumbar Tuberculosis with Kyphosis in Children

Hongqi Zhang, MD; Yuxiang Wang, MD
China

E-Poster Index

#616: Differences Between Patients who Choose Operative vs. Nonoperative Management of AIS
Paul Sponseller; Joseph P. Gjolaj, MD; Peter O. Newton, MD; Suken A. Shah, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Philip Neubauer, MD
United States

#617: Postoperative Spinal Alignment Remodeling in Lenke 1C Type Scoliosis Treated with Selective Thoracic Fusion
Yu Wang, MD, PhD; Cody E. Bunger
Denmark

#618: Correction Capacity of all Pedicle Screw vs. Hybrid Instrumentation for Posterior Spinal Correction Surgery in Adolescent Idiopathic Scoliosis: A Flexibility-Matched Comparison
Ming Li; Changwei Yang
China

#619: Review of Magnetic Resonance Imaging Results for Patients with Adolescent Idiopathic Scoliosis
Mehmet B. Balioglu, MD; Osman Cimen; Mehmet A. Kaygusuz, MD
Turkey

#620: Infection after the Surgical Treatment of Adolescent Idiopathic Scoliosis
Hideki Murakami; Ken Yamazaki, MD
Japan

#621: Is Cobb Angle Representative of Lateral Vertebral Translation in Idiopathic Scoliosis?- Radiographic Study
Easwar T. Ramani, MBBS, DNB(Orth), MNAMS; Jae Hyuk Yang, MD; Seung-Woo Suh, MD, PhD; Jae-Young Hong, MD
India

#622: Can Patient Position Address Safety Concerns with Apical Pedicle Screw Fixation in Scoliosis Surgery? MRI-Analysis of Spinal Cord Transposition in Neutral and Tilted Trunk Position
Juliane Zenner, MD; Virpi Shiratori, MD; Michael Mayer, MD; Oliver Meier; Axel Hempfing, Consultant; Susanna Nunez, MD; Jochen Bogert, MD; Heiko Koller, MD
Germany

#623: Concave Implant Density Poorly Correlates with Curve Correction in Posterior Surgery for AIS
Saumyajit Basu, MD; Jay D. Ghosh, MBBS, MS(Ortho); Agnivesh Tikoo, MS Ortho
India

#624: The Reliability and Validity of Adapted Arabic Version of Scoliosis Research Society-22 (SRS-22r-a) Questionnaire
Mohamed O. Ramadan, MD, M.Sc; Wael Koptan, MD; Yasser ElMiligui, MD, FRCS; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa
United States

#625: Change of the Cobb Angle Between the Supine and Prone Positions in Scoliosis Patients
Jun Takahashi, MD; Hiroki Hirabayashi; Hiroyuki Hashidate; Nobuhide Ogihara; Keijiro Mukaiyama; Hiroyuki Kato, MD, PhD
Japan

#626: Bilateral Interval Pedicle Screw Placement for Lenke 1 Adolescent Idiopathic Scoliosis
Ming Li; Wei Zhang, MD
China

#627: Analysis of Pediatric Spine and Rib Data from the Hamann-Todd (H-T) Collection
Richard M. Schwend, MD; Behrooz A. Akbarnia, MD; Laurel C. Blakemore, MD; John A. Schmidt, PhD; Kevin Strauss, ME; Complex Spine Study Group
United States

E-Poster Index

#629: Incidence of Spinal Instrumentation Revision or Partial Removal Following Deformity Surgery
Christina Hardesty, MD; Connie Poe-Kochert, BSN; Jochen P. Son-Hing, MD, FRCSC; George H. Thompson, MD
United States

#630: Comparison of Anterior Exposure of the Lumbar Spine by a Spine Surgeon with and without the Assistance of an Access Surgeon
Micah W. Smith, MD; Kevin Rahn, MD; Robert Shugart, MD; Christopher Belschner, PA-C; Kary Stout, BS; Ivan Cheng, MD
United States

#631: Complications and Unfavorable Clinical Outcomes in Obese and Overweight Patients Treated for Adult Lumbar or Thoracolumbar Scoliosis with Combined Anterior/Posterior Surgery
Mitsuru Yagi, MD, PhD; Akilah B. King, BA; Oheneba Boachie-Adjei, MD
Japan

#632: The Efficacy and Safety of Occipital Screw Placement for Occipitocervical Fusion in Children
Steven Hwang, MD; Loyola V. Gressot, MD; Joshua Chern, MD/PhD; Andrew Jea, MD
United States

#633: Revision Surgery for Spinal Stenosis at the Adjacent Segments after Lumbar Spinal Fusion
Kyu-Jung Cho, MD; Sang Hyun Shin
Republic of Korea

#635: Results of Surgical Treatment of Congenital Spinal and Thorax Deformities in Skeletally Immature Patients using "Growing Instrumentation"
Daniel Zarzycki, MD, PhD; Tomasz Potaczek, MD; Slawomir Duda, MD; Maciej Tesiorowski, MD, PhD
Poland

#636: The Usefulness and Limitation of MRI as an Imaging Modality for Evaluation of Pedicle Morphology and Apical Rotation
Adam L. Wollowick, MD; Beverly Thornhill, MD; Terry D. Amaral, MD; Etan P. Sugarman, MSIV; Joshua Grossman; Jonathan J. Horn; Vishal Sarwahi, MD
United States

#637: Validation of a Simple Computerized Tool for Measuring Spinal and Pelvic Parameters
Chun Kee Chung; Chi Heon Kim, MD, PhD; Tae-Ahn Jahng, MD, PhD; Soo Eun Lee, MD
Republic of Korea

#639: Surgical Results of Micro-Endoscopic Surgery for Destructive Spondyloarthropathy (DSA) in Dialysis Patients
Kazuo Nakanishi, MD,PhD.; Kentaro Yamane, MD
Japan

#640: Clinical and Radiographic Evaluation of a Novel Interlaminar Fusion Implant (coflex-F™) System to Augment Lumbar Interbody Fusion
Marcus Eif, MD; Mark E. Schweitzer, MD; Joshua D. Auerbach, MD
United States

#641: Prospective Study of a Novel Expandable TLIF Cage: The South African Experience
Robert N. Dunn, FCS (SA) Orth; Louis Nel; Murali P. Kadaba, PhD, MBA; Sigurd H. Berven, MD
United States

E-Poster Index

#643: Halo Traction for the Treatment of Severe Vertebral Deformities
Martiniano Uranga, MD; Ida Alejandra Francheri Wilson, MD; Eduardo Galaretto, MD; Mariano A. Noel, MD; Carlos A. Tello, MD; Romina Corrado, MD; Ernesto Bersusky, MD
Argentina

#644: Evaluation of Apical Region Rotation Corrected by Posterior Vertebral Column Resection in Treatment of Severe Thoracic Kyphoscoliosis
Jingming Xie; Yingsong Wang, MD; Ying Zhang; Zhi Zhao; Zhendong Yang; Tao Li; Hong Chen; Ni Bi
China

#645: Stand Alone Multiple Level Anterior Cervical Fusion Using Polyetheretherketone (PEEK) Cages Containing Calcium Sulphate Pellets
Yasser ElMiligui, MD, FRCS; Wael Koptan, MD; Mohammad M. El-Sharkawi, MD; AbdElMohsen Arafa
Egypt

#647: Surgical Treatment of Denis Type-B Lumbar Burst Fracture Anterior Decompression and Reconstruction by One Level Fixation through Single Posterior Approach
Ken Nagahama; Kuniyoshi Abumi, MD; Manabu Ito, MD, PhD; Yoshihisa Kotani, MD; Hideki Sudo; Yuichiro Abe, MD, PhD; Akira Iwata, MD; Akio Minami, MD, PhD
Japan

#648: Is it Possible to Save One More Lumbar Segment in the Treatment of Thoracolumbar Fractures?
Ali A. Ugras, MD
Turkey

#649: Validation of the Korean Version of the Scoliosis Research Society-22 Questionnaire
Jung Sub Lee, MD, PhD; Jong Min Lim; Tae Sik Goh
Republic of Korea

#650: Roentgenographic Progression of Degenerative Lumbar Scoliosis and Clinical Evaluation after Short Segment Decompression and Fusion
Taku Nakakohji
Japan

#651: Retrospective Study of Radiographic Measurements of the Interval Between the Thoracic Transverse Process and the Rib in Scoloitic Patients
Richard E. McCarthy; Dong Sun, PhD
United States

#652: Bilateral vs. Unilateral Approach to Balloon Kyphoplasty
Hester Chan; Samuel Bolosan; Roxanne Simon
United States

#654: Coagulation Parameters in Scoliosis Surgery
Patrick Bosch, MD; C. B. Blackwood, MD; Joanne A. Londino, BSN, RN; James E. Bost, PhD
United States

#655: Curve Flexibility in AIS as Judged by Bending/Bolster/Traction Views - Which Correlates Best with Postoperative Cobb Correction?
Saumyajit Basu, MD; Jay D. Ghosh, MBBS, MS(Ortho); Agnivesh Tikoo, MS Ortho
India

E-Poster Index

#656: Current Trends in the Surgical Treatment of Adolescent Idiopathic Scoliosis in Canada

Stephen Lewis; Jason J. Howard, MD, FRCSC; Ron El-Hawary, MD; Paul J. Moroz, MD, MSc, FRCSC; Peter Jarzem, MD; Reinhard D. Zeller, MD, FRCSC; Douglas Hedden, MD

Canada

#657: Study of Pedicle Morphology Using CT-Based Navigation System in Adolescent Idiopathic Scoliosis

Shugo Kuraishi; Jun Takahashi, MD; Hiroki Hirabayashi; Hiroyuki Hashidate; Nobuhide Ogihara; Keijiro Mukaiyama; Hiroyuki Kato

Japan

#658: The Concave and Convex Hemi-Pelvis Volumes were Equivalent in Patients with Adolescent Idiopathic Scoliosis

Xu-sheng Qiu; Weiwei Ma, MD; Yong Qiu, MD

China

#659: How to Treat Triple Major Curve (Lenke Type 4)? : It is a Troublesome Curve

Taichi Tsuji; Noriaki Kawakami, MD; Koki Uno, MD, PhD; Teppei Suzuki; Morio Matsumoto, MD; Kota Watanabe; Shohei Minami; Toshiaki Kotani

Japan

#660: Correction of Scoliosis: A Comparison of Single vs. Double-Rod Derotation Techniques in Saw-Bone Models

Hamid Hassanzadeh, MD; Benjamin E. Stein, MD; Philip Neubauer, MD; Khaled Kebaish; Amit Jain; Michael C. Ain, MD

United States

#661: The Impact of Posterior Concave Rib Head Resection on the Correction of Thoracic Curve of Adolescent Idiopathic Scoliosis

Takashi Namikawa, MD, PhD; Hiroshi Taneichi, MD; Satoshi Inami; Daisaku Takeuchi; Chizuo Iwai; Nakayuki Kato; Yutaka Nohara, MD

Japan

#662: Posterior Decompression and Instrumented Fusion for Management of Degenerative Lumbar Scoliosis

Jun Young Yang, MD, PhD; Yong Bum Joo; Soo Min Cha; June Kyu Lee

Republic of Korea

#663: Clinical Validation of a Universal Deformity Correction Strategy using Direct Incremental Segmental Translation (DIST)

Dennis Crandall, MD; Jan Revella, RN; Ryan McLemore, PhD

United States

#664: Long-Segment Lumbosacral Revision Spine Surgery in Patients without Iliac Fixation: When is Iliac Fixation Necessary?

Mario J. Cardoso, MD, DC; Sara E. Thompson, BA; Tyler Koski, MD

United States

#665: Comparative Analysis of Surgical Approaches and Osteotomies for the Correction of Sagittal Plane Spinal Deformity in Adults

Pedro A. Ricart-Hoffiz, MD; Benjamin W. Burkett, MD; Frank Schwab, MD; Marc N. Ialenti, BA; Jean-Pierre C. Farcy, MD; Baron S. Lonner; Thomas Errico; John A. Bendo, MD

United States

E-Poster Index

#666: The Association Between DRAM and the SRS 22r: Can We Substitute the SRS 22r for the DRAM for Assessing Psychological Distress?
Douglas C. Burton, MD; Sue Min Lai, PhD; Behrooz A. Akbarnia, MD; Christopher P. Ames, MD; Shay Bess, MD; Vedat Deviren, MD; Robert A. Hart, MD; Khaled Kebaish; Gregory M. Mundis, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group
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#667: Clinical Outcome and Radiographic Assessment of Stand-Alone Lateral Lumbar Inter-Body Fusion
Suhel Kotwal, MD; Matthias Pumberger, MD; Darren R. Lebl, MD; Ignacio Merino; Andrew A. Sama, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD
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#668: Pediatric Transverse Process (TP) Features and Growth Pattern from the Hamann-Todd (H-T) Collection
Richard M. Schwend, MD; Behrooz A. Akbarnia, MD; Laurel C. Blakemore, MD; Joshua D. Stewart, BS; John A. Schmidt, PhD; Kevin Strauss, ME; Complex Spine Study Group
United States

#669: Biomechanical Analysis of Crosslink and Lateral Offset Connectors for an Unstable Atlantoaxial Joint Using the C2 Intralaminar Technique
Kevin Wilson, MD; Melvin Helgeson, MD; Ronald A. Lehman, MD; Anton E. Dmitriev, PhD; Daniel G. Kang, MD; Mario J. Cardoso, MD, DC
United States

#670: Measurements of Pediatric Ribs from the Hamann-Todd (H-T) Collection
Richard M. Schwend, MD; Behrooz A. Akbarnia, MD; Laurel C. Blakemore, MD; John A. Schmidt, PhD; Kevin Strauss, ME; Complex Spine Study Group
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#671: Biomechanical Effects of Pedicle Screw "Hubbing" in the Immature Thoracic Spine. A Calf Spine Study
Anton E. Dmitriev, PhD; Ronald A. Lehman, MD; Rachel E. Gaume, BS; Haines Paik, MD; Divya V. Ambati, MS
United States

#672: Biomechanical Testing of Pedicle Screws: Polyaxial, Monoaxial, and a Monoplanar Design
Samuel Schroerlucke, MD; Robert K. Eastlack, MD; Nikolai Steklov, BS; Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; James F. Marino, MD
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#673: Correlation and Reproducibility of 2D and 3D Spinal Measurements
Diana A. Glaser, PhD; Josh Doan, MEng; Christine L. Farnsworth, MS; Vidyadhar V. Upasani, MD; Peter O. Newton, MD
United States

#675: The Anatomic Relationship of the Diaphragm to the Thoracolumbar Junction (TLJ) during the Minimally Invasive Lateral Approach
Elias Dakwar, MD; Clinton Burkett, MD; Ali A. Baaj; Gisela Murray, MD; Juan S. Uribe, MD
United States

#676: Biomechanical Investigation of a New Cervical Laminoplasty Plate Fixation System
David G. Schwartz, MD; Alexander W. Turner, PhD; Christopher R. Brown, MD
United States

#678: Can Infection Associated with Rib-Based Distraction be Managed without Implant Removal? A Multicenter Study
John T. Smith, MD; Jennie B. Mickelson, BS; Patrick J. Cahill, MD
United States

E-Poster Index

#679: Evaluation of Preoperative Pulmonary Function in Severe Scoliosis Patients and its Clinical Significance
Jianxiong Shen, MD; Lifeng Lao, MD; Guixing Qiu
China

#680: Risk Analysis of Cervical Spine Surgery Including Prescription-Based Chronic Disease Assessment
Tetsuya Kobayashi, MD, PhD; Kiyoshi Aono; Shizuo Jimbo
Japan

#681: Early Outcomes and Complications of Posterior Vertebral Column Resection Performed in Underdeveloped and Underserved Regions
Oheneba Boachie-Adjei, MD; Han Jo Kim, MD; W. F. Hess, MD; Elias C. Papadopoulos, MD; Francisco Javier Sánchez Pérez-Grueso; Munish C. Gupta, MD; Baron S. Lonner; Kenneth J. Paonessa, MD; Maria Cristina Sacramento Dominguez, MD, PhD; Michael J. Mendelow, MD; Matthew E. Cunningham, MD, PhD; Complex Spine Study Group; Focos Organization; Ferran Pellise, MD
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#682: Posterior Transpedicular Egg Shell Procedure And Convex Short Segment Instrumentation For Congenital Hemivertebra
Serkan Bilgic; Gokhan Cakmak; Huseyin Ozkan; Yuksel Yurttas; Mustafa Kurklu; Tolga Ege; Ali Sehirlioglu
Turkey

#683: The Effect of Patient Positioning During Radiographs on Resulting Cobb Angle Measurements
Matthew Siljander, MS, BSME; Patrick Knott, PhD, PA-C; Steven M. Mardjetko, MD, FAAP
United States

#684: Evaluation of the Utility of Evoked EMG's in Pedicle Screw Placement
Steven M. Fiore, MD
United States

#685: Does the Implantation of a Cervical TDR (PCM, Discover)Reconstruct the Physiological MCR and Does the Adjacent MCR Change as Well?
Kristin Aretz, MD; Nora Lamos; Dezsoe J. Jeszenszky, MD; Frank S. Kleinstueck, MD; Tamas Fekete, MD; Daniel Haschtmann, MD; Jurgen Harms, MD
Switzerland

#686: Radiographic Analysis of Minimally Invasive Lumbar Spine Surgery Performed on the Jackson Table vs. the Wilson Frame
Mario J. Cardoso, MD, DC; Audra Mendelsohn, BA; Sara E. Thompson, BA; Frederick L. Stephens, MD; John C. Liu, MD; Tyler Koski, MD; Michael Rosner, MD
United States

#687: Can a New Pedicle Drilling Probe with Electrical Conductivity Measurement Capabilities Anticipate Pedicle Breach? A Cadaver Study
Randal R. Betz, MD; John I. Williams, MD; Keri George, RN; John Gaughan; Amer F. Samdani, MD
United States

#689: A Prospective Look at the Learning Curve Associated with Transition from Open TLIF to MAS® TLIF for the Treatment of Symptomatic Lumbar Degenerative Conditions
Frank Feng, DO; Jason Bergandi
United States

#690: The Two-Cage Unilateral Approach for Lumbar Interbody Fusion. Technique, Device, and One-Year Results
Steven E. Mather, MD
United States

E-Poster Index

#691: Surgical Data and Patient Outcomes for Axial Lumbar Interbody Fusion (AxiaLIF): Our Initial Experience
Nael Shanti, MD; Rachel Mistur, MS; Atiq Durrani, MD
United States

#692: An Innovative Solution in the Treatment of Facet Arthropathy: The Facet Resurfacing Concept
Luis Marchi, MSc; Leonardo Oliveira, BSc; Etevaldo Coutinho; Luiz Pimenta, MD, PhD
Brazil

#693: A New TLIF Cage Introducer: Preliminary Clinical Application
Hongxing Jiang, MD; Richard Fox, MD
Canada

#694: Influence of an Auxiliary Facet System on Lumbar Spine Biomechanics
Yann Philippe Charles, MD; Sylvain Persohn, MSc; Jean-Paul Steib, MD; Christian Mazel, MD; Wafa Skalli, PhD
France

#695: Extreme Lateral Interbody Fusion (XLIF) in Smokers
William B. Rodgers, MD; Edward J. Gerber, PA-C; Jeffrey A. Lehmen, MD; Jody A. Rodgers, MD, FACS
United States

#696: Proximal Junctional Failure following Surgical Treatment of Global Sagittal Imbalance: Predictive Analysis using a 2D Biomechanical Model
Heather Murray, MASc; John Street, MD, PhD; Thomas Oxland
Canada

#697: Pedicle Subtraction Osteotomy For Cervical-Thoracic Kyphosis: A New Approach
Hooman M. Melamed, MD
United States

#698: Comparisons of Outcomes after Single or Multi-Level Dynamic Stabilization: Effects on Adjacent Segment
Chi Heon Kim, MD, PhD; Tae-Ahn Jahng, MD, PhD; Chun Kee Chung, professor; Soo Eun Lee, MD
Republic of Korea

#699: Lumbar Spinal Stenosis Treatment with a Minimally Invasive Interspinous Spacer: Preliminary Results of a Prospective, Multi-Center, Randomized, Controlled Trial
W. Daniel Bradley, MD; Jon E. Block, PhD; Larry E. Miller, PhD; Peter G. Whang, MD
United States

#700: Dynamic Stabilization Combined with Laminectomy vs. Laminectomy Alone in Degenerative Lumbar Stenosis in Elderly Patients: Is it Effective?
Mario Di Silvestre, MD; Francesco Lolli; Georgios Bakaloudis; Konstantinos Martikos
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#701: Anterolateral Plating in the Minimally-Invasive Extreme Lateral Interbody Fusion Technique
Ali A. Baaj; Elias Dakwar, MD; Clinton Burkett, MD; Gisela Murray, MD; Donald A. Smith, MD; Fernando L. Vale, MD; Juan S. Uribe, MD
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#702: L4/5 XLIF. Is There a Safe Zone?
Elias Dakwar, MD; Clinton Burkett, MD; Ali A. Baaj; Gisela Murray, MD; Juan S. Uribe, MD
United States

E-Poster Index

#703: Analysis of Cost Differences in Pediatric Spinal Fusion Surgery
Julie Legakis, PhD; YoungKey Chung; Ahmed Bazzi, DO; Ronald L. Thomas, PhD; Richard A. Reynolds, MD; Walid K. Yassir, MD
United States

#704: Lumbar Minimally Invasive Microdiscectomy in Pediatric Patients: A Series of Six Patients
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United States

#705: Neuromuscular Scoliosis: Standardized Correction of Deformity with Pedicle Screw Construct
Pedro Domenech, MD; Jane S. Hoashi, MD, MPH; Gabriel Piza Vallespir, MD, PhD; Ramon Navarro; Jesús J Burgos Flores, PhD; Ignacio Sanpera, MD, PhD; Eduardo Hevia, Dr; Carlos Barrios Pitarque
Spain

#706: Posterolateral vs. Transforaminal Lumbar Interbody Fusion: A Comparison of Fusion Rates in Patients who Underwent Both Procedures
Khoi D. Than, MD; Shayan Rahman, MD; Monique Vanaman, MD; Anthony C. Wang, MD; Frank La Marca, MD
United States

#707: Results and Complications of Posterior-Only Reduction and Fusion for High-Grade Spondylolisthesis
Stephen Lewis; Sergey Goldstein, MD; Andrew W. Bodrogi, BSc; Hitesh N. Modi, MS, PhD; Sofia Magana, BSc
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#709: Treatment of Unstable Sacral Fracture with a Modified Galveston Technique
Koichiro Koshimune, MD; Yasuo Ito, MD, PhD; Tomoyuki Takigawa; Shoichiro Mizuno; Kazukiyo Toda; Hideki Ohashi
Japan

#710: Effect of Kyphosis and Wedge Angle on Functional Outcome of Percutaneous Vertebroplasty - A Prospective Cohort Study
Ketan Khurjekar, MS(Orth); Ashok K. Shyam, MS(Orth); Shailesh Hadgoankar, MS, Orth, FCPS, FISS; Parag K. Sancheti, Mch, MS
India

#711: Single-Stage Removal of Thoracic Dumbbell Tumors Only from Posterior Approach with Costotransversectomy
Kei Ando; Shiro Imagama, MD; Norimitsu Wakao, MD, PhD; Naoki Ishiguro, MD, PhD; Yukihiro Matsuyama, MD
Japan

#712: Operative Reults of Corrective Spinal Osteotomy for Congenital Scoliosis
Hitoshi Kono; Hironobu Watanabe; Masafumi Machida, MD; Saito Masashi; Kentaro Fukuda; Naobumi Hosogane; Kiyohiro Nakamichi
Japan

#713: Analysis of the Radiological Parameters for AIS
Osman Cimen; Mehmet B. Balioglu, MD; Mehmet A. Kaygusuz, MD
Turkey

#714: Cost Comparison of Thoracic Pedicle Screw Fixation vs. Hook Constructs for Deformity Correction in Adolescent Idiopathic Scoliosis
Derek M. Kelly, MD; Jeffrey R. Sawyer, MD; William C. Warner, MD; Freeman Barney, MD; Bradley P. Jaquith, BS; Phillip O. Flinn, BS; Adam Chase, MD
United States

E-Poster Index

#715: Single Stage Rigid Scoliosis Correction using Wide Multiple Level Posterior Release: Results of a Prospective Study
Krishna Kumar Ramachandran Nair, MBBS, MNAMS, DO, DNB
India

#716: Consensus on Scoliosis Screening: Reviewing the Evidence on Effectiveness
Marie Beauséjour; Stefan Parent, MD, PhD; Lise Goulet; Debbie E. Feldman, PhD; Isabelle Turgeon; Marjolaine Roy-Beaudry, MSc; Hubert Labelle, MD
Canada

#717: The Effects of Obesity on Deformity Correction in Adolescent and Juvenile Idiopathic Scoliosis
Christina Hardesty, MD; George H. Thompson, MD; Connie Poe-Kochert, BSN
United States

#718: Categorization of Scoliosis Trunk using Cluster Analysis
Mathias M. Adankon, PhD; Farida Cheriet, PhD; Jean Dansereau, PhD; Hubert Labelle, MD
Canada

#719: Supine MRI Cobb Measurements for Adolescent Idiopathic Scoliosis (AIS) are Linearly Related to Measurements from Standing Plain Radiographs
Mark C. Lee, MD; Archit Patel, MD; Matthew Solomito, BS
United States

#721: Anatomy of Lamina in the Thoracolumbar Spine with the Special Reference to Translaminar Screws: CT and Cadaveric Analysis with Screw Simulation
Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; Michael Iwanik, PhD; John Glaser, MD; Joshua E. Heller, MD; Kai-Ming Fu, MD, PhD; Francis H. Shen, MD
United States

#722: Defining the Pre-Vertebral Safe Zone for Pedicle Screw Placement: A Strategy to Avoid Vascular and Visceral Injuries
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United States

#723: Intraoperative Spinal Cord Monitoring using Double-Train Transcranial Electrical Stimulation
Sho Kobayashi, PhD; Tomohiko Hasegawa; Tatsuya Yasuda; Yukihiro Matsuyama, MD
Japan

#724: Incidence of Allograft Contamination during Intraoperative Processing in Patients with Spinal Deformity Correction Surgery
Hamid Hassanzadeh, MD; Amit Jain; Philip Neubauer, MD; Khaled Kebaish; Benjamin E. Stein, MD; Addisu Mesfin, MD; Michael C. Ain, MD
United States

#725: Injury to Major Blood Vessels in Anterior Thoracic and Lumbar Spinal Surgery
Jan Stulik; Tomas Vyskocil; Michal Barna
Czech Republic

#726: Posterior Approach in Thoracolumbar Tuberculosis - A Panacea. A Clinical and Radiological Review of 83 Operated Cases
Saurabh Rawall; Abhay Nene
India

E-Poster Index

#727: Multicenter Prospective Controlled Study of Lumbar Revisions
Mihir R. Bapat, MS, DNB; Prasanna C. Rathi; Mehandi Hassan S. Ansari, MS(Ortho); Kshitij S. Chaudhary, MS, DNB
India

#729: Impact of Combined Transcranial Electric Stimulation Motor Evoked and Somatosensory-Evoked Potential Monitoring During Surgery for Spine Deformity
Bin Feng, MD; Jianxiong Shen, MD; Jianguo Zhang
China

#730: Inter- and Intra-Observer Reliability in Radiographic Parameters of Early Onset Scoliosis
Klane K. White, MD, MSc; Kit Song, MD, MHA; Walter F. Krengel, MD; Brian K. Daines, MD; Viviana Bompadre, PhD
United States

#731: Clinical and Radiographic Outcomes following MIS TLIF Supplemented with Percutaneous Pedicular Screws (PPS): 24 Months Follow-Up
Manuel Da Silva; Hazem Nicola; Daniel Onay
Venezuela

#732: The Impact of the Changes in Lumbar Lordosis Following Lumbar Fusion on Clinical Outcome
Jun Young Yang, MD, PhD; June Kyu Lee; Soo Min Cha; Yong Bum Joo
Republic of Korea

#733: Osteoporotic Vertebral Fracture in DISH Requires Vertebroplasty Combined with Posterior Song Fusion
Hidetomi Terai, MD,PhD; Akinobu Suzuki; Hiromitsu Toyoda; Hiroaki Nakamura
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#734: Characterization of Spinal Column Injuries in the Global War On Terrorism
James A. Blair, MD; Jeanne C. Patzkowski, MD; Jessica D. Cross; Eric Grenier, MD; Ronald A. Lehman, MD; Andrew J. Schoenfeld, MD; Daniel G. Kang, MD; Joseph R. Hsu, MD
United States

#735: Post-Injury Ketogenic Diet Improves Gross and Skilled Forelimb Motor Function after Cervical SCI in Rats
Femke Streijger; Ward T. Plunet, PhD; Jae HT Lee; Jie Liu, MD; Clarrie K. Lam; So Eyun Park; Peggy Assinck; Brian K. Kwon, MD, PhD, FRCSC; Wolfram Tetzlaff, MD, PhD
Canada

#736: The Effect of Lidocaine, Volume Expansion, Pressors, and Decompression on Spinal Cord Blood Flow & Signal Changes (MEPs): Do They Really Work? A Porcine Study
Vishal Sarwahi, MD; Adam L. Wollowick, MD; Seth A. Grossman, MD; Terry D. Amaral, MD; Farzin Kabaei, MD; Etan P. Sugarman, MSIV; Christian Keller, MD; Alan Legatt, MD, PhD
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#737: A Novel Technique to Quantify Cage Translation as a Function of Loading in a Lumbar Spine Instrumented at Two Levels with Lateral Inter-Body Cages in a Lateral Plate Fusion Construct
Aniruddh Nayak, MS; Brandon G. Santoni, PhD; Andres F. Cabezas, BSCE; Antonio E. Castellvi, MD
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#738: Four-Level Anterior Cervical Discectomies and Cage-Augmented Fusion with and without Fixation
Mootaz Shousha, MD; Ali Ezzati; Heinrich Böhm
Germany

E-Poster Index

#739: Role of Scrape Cytology in Transpedicular Biopsy of Vertebral Body Lesions - A Novel Technique to Increase the Specimen Accuracy
J. Naresh-Babu, MD; Cheekatla Suresh; Ch V. Swamy
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#740: Thoracic Lung Volume Measurement with Congenital Spinal Deformity
Mehmet B. Balioglu, MD; Mehmet A. Kaygusuz, MD
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#741: Far-Lateral Interbody Fusion (FLIF): A Less Invasive Muscle Sparing Technique for Revision Surgery and Junctional Failure. Converting a Revision into a Primary Operation
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#742: Minimally Invasive Disc Space Preparation in a Cadaver Model
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#743: Endoscopic Interlaminar Lumbar Discectomy with Splitting of the Ligament Flavum under Visual Control
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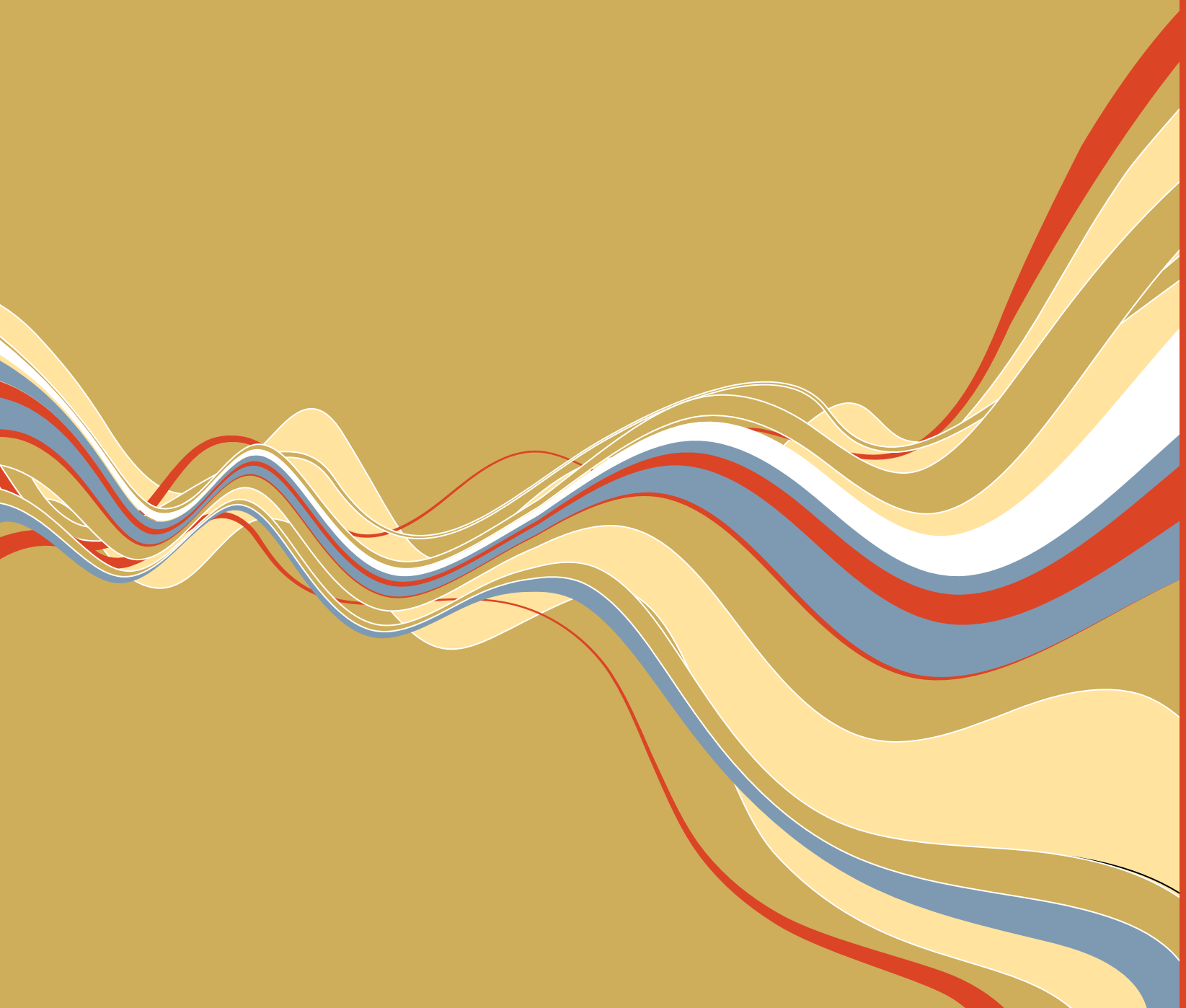

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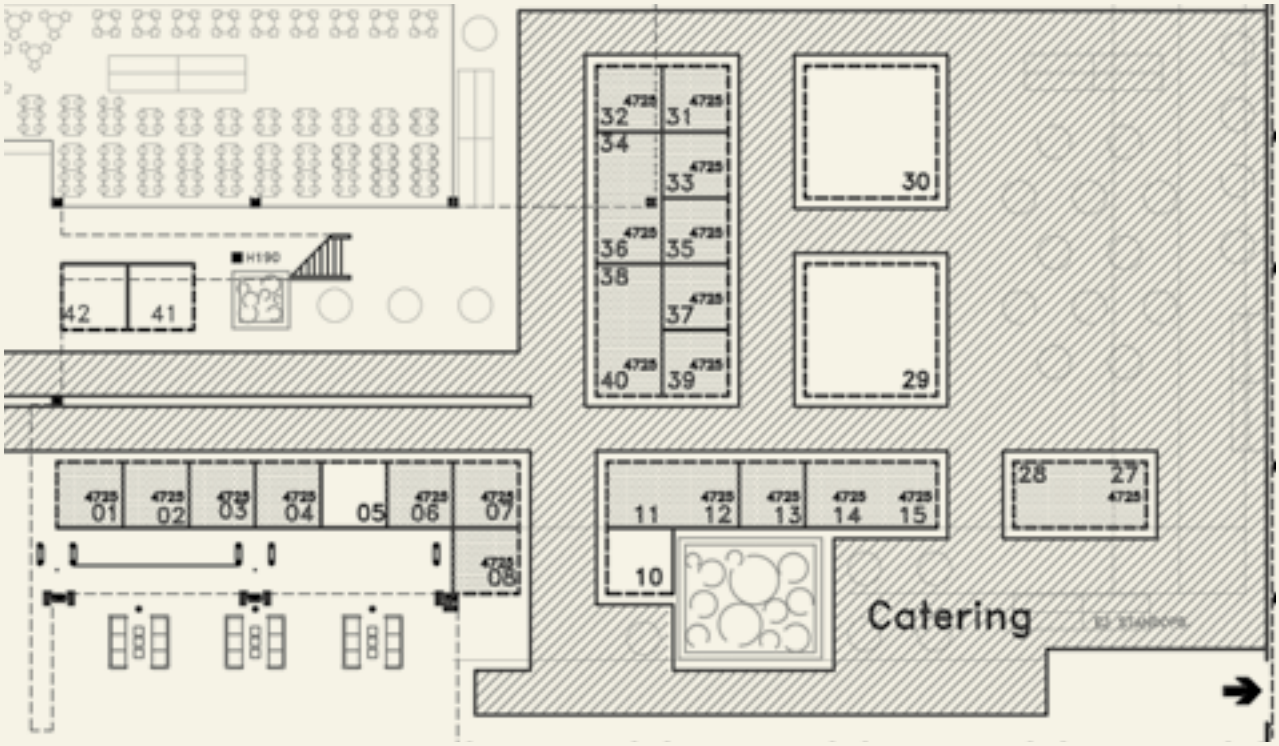

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7 Ha'eshel
Caesarea 38900
ISRAEL
Tel: 972-4-6187101
Fax: 973-4-61871111
www.mazorrobotics.com

Mazor Robotics is a leading innovator in spine surgery — inspiring the art of surgery with robotic guidance systems and complementary products that provide a safer surgical environment for patients, surgeons, and OR staff. Mazor Robotics' new Renaissance™ Surgical Guidance Robot is transforming spine surgery from freehand procedures to highly-accurate, state-of-the-art robotic-guided procedures that raise the standard of care with better clinical outcomes. Based on surgeons' experience with SpineAssist® in over 2,000 procedures worldwide (over 10,000 implants), the new Renaissance™ Surgical Guidance Robot is powered by clinically validated technology. Via Renaissance's intuitive interface, preoperative planning in a virtual 3D environment creates a surgical blueprint for state-of-the-art robotic-guided surgery. Renaissance™ easily integrates into OR workflows, providing the highest level of accuracy with less radiation for deformities, revisions, and minimally invasive surgeries. For peer-reviewed publications on Mazor Robotics' technologies, including a recent 14-center study demonstrating 98.3% accuracy in hundreds of patients, see www.MazorRobotics.com

Medicrea

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Medtronic Spinal & Biologics

2600 Sofamore Danek Drive
Memphis, TN 38132
USA
Tel: 1-901-396-3133
Fax: 1-901-399-2012
www.medtronic.com

At Medtronic (www.medtronic.com), we're committed to Innovating for life by pushing the boundaries of medical technology and changing the way the world treats chronic disease. To do that, we're thinking beyond products and beyond the status quo - to continually find more ways to help people live better, longer. Please visit us at Booth(s) #38/40.

Exhibitors

Misonix

1938 New Highway
Farmingdale, NY 11732
USA
Tel: 1-631-694-9555
Fax: 1-631-694-3285
www.misonix.com

Misonix, Inc. is a world leader in developing ultrasonic surgical devices for hard and soft tissue removal. The Misonix BoneScalpel™ is a novel ultrasonic osteotome for tissue-selective bone dissection. It is designed to provide clean cuts through osseous structures with minimal loss of viable bone, in addition to sparing adjacent soft tissues. Any wrapping or tearing associated with common rotary power instruments is eliminated due to a purely linear motion. The advantages of the BoneScalpel are beneficial for standard open, microscopic and minimally invasive approaches. The BoneScalpel has been used in a variety of ostetomies such as laminectomies, hemi-laminectomies, laminotomies, laminoplasties, corpectomies, correction of scoliosis, bone harvesting and tumor resection. Please visit us at the IMAST 2011 at booth #9 for more information.

NuVasive

7475 Lusk Blvd
San Diego, CA 92121
USA
Tel: 1-858-909-1800
Fax: 1-858-909-2000
www.nuvasive.com

NuVasive 's current principal product offering includes a minimally disruptive surgical platform called Maximum Access Surgery, or MAS®, as well as a growing offering of cervical, thoracolumbar, biologic and motion preservation products.The MAS platform offers advantages for both patients and surgeons such as reduced surgery and hospitalization time and faster recovery. MAS combines four categories of current product offerings: NVM5™ a proprietary software-driven nerve avoidance system; MaXcess® a unique spinal access system, specialized implants, like SpheRx® and CoRoent® and a biologic platform that collectively minimize soft tissue disruption during spine surgery while allowing maximum visualization and surgical reproducibility.

Orthofix, Inc.

3451 Plano Parkway
Lewisville, TX 75056
USA
Fax: 1-214-937-2730
www.orthofix.com

Orthofix products surround the patient with preventative, intra-operative and post-operative treatment options. Our spine solutions help surgeons respond with the best treatments available to enhance clinical outcomes, including Spinal Implants, Biologics Technology, Bone Growth Stimulators, and Spine Bracing. Our promise is to be Customer Focused, Patient Driven and Always Responsive.

Paradigm Spine

Eisenbahnstrasse 84
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GERMANY
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www.paradigmspine.com

Paradigm Spine is a provider of non-fusion spinal implant solutions that serves to address the unmet clinical needs of spine surgeons and their patients. Starting with the coflex™ interlaminar implant technology Paradigm Spine develops a full non-fusion product portfolio of motion preserving tissue sparing technologies. The company presents the DCI™ implant for cervical dynamic stabilization, the DSS™ implant for lumbar dynamic stabilization, the coflex-F™ implant as a minimally invasive solution as an adjunct to fusion and the GSP™ system for early onset spinal deformities (TIS).

Providence Medical Technology

201 Spear Street
Suite 1310
San Francisco, CA 94105
USA
Tel: 1-415-923-9375
Fax: 1-415-923-9377
www.providencemt.com

The DTRAX Facet Screw System is a posterior fixation construct to provide distraction of the facet joint, decompression of the nerve root and spinal stabilization.

Exhibitors

Salient Surgical Technologies

180 International Drive
Portsmouth, NH 03801
USA
Tel: 1-603-742-1515
www.salientsurgical.com

Salient Surgical Technologies manufactures advanced energy devices that provide hemostatic sealing of soft tissue and bone in a variety of surgical procedures, resulting in lower blood transfusion rates and a reduced need for other blood management products.

Spineguard, Inc.

5,7, rue de l'Amiral Courbet
Sant Mande 94170
FRANCE
Tel: +33-145-184524
Fax: +33-145-184520
www.spineguard.com

PediGuard is the world's first and only handheld device capable of alerting surgeons to potential pedicular or vertebral breaches. Real-time feedback is provided via audio and visual signals. Two multi-center clinical studies about PediGuard have been published: one by Ciaran Bolger, MD, PhD et al., in the *European Spine Journal*, and the other by Randy Betz, MD et al., in the Temple University *Journal of Orthopaedic Surgery & Sports Medicine*. These two studies demonstrated that PediGuard doubles the pedicle breach detection rate, reduces radiation exposure by 30 percent, and decreases by up to 10% the average time for pedicle screw placement. SpineGuard's mission is to make spine surgery safer. The company has offices in San Francisco and Paris. For further information, visit www.spineguard.com.

Stryker Spine

2 Pearl Court
Allendale, NJ 07401
USA
Tel: 1-866-987-7463
www.stryker.com

Stryker Spine invents, manufactures, and sells a full range of spinal implants for use in spinal surgeries worldwide. Stryker Spine began internationally in the mid 1990's and has rapidly become a major participant in the global spine instrumentation market. Operations are based in three locations; Bordeaux, France; Neuchatel, Switzerland and Allendale, NJ, USA. Stryker Spine's ISO compliant manufacturing facilities in Switzerland and France produce implants for the global market while our headquarters in Allendale, NJ serves as the nexus for R&D and Marketing. We are proud of our collaboration with spinal surgeons and other health care professionals throughout the world to help bring patients more productive, less painful lives. Stryker Spine works closely with its sister divisions: Navigation, Instruments and Interventional Spine to offer a comprehensive set of solutions to our surgeon customers worldwide.

Synthes GmbH

Oberdorf/BL 4436
SWITZERLAND
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www.synthes.com

Synthes, headquartered in West Chester, PA (USA), is a leading global medical device company, employing over 11,000 people whose mission is to improve patient care around the world. Through its five product groups (Trauma, Spine, Cranio-Maxillofacial, Biomaterials and Power Tools), Synthes develops, produces and markets instruments, implants and biomaterials for the surgical fixation, correction and regeneration of the human skeleton and its soft tissues. We operate in product markets with high growth, driven by the aging population and improvements in technology that allow treating more patients with better implants.

Exhibitors

TranS1

301 Government Center Drive
Wilmington, NC 28403
USA
Tel: 1-910-332-1700
Fax: 1-910-332-1701
www.trans1.com

TranS1® offers an innovative, trans-sacral approach to lumbar surgery. A mini-open access and fusion system enables lumbar fusion to be performed with complete preservation of the annulus and all paraspinal soft tissue structures. AxiaLIF/AxiaLIF 2L+ technologies result in high fusion rates, low complication rates, and improved patient recovery time.

Vexim SAS

75, rue St-Jean
Balma 31130
FRANCE
Tel : +33-671607207
Fax : +33-5-61-48-95-19
www.vexim.fr

Vexim is a European company offering clinically and scientifically proven solutions for the minimally invasive treatment of patients suffering from spinal trauma disorders. Pioneering the concept of anatomical restoration, our mission is to relieve pain, restore vertebral anatomy and rebalance spine. Today, we are developing a complete portfolio of innovative solutions to prevent and treat the symptoms, causes and consequences of vertebral compression fractures. SpineJack® system and Cohesion® bone cement are just two of the innovative products developed by Vexim.

Zimmer Spine

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Fax: +33-556-001821
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Zimmer Spine develops, produces and markets the highest quality spine products and services that repair, replace and regenerate spine health. Zimmer Spine works directly with surgeons to share best practices, facilitate surgeon-to-surgeon training and to provide continuous access to relevant information, all to improve patient outcomes. With continual technological advancement, Zimmer constructs superior fusion and non-fusion spine systems, instrumentation systems, cervical plates, allograft bone filler and trabecular metal. We use our resources to advance industry evolution, and our products and procedures exceed doctor and patient expectations. Through the hands of skilled surgeons, Zimmer enhances patient quality of life.

Hands-On Demonstrations

Thursday, July 14, 2011

Cervical and Thoracolumbar Systems

Global Derotation Correction Technique with MESA® Deformity

Presented by: K2M
Products: RANGE® Spinal System
Instructors: Stewart Tucker, FRCS

K2M will be demonstrating the RANGE® Spinal System and its unique Global Derotation technique for treating deformity pathologies utilizing the MESA® screw and innovative reduction instrumentation. The system offers a complete array of unique screws, rod connectors, hooks, coupled with exciting innovations in instrumentation.

Kyphoscoliosis Correction Technique with MESA® Deformity

Presented by: K2M
Products: RANGE® Spinal System
Instructors: Oheneba Boachie-Adjei, MD

K2M will be demonstrating the RANGE® Spinal System and its clinical applications for treating Kyphoscoliosis pathologies. The system is a fusion of DENALI® and MESA®, offering a complete array of unique screws, rod connectors, hooks, coupled with exciting innovations in instrumentation.

Bone on Bone: Anterior Instrumentation

Presented by: K2M
Instructors: Robert Gaines, MD

K2M will be discussing the bone on bone techniques and clinical applications for treating complex spinal pathologies from an anteriolateral approach.

VEPTR Construct Strategy to Treat Thoracic Insufficiency Syndrome: Implants, Technology and Clinical Applications

Presented by: Synthes Spine
Products: VEPTR and VEPTR II
Instructors: Dr. Rolf Riise

Friday, July 15, 2011

Interbody Devices; Biologics and Deformity Systems; Other

Sacropelvic Fixation Techniques with MESA® Deformity

Presented by: K2M
Products: RANGE® Spinal System
Instructors: Laurel Blakemore, MD

K2M will be demonstrating the RANGE® Spinal System and its clinical applications for treating adult deformities. The system is a fusion of DENALI® and MESA®, offering a complete array of unique screws, rod connectors, hooks, coupled with exciting innovations in instrumentation.

Hybrid Construct Techniques with MESA® Deformity and SERENGETI ® Minimally Invasive Retractor System

Presented by: K2M
Products: SERENGETI® Minimally Invasive Retractor System
Instructors: Pierce Nunley, MD

K2M will be demonstrating the use of the SERENGETI® Minimally Invasive Retractor System in conjunction with the RANGE® Spinal System as a hybrid option for clinical applications. SERENGETI® is a screw-based, minimally invasive method of retraction that provides a fixed position to the anatomy. This design allows for one-step, percutaneous placement of the screw and retractor providing direct visualization and improved access for rod introduction.

Biologics and Deformity Systems: Corrective Techniques for AIS Procedures

Presented by: Stryker Spine
Products: Xia3, Suk DVR, Xia3 Ilios + Revision
Instructors: Se-Il Suk, MD, PhD

AxiaLIF®

Presented by: TranS1
Products: AxiaLIF, AxiaLIF 2L+, Presacral Access Kit, Discectomy Tools/Rasps
Instructors: Isadore H. Lieberman, MD

AxiaLIF® is a spinal fixation system, delivered through a pre-sacral approach that facilitates fusion through axial stabilization of the anterior lumbar spine at L4-S1. AxiaLIF® provides controlled distraction at L5-S1, independent distraction at L4/L5 and resistance to compressive forces. AxiaLIF® constructs provide excellent biomechanical stability when used with posterior fixation.

Hands-On Workshops

Thursday, July 14, 2011

Expanding the Limits of MIS: Complex Correction Techniques

Presented by: DePuy Spine
Instructors: Steven C. Ludwig, MD, D. Greg Anderson, MD and Prof. Cornelius Wimmer
Room: Room 17, First Floor

This hands-on workshop is designed for surgeons experienced with MIS procedures who want to learn new MIS techniques and advance their expertise in this area. This session will include a discussion on techniques for deformity correction through percutaneous fixation and an overview of the lateral approach to interbody fusion with the DePuy Spine MIS Lateral Platform.

Complex Curve Correction Dual Rod technique with MESA® Deformity

Presented by: K2M
Instructors: Oheneba Boachie-Adjei, MD and Mr. David Marks, FRCS
Room: Room 18, First Floor

K2M will be demonstrating the RANGE Spinal System and its unique Dual Rod Correction technique for treating deformity pathologies utilizing the MESA screw and innovative reduction instrumentation. The system offers a complete array of unique screws, rod connectors, hooks, coupled with exciting innovations in instrumentation.

Minimally-Invasive Surgery for Complex Spine: A New Direction in Correction

Presented by: Medtronic
Instructors: Mark Dekutoski, MD
Room: Room 19, First Floor

This Hands-On Workshop will feature case presentations and technique reviews for novel minimally-invasive procedures. Navigation, Tumor/Trauma, and advanced degeneration of the aging spine will all be components of the session.

Direct Vertebral Body Maneuver Techniques

Presented by: Stryker Spine
Instructors: Se-Il Suk, MD, PhD
Room: Room 20, First Floor

This hands-on course will offer participants an opportunity to evaluate new corrective techniques for the treatment of idiopathic scoliosis. Participants will also assess the applications of deformity implants and how they impact decision-making outcomes.

Friday, July 15, 2011

Advanced Techniques in Treating AIS

Presented by: DePuy Spine
Instructors: Peter O. Newton, MD, Harry L. Shufflebarger, MD, Randal R. Betz, MD and Mr. David S. Marks
Room: Room 17, First Floor

This hands-on workshop is designed for surgeons who want to learn about advanced techniques in treating AIS. This session will include an overview of the latest available technology and techniques for treating AIS including vertebral body derotation.

New Techniques in Lateral Access Deformity Fusion with RAVINE™ Lateral Access System and SERENGETI® Minimally Invasive Retractor System

Presented by: K2M
Instructors: Pierce Nunley, MD and Mr. Colin Natali, MBBS, BSC, FRCS
Room: Room 18, First Floor

A dual flat blade platform for a true muscle splitting transpsoas approach that offers rigid fixation to the spine and an option for both a third and fourth blade. K2M's lateral access system represents an innovative design departure from the tubular retractors, while providing tremendous adaptability to both patient anatomy and surgeon technique.

A New Solution for Degenerative Spine Procedures: PEEK Rods

Presented by: Medtronic
Instructors: Dr. Jörg Franke
Room: Room 19, First Floor

This session will review the rationale of using PEEK rod vs. Titanium rods in degenerative procedures, design rationale, and discuss clinical experiences.

XLIF Expanded Indications

Presented by: NuVasive
Instructors: Behrooz Akbarnia, MD; Luiz Pimenta, MD; William Smith, MD; Juan Uribe, MD
Room: Room 20, First Floor

During the XLIF Expanded Indication workshop the followings will be discussed:

- Importance of NVM5 during XLIF procedure
- XLIF for Scoliosis, Deformity
- XLIF for Sagital Balance
- XLIF for Corpectomy

Hands-On Workshops

Saturday, July 16, 2011

Techniques, Considerations, and Strategies for Adolescent Idiopathic Scoliosis Procedures

Presented by: Medtronic
Instructors: David Skaggs, MD
Room: Room 19, First Floor

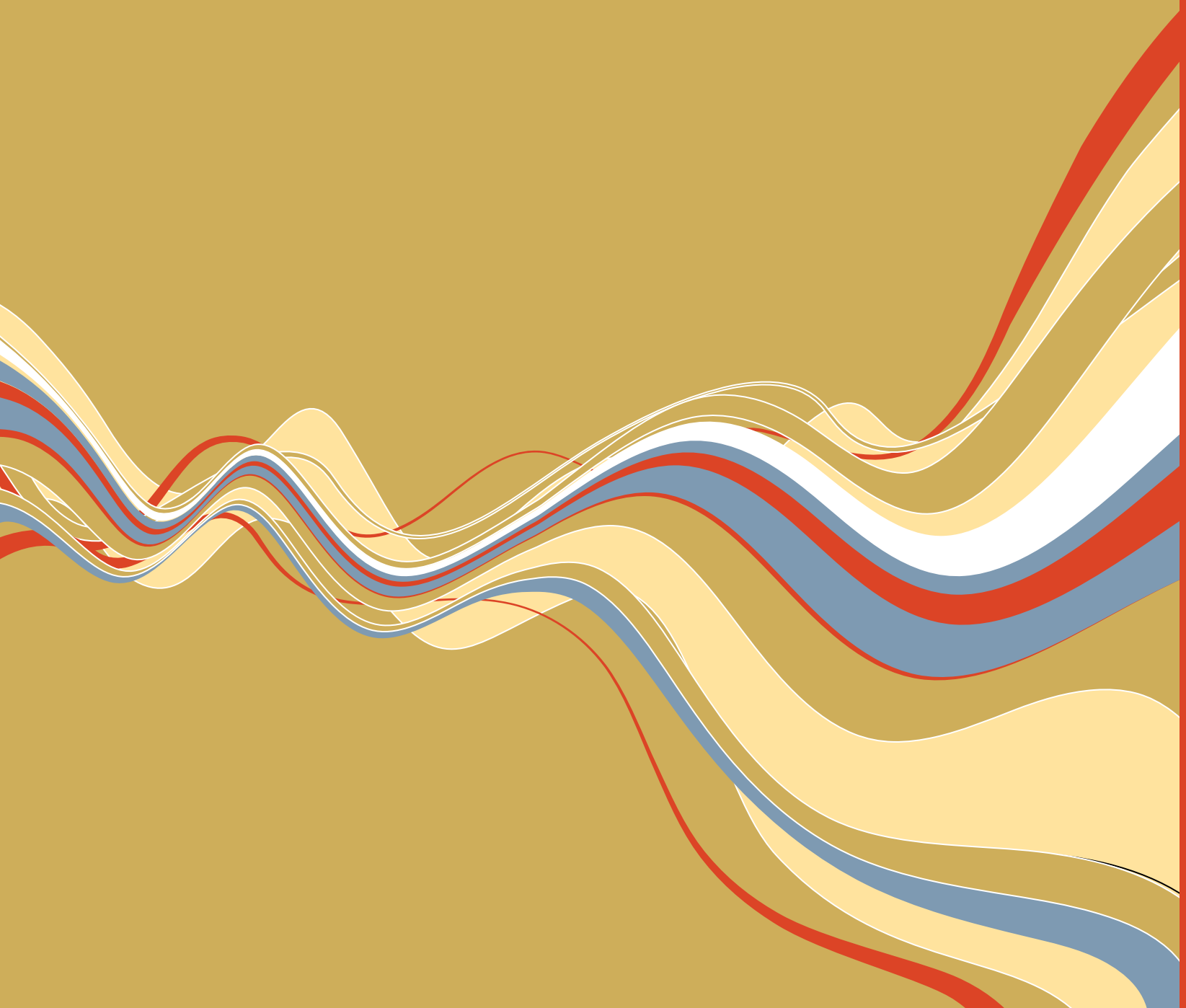
This Hands-On Workshop will feature case presentations, surgical considerations, and technique reviews for patients with adolescent idiopathic scoliosis.

Posterior Approaches to Spinal Deformity: The Importance of Implant System Versatility in the Planning of Complex Spine Cases

Presented by: Orthofix
Instructors: Rajiv K. Sethi, MD – Chief – Neuro/Ortho Spine Service, Virginia Mason Medical Center
Room: Room 20, First Floor

Presentation and discussion regarding the importance of implant and instrumentation flexibility when treating complex spinal deformities. Orthofix's recently introduced Firebird Deformity Correction system offers a variety of unique implant and instrument options that adapt to each surgeons individual surgical approach instead of dictating it.

Author Index



The Scoliosis Research Society gratefully acknowledges the following companies for their support of the Hands-On Workshops:

DePuy Spine
K2M
Medtronic
Nuvasive
Orthofix
Stryker Spine

And the following companies for their support of the Hands-On Demonstrations:

Globus Medical, Inc.
K2M
Stryker Spine
Synthes Spine
Trans1

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Abdul-Jabbar, Amir	441
Abe, Yuichiro	266, 380, 516, 647
Abjornson, Celeste	13, 117, 468
Abrams, Joshua H.	344
Abul-Kasim, Kasim	586
Abumi, Kuniyoshi	266, 357, 380, 516, 647
Acacio, Ricardo	336
Adam, Clayton J.	85
Adankon, Mathias M.	718
Afshari, Payman	515
Agel, Julie	387
Aghayev, Kamran	114, 206
Ahmad, AlaaEldin A.	454
Ahmadinia, Kasra	27
Ahn, Dongki	117
Ahn, Nicholas U.	41, 131, 324, 388, 415, 537, 538
Ahn, Young-Jun	356
Ain, Michael C.	249, 252, 660, 724
Akazawa, Tsutomu	370, 583
Akbarnia, Behrooz A.	3B, 4, 23, 75, 95, 319, 336, 339, 440, 443, 451, 480, 502, 505, 576, 601, 627, 666, 668, 670, 672
Alam, Milad	336, 401
Alanay, Ahmet	1B, 12, 35, 55, 101, 291, 302, 400
Albert, Todd J.	2A, 5A, 471
Aldakheel, Dakheel A.	466
Allen, Abigail	369
Allen, R. Todd	237
Al-Mukhtar, Mohannad	77, 306
Altaf, Farhaan	76, 77
Alvarado, Manuel A.	38
Amaral, Terry D.	16, 129, 280, 298, 378, 448, 636, 722, 736
Ambati, Divya V.	384, 518, 554, 671
Ames, Christopher P.	9, 49, 94, 95, 319, 439, 440, 441, 502, 666
Aminian, Afshin	544
An, Howard S.	597
Anand, Neel	4C, 53, 458
Anderson, D. Greg	2D, 4C, 471
Anderson, John T.	210
Anderson, Paul A.	457
Andersson, Gunnar	206
Ando, Kei	711
Aneiba, Khaled	720
Ansari, Mehandi Hassan S.	727
Antonacci, M. Darryl	560, 741
Aono, Kiyoshi	476, 680
Apazidis, Alexios	330
Arafa, AbdElMohsen	58, 59, 100, 290, 449, 519, 624, 645
Archer, Benjamin J.	386
Archer, Gregory B.	506, 596
Aretz, Kristin	685
Arlet, Vincent	46
Arnold, Paul	5, 7, 38, 106, 119, 119, 294
Arun, Ranganathan	491
Asghar, Jahangir	230, 278, 338, 373, 543, 581
Ashraf, Talat	6
Askin, Geoffrey N.	85
Assinck, Peggy	735
Atanasov, Amy	533
Atupan, Jereme B.	424, 425, 498
Aubin, Carl-Eric	11, 73, 258, 259, 582
Auerbach, Joshua D.	56, 72, 256, 464, 525, 592, 640
Aydogan, Mehmet	101, 302, 400
Baaj, Ali A.	352, 675, 701, 702
Bae, Hyun	72, 534
Bagheri, Ramin	4, 443
Bago, Juan	310
Bai, Yushu	277
Bains, Ravi S.	329
Bajwa, Navkirat S.	41, 131, 324, 388, 415
Bakaloudis, Georgios	247, 304, 452, 700
Balioglu, Mehmet B.	35, 619, 713, 740
Banagan, Kelley	276
Banco, Robert	7, 119, 119, 294
Bapat, Mihir R.	327, 727
Barbagallo, Giuseppe	38
Barna, Michal	725
Barnes, James	105
Barney, Freeman	714
Baron, Eli	53
Barrios, Carlos	31, 32, 66, 417, 433, 445, 500, 585, 705
Bartels, Ronald H.	38
Bartley, Carrie E.	341, 605
Bastian, Leonard	6
Bastrom, Tracey	61, 132, 225, 230, 232, 241, 271, 297, 300, 339, 341, 373, 401, 543, 605, 616
Basu, Saumyajit	623, 655
Bazzano, Robert B.	530
Bazzi, Ahmed	703
Beauséjour, Marie	716
Becker, Philipp	375, 459, 514
Bellabarba, Carlo	37, 387, 410, 547
Bellefleur, Christian	582
Belschner, Christopher	630

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Bendo, John A.	43, 479, 665
Berenson, James R.	6, 206
Bergandi, Jason	689
Bersusky, Ernesto	588, 643
Berven, Sigurd H.	1C, 2C, 3A, 4D, 123, 217, 246, 279, 317, 402, 441, 458, 558, 641
Bess, Shay	94, 95, 439, 440, 502, 505, 510, 666
Betz, Randal R.	2B, 4B, 63, 225, 234, 271, 278, 288, 297, 300, 326, 587, 687
Beyerlein, Joerg	612
Bhojraj, Shekhar	460
Bi, Ni	116, 127, 218, 589, 644
Bidre, Upendra	521, 572
Bilgic, Serkan	570, 682
Blackwood, C. B.	654
Blair, James A.	102, 734
Blaisdell, Gregory	547
Blakemore, Laurel C.	587, 627, 668, 670
Blanco, John S.	88
Bland, Melanie	276
Blanke, Kathy	296, 446
Block, Jon E.	699
Blondel, Benjamin	94, 96, 251, 318, 332
Blumberg, Todd	418
Blumenthal, Scott L.	201, 257, 334, 359
Boachie-Adjei, Oheneba	2C, 3C, 88, 94, 95, 235, 283, 299, 310, 312, 320, 407, 431, 435, 472, 502, 505, 517, 575, 576, 631, 681
Boatey, Jerome	235, 283, 575
Bodin, Nathan D.	20, 453
Bodrogi, Andrew W.	409, 707
Boehm, Heinrich	39
Boenigk, Kirsten	1
Bogert, Jochen	623
Böhm, Heinrich	107, 546, 738
Bolosan, Samuel	652
Bompadre, Viviana	730
Bono, Christopher	106, 119, 294
Bosch, Patrick	654
Bost, James E.	654
Bou Ghosn, Rony	42
Bowen, J. Richard	78
Bowen, Richard E.	353, 494
Boyd, Michael	450
Bradley, W. Daniel	699
Braid-Forbes, Mary Jo	123
Braman, Jonathan P.	293
Bransford, Richard J.	37, 387, 410, 547
Bratcher, Kelly R.	69, 217
Bretschneider, Wolfgang	375
Bridwell, Keith H.	2, 24, 47, 48, 51, 80, 133, 246, 250, 251, 267, 268, 275, 316, 318, 342, 348, 366, 406, 541, 613
Briseno, Michael R.	344
Brodke, Darrel S.	7, 106, 119, 119, 294
Brown, Christopher R.	676
Buchowski, Jacob M.	3D, 5A, 2, 47, 48, 96, 113, 406, 478, 484, 517, 541, 542
Bumpass, David	133
Bundoc, Rafael C.	558
Bunger, Cody E.	2D, 608, 617
Burch, Shane	49, 402, 441
Burgos Flores, Jesús J	31, 32, 66, 417, 433, 445, 500, 585, 705
Burke, Lauren O.	68, 365
Burkett, Benjamin W.	665
Burkett, Clinton	352, 675, 701, 702
Burton, Douglas C.	94, 212, 353, 439, 440, 494, 502, 505, 666
Caballero, Alberto	32, 417
Cabezas, Andres F.	261, 556, 737
Cahill, Patrick J.	20, 63, 227, 278, 300, 453, 543, 678
Caird, Michelle S.	594
Cakmak, Gokhan	682
Cameron, Brian	361
Camisa, William J.	601
Cammisa, Frank P.	13, 117, 289, 346, 381, 468, 511, 667
Campbell, Mitchell J.	124
Campbell, Robert M.	285, 337, 526
Canan, Chelsea E.	68, 365
Capobianco, Robyn A.	123
Cappuccino, Andrew	118, 120, 202, 216, 602
Cardoso, Mario J.	518, 554, 664, 669, 686
Caridi, John	312
Carl, Allen L.	601
Carlson, Brandon B.	212
Carreau, Joseph H.	241, 341, 470
Carreon, Leah Y.	65, 68, 69, 121, 124, 217, 229, 242, 246, 358, 362, 365, 427, 457
Carstens, Alan	85
Carstens, Claus	490
Cartar, Lydia	593
Castellvi, Antonio E.	18, 261, 556, 737
Ceratt, Dustin	603
Cha, Soo Min	245, 355, 376, 662, 732
Cha, Thomas D.	216, 597

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Chafetz, Ross	278
Chamas, Firas	50
Chan, Hester	652
Chan, Yiong Huak	424, 425
Chang, Michael S.	64, 67, 287, 314, 354, 383, 532
Chang, Yu-Hui H.	314
Chapman, Jens R.	7, 37, 106, 119, 119, 294, 387, 410, 547
Chaput, Christopher	118, 120, 202, 216, 288
Charles, Yann Philippe	466, 694
Chase, Adam	714
Chastain, Sara	279
Chaudhari, Rahul D.	511
Chaudhary, Kshitij S.	327, 727
Chavanne, Albert	375
Chay, Edward	251
Chen, Hong	116, 127, 218, 589, 644
Chen, Zhongqiang	512
Chen, Zi-Qiang	301, 432, 497
Cheng, Ivan	344, 578, 630
Cheng, Jack C.	33, 82, 213, 569, 571
Cheriet, Farida	718
Chern, Joshua	632
Cheung, Antoinette	593
Cheung, Kenneth M.	4A, 74, 75
Chiba, Kazuhiro	15, 36, 254, 428, 447, 501, 584
Chikuda, Hirotaka	574
Cho, Kyu-Jung	633
Cho, Samuel K.	47, 369, 541, 613
Cho, Woojin	46, 47, 56, 92, 316, 390, 396, 474, 478, 482, 541, 613, 721
Choi, Dae Jung	117
Choi, Seung-Hyun	54, 99
Choma, Theodore J.	413
Chou, Dean	441
Chu, Alice	536
Chua, Beverly	579
Chung, Chun Kee	110, 111, 414, 637, 698, 743
Chung, Jae-Yoon	420
Chung, YoungKey	703
Cimen, Osman	619, 713
Cioni, Alfredo	247
Clegg, Travis	358
Clement, Jean-Luc	299, 435, 437
Clements, David H.	278
Coe, Jeffrey D.	96, 528
Cohen, David B.	311
Colacchio, Nicholas D.	89, 90
Cole, Ashley A.	438
Collignon, Frederic	562
Complex Spine Study Group	88, 235, 283, 310, 312, 320, 517, 575, 576, 627, 668, 670, 681
Connolly, Patrick J.	386, 483
Cook, Christina	561, 606
Cook, Dennis T.	233
Cook, P. Christopher	513
Copas, David P.	226, 491, 507
Corcoran-Schwartz, Ian	578
Cordell, Davin	337, 526
Cornwall, G. Bryan	602
Corona, Jacqueline	587
Corrado, Romina	588, 643
Coussement, Alain	437
Coutinho, Etevaldo	8, 115, 122, 240, 281, 282, 315, 333, 412, 692
Covington, Lisa	325
Craig, Niall J.	562
Crandall, Dennis	11, 64, 67, 287, 314, 354, 383, 458, 532, 663
Crawford, Charles H.	69, 362, 365
Crawford, Neil R.	555
Cripton, Peter A.	442, 469, 579
Cronk, Katharine	125, 465
Cross, Jessica D.	102, 734
Crowder, Terrence	64, 67, 287, 354, 383, 532
Cuddihy, Laury A.	560, 741
Cui, Guanyu	584
Cunha, Cunha A.	600
Cunningham, Bryan W.	488
Cunningham, Matthew E.	88, 235, 283, 310, 468, 575, 576, 681
Curry, E. Patrick	78
Da Silva, Manuel	97, 99, 731
Dahia, Chitra L.	389, 552
Dahl, Benny	1A, 108
Daines, Brian K.	730
Dakwar, Elias	352, 675, 701, 702
d'Amato, Charles R.	20, 285, 453
Daniels, Eldra W.	537, 538
Dannawi, Zaher	75, 306
Dansereau, Jean	718
Darwish, Ashraf	334
Datta, Jason	64, 67, 287, 354, 383, 532
Davis, Kenneth E.	742
Davis, Reginald J.	72, 592
Day, Jessica	276
De Blas, Gema	31, 32, 433, 585
Defino, Helton	38

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Deinlein, Donald A.	96, 517
Dekutoski, Mark B.	5, 7, 106, 119, 119, 294
del Cura, Maria Soledad	32, 417, 433
Deluzio, Kevin J.	398
Demakakos, Jason	318, 322, 440
Demura, Satoru	232
Deore, Tushar	460
DeVine, John G.	118, 120, 202, 216
Deviren, Vedat	9, 49, 319, 402, 439, 440, 441, 666
DeWald, Christopher J.	96
Dhall, Sanjay S.	44
Di Silvestre, Mario	247, 304, 452, 700
Diamond, Beverly E.	229, 273
Diaz, Fernando G.	561, 606
Dibra, Florian	471
Dickson, Douglas D.	48, 51
Diefenbach, Christopher	330
Dimar, John R.	1A, 5B, 69, 121
DiPaola, Christian P.	450, 483
Disch, Alexander C.	548
Djurasovic, Mladen	65, 68, 69, 217
Dmitriev, Anton E.	384, 518, 554, 669, 671
Doan, Josh.	84, 470, 673
Dolan, Lori A.	83
Domenech, Pedro	417, 445, 500, 705
Dominguez, Felix	555
Donald, Gordon	517
Donaldson, William F.	328
Dorward, Ian G.	316, 478, 541, 613
Downs, Jennepher.	587
Driscoll, Mark	73, 258
Druschel, Claudia	548
Dryer, Joseph W.	1
Dubousset, Jean	559
Duda, Slawomir	286, 635
Dunn, Robert N.	641
Durrani, Atiq.	52, 691
Dvorak, Marcel F.	450, 593
Eastlack, Robert K.	4, 672
Eck, Jason C.	328, 386, 483
Eder, Claudia	375, 459, 514
Edwards, Asher	63
Ege, Tolga	682
Egge, Natalie	386, 483
Egorova, Natalia N.	369
Eif, Marcus.	640
Eisler, Jesse G.	506, 596
El Dafrawy, Mostafa H.	50, 98, 252, 311
El Hawary, Youssry	308, 367, 436, 621
Eleraky, Mohammed	114, 206
El-Hawary, Ron	20, 453, 461, 513, 656
Elie, Caroline	87
ElMiligui, Yasser	58, 59, 100, 290, 419, 431, 449, 519, 624, 645
ElSaghir, Hesham	39, 107
Elsebaie, Hazem B.	75, 306
El-Sharkawi, Mohammad M.	58, 59, 100, 290, 419, 449, 519, 624, 645
Emans, John B.	339, 451, 480
Enercan, Meric	12, 35, 55, 101, 219, 291, 302, 400
Enguidanos, Stephen T.	506, 596
Erickson, Mark A.	89
Erni, Caroline	560, 741
Errico, Thomas	1, 72, 250, 313, 665
Ersen, Omer	570
Eskander, Mark S.	386
Eyster, Edward F.	558
Ezzati, Ali	39, 738
Fairbank, Jeremy C.	720
Falkner, Erwin	514
Farcy, Jean-Pierre C.	665
Farley, Frances A.	594
Farnsworth, Christine L.	470, 673
Fazal, Akil	431
Fehlings, Michael	5, 7, 38, 106, 119, 119, 294, 540
Fekete, Tamas	685
Feldman, David S.	536
Feldman, Debbie E.	716
Feng, Bin.	729
Feng, Frank	689
Ferguson, Joseph	63
Fernández-Baillo, Nicomedes	81
Ferrara, Lisa.	472
Ferraris, Luis	40, 80, 477, 529, 553
Fessler, Richard G.	531
Field, Justin	534
Fine, Anthony.	63
Finkelstein, Joel	5
Fiore, Steven M.	684
Fischer, Charla R.	299
Fisher, Charles G.	5, 450
Fleischer, Gary D.	472
Fletcher, Terry.	604
Flinn, Phillip O.	714
Flint, Kathy	742
Flippin, Michael	443

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Flynn, John M.	338
Focos Organization	235, 283, 310, 575, 681
Fox, Richard	693
France, John C.	106
Francheri Wilson, Ida Alejandra	588, 643
Franklin, Patricia	386
Fransen, Patrick	332, 562
Freeborn, Mark A.	37
Freedman, Brett A.	361
Freeman, Andrew L.	472, 601
French, Keisha	537, 538
Frerich, Jason M.	523
Fu, Kai-Ming	46, 92, 93, 390, 396, 474, 482, 721
Fujii, Atsushi	567
Fujisaki, Kazuhiro	516
Fukuda, Kentaro	712
Gabos, Peter G.	20, 78, 453
Gaines, Robert W.	128
Gala, Vishal	394
Galaretto, Eduardo	588, 643
Gallego Rivera, Jose Ignacio	433
Gambassi, Melanie	280, 722
Gao, Qile	598
Gao, Yubo	103, 368, 403
García Fernández, Alfredo	81
Gardner, Adrian	336
Garg, Bhavuk	126, 521, 572
Garg, Hitesh	300
Garg, Sumeet	423
Gargas, Jessie	132
Garibo, Felipe	66
Garrido, Enrique	77
Garton, Hugh	594
Garvey, Timothy A.	45
Gates, Marilyn	517
Gaughan, John	288, 687
Gaume, Rachel E.	263, 518, 554, 671
Gautam, Nischal K.	604
Gebhardt, Melissa	383
Gehrchen, Martin	108
Geisler, Fred H.	118, 120, 202, 216
Gelb, Daniel E.	17
Geoffray, Anne M.	437
George, Keri	288, 687
Gerber, Edward J.	224, 399, 489, 610, 695
Ghosh, Jay D.	623, 655
Giannoulis, Kyriakos E.	109, 421
Gibson, Alex	306
Giglio, Giancarlo	545
Gilder, Kye	118, 120, 202, 216
Gilotra, Mohit	17
Giorgio, Paul A.	10
Girardi, Federico P.	13, 117, 289, 346, 381, 511, 667
Girres, Pamela	394
Gjolaj, Joseph P.	61, 311, 543, 616
Glaser, Diana A.	84, 221, 470, 673
Glaser, John	390, 396, 474, 482, 721
Glassman, Steven D.	3A, 65, 68, 69, 121, 124, 217, 242, 246, 250, 251, 318, 427, 457
Glorion, Christophe	42, 87
Gnanapradeep, Gnanapragasam	103, 368, 403
Godbey, Tamara	579
Godde, Gregor	562
Gogia, Jaspaul	88, 312, 576
Goh, Tae Sik	295, 566, 649
Gokaslan, Ziya L.	5, 7, 106, 119, 119, 294
Goldstein, Jeffrey A.	5A, 43
Goldstein, Sergey	409, 707
Gordon, Zachary L.	537, 538
Gorenstein, Joel	560, 741
Goulet, Lise	716
Graf, Adam	231
Grauer, Jonathan N.	279
Gray, Gordon T.	579
Greggi, Tiziana	247, 304, 452
Greiner, Bernhard F.	374
Grenier, Eric	102, 734
Gressot, Loyola V.	243, 632
Grevitt, Michael	438, 490, 549
Grewal, Harsh	278
Griffith, Cullen	17
Grimard, Guy	71
Grimm, Dulce H.	600
Gross, Richard H.	454
Grossman, Joshua	298, 636
Grossman, Seth A.	16, 736
Growing Spine Study Group	336, 339, 451, 480
Guevara, Ben	104
Guidera, Kenneth J.	86, 284
Guillory, Steve A.	524
Guixing, Qiu	377
Gum, Jeffrey L.	242
Guo, Chaofeng	307, 499
Gupta, Ankit	521, 572

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Gupta, Munish C.	95, 283, 299, 310, 439, 505, 510, 681
Gupta, Purnendu	231
Guyer, Richard D.	3A, 201, 257, 334, 359, 533
Gwinn, David E.	456
Ha, Sang-Soo	215
Haas, Norbert	548
Hadgoankar, Shailesh	710
Hai, Yong	350
Haid, Regis W.	44
Halm, Henry	2C, 5C
Hamed, Abla	308, 367, 436, 621
Hammerberg, Kim W.	231, 276, 416
Hamzaoglu, Azmi	3B, 4A, 12, 35, 55, 101, 219, 291, 302, 400
Hansen, Lars V.	108
Hansen-Algenstaedt, Nils	612
Hanson, Beate	540
Hanson, Darrell S.	210
Hanulewicz, Pawel	256
Hardenbrook, Mitchell	481
Hardesty, Christina	238, 629, 717
Harms, Jurgen	130, 486, 685
Harms Study Group	232, 401
Harris, Colin	20, 453
Harris, Gerald F.	231
Harrison, Alicia	293
Harrison, Dale	604
Harrop, James S.	2D, 4A
Hart, Robert A.	94, 439, 440, 502, 505, 666
Harten, Robert	468
Hartl, Roger	106, 539
Haruo, Misawa	467, 564, 599
Haschtmann, Daniel	685
Hasegawa, Tomohiko	723
Hashidate, Hiroyuki	422, 473, 625, 657
Hassani, Sahar	231, 416
Hassanzadeh, Hamid	50, 83, 98, 249, 252, 311, 408, 660, 724
Hauger, Olivier	559
Haynes, Paul	129
Hecht, Andrew C.	369
Hedden, Douglas	461, 656
Hee, Hwan Tak	424, 425
Helenius, Ilkka	62, 340
Helgeson, Melvin	669
Heller, Joshua E.	46, 92, 278, 390, 396, 474, 482, 721
Hempfing, Axel	80, 509, 553, 623
Hennessy, Michael W.	23
Hensinger, Robert N.	594
Hershman, Stuart	536
Hertzler, Kristen	523
Hess, W. F.	235, 283, 310, 681
Hevia, Eduardo	31, 32, 66, 417, 433, 445, 500, 585, 705
Highsmith, Jason M.	44
Hilibrand, Alan S.	2A
Hipps, Sarah	394
Hirabayashi, Hiroki	422, 473, 625, 657
Hirano, Toru	335
Hitzl, Wolfgang	40, 79, 80, 475, 477, 509
Hoashi, Jane S.	500, 705
Hoelscher, Christian M.	1, 43, 250, 313, 479
Hoernschemeyer, Daniel G.	210
Hofstetter, Christoph	539
Hong, Chang Hwa	404
Hong, Jae-Young	236, 429, 430, 622
Hopkins, Jeffrey	423
Hopton-Jones, Jennifer	565
Horan, Michael P.	325
Horn, Jonathan J.	129, 280, 298, 378, 448, 636, 722
Hoskins, Jonathan A.	347, 487
Hosogane, Naobumi	15, 36, 254, 428, 447, 501, 712
Hostin, Richard	95, 439, 440, 505, 510
Howard, Jason J.	461, 656
Howell, Kelli M.	118, 120, 202, 216
Hsu, Joseph R.	102, 734
Hu, Guangxun	267, 268, 541
Hu, Nianbin	488
Hu, Serena S.	3A, 5B, 49, 402, 404, 441
Huh, Jeannie	372
Huish, Eric	64, 287, 458
Huncke, Tessa	1
Hung, Vivian WY	82, 569
Hwang, Chang Ju	262
Hwang, Jang Hoe	590
Hwang, Steven	63, 243, 418, 632, 704
Hyder, Zeshan	359
Hyman, Joshua E.	325
Ialenti, Marc N.	665
Ibrahim, Kamal N.	4B
Idler, Cary	611
Ignacio, Jose Manuel	558
Ilharreborde, Brice	205, 495, 522
Imagama, Shiro	335, 711
Inami, Satoshi	91, 360, 661
International Spine Study Group	94, 95, 439, 440, 502, 505, 510, 666
Inui, Yoshihiro	343, 426

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Isaza, Jorge E.	524
Ishiguro, Naoki	711
Ishii, Ken	15, 447
Issack, Paul	407
Ito, Kenyu	264
Ito, Manabu	266, 335, 357, 380, 516, 647
Ito, Yasuo	709
Iwai, Chizuo	91, 360, 661
Iwanik, Michael	390, 396, 474, 482, 721
Iwasaki, Norimasa	380
Iwata, Akira	266, 357, 380, 516, 647
Izatt, Maree T.	85
Jackson, Keith L.	361
Jackson, Robert S.	212
Jackson, Roger P.	259
Jahng, Tae-Ahn	111, 414, 637, 698, 743
Jain, Akshay	460
Jain, Amit	83, 98, 249, 252, 311, 660, 724
Jalanko, Tuomas	62
James, Andrew R.	539
Janssen, Michael	7, 119, 119, 294
Jaquith, Bradley P.	714
Jarzem, Peter	6, 461, 656
Jasiewicz, Barbara M.	573
Jayaswal, Arvind	126, 521, 572
Jea, Andrew	243, 418, 632, 704
Jeffries, Joel T.	413
Jenkins, Tyler	413
Jeon, Jae-Min	54, 99
Jeszenszky, Dezsoe J.	685
Ji, Mingliang	349, 492
Jiang, Hongxing	693
Jiang, Hua	349
Jiang, Jun	434, 492
Jianguo, Zhang	60, 377, 393
Jimbo, Shizuo	680
Jiménez, Daniel	417, 433
Jodoin-Fontaine, Xavier	259
Johnston, Charles E.	480, 587
Jones, Claire F.	442, 469, 579
Joo, Yong Bum	245, 355, 376, 662, 732
Joshi, Ajeya P.	337, 526
Kabaei, Farzin	16, 736
Kabir, Koroush	14
Kabirian, Nima	4, 75, 336, 339, 480
Kadaba, Murali P.	458, 641
Kahwaty, Sheila	53
Kajiyama, Glen	578
Kakarla, Udaya K.	351
Kakis, Anthony	441
Kakutani, Kenichiro	426
Kalb, Samuel	351, 465
Kale, Shashank S.	38
Kandwal, Pankaj	521, 572
Kang, Daniel G.	102, 263, 456, 496, 554, 669, 734
Kang, James D.	328
Kang, Kevin K.	463
Kang, Kyu-Bok	356
Kang, Matthew M.	47, 541, 613
Kanu, Okezika	293
Kapsokavathis, Michael	481
Karadeniz, Emre	12, 35, 291
Karadereler, Selhan	55, 219
Karahalios, Dean G.	555
Karaikovic, Eldin E.	128
Karellas, Andrew	483
Kathare, Ambadas	337
Kato, Hiroyuki	422, 473, 625, 657
Kato, Nakayuki	91, 360, 661
Kawakami, Noriaki	264, 335, 370, 659
Kawamura, Ryuhei	595
Kaygusuz, Mehmet A.	619, 713, 740
Kebaish, Khaled	1C, 3C, 5D, 50, 83, 95, 98, 112, 249, 252, 311, 320, 408, 440, 484, 517, 660, 666, 724
Keller, Christian	16, 736
Kelly, Derek M.	104, 714
Kelly, Michael P.	113, 406, 484
Kepler, Christopher K.	471
Keshavarzi, Sassan	49, 319
Khajavi, Kaveh	253
Khan, Safdar N.	487, 597
Khandehroo, Babak	53
Khanna, Sandeep	132
Khurjekar, Ketan	710
Killebrew, Pamela M.	604
Killian, John T.	565
Kim, Chi Heon	110, 111, 414, 637, 698, 743
Kim, Dong Hyun	590
Kim, Han Jo	235, 283, 310, 431, 575, 681
Kim, Jae Keon	590
Kim, Jin-Hyok	54, 99
Kim, Kyle	394
Kim, Sung-Kyu	420

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Kim, Sung-Soo	54, 99
Kim, Whoan Jeang	420
Kim, Yongjung J.	133, 299, 356, 435, 472
Kim, Youngbae B.	356
King, Akilah B.	88, 235, 320, 407, 431, 575, 576, 631
King, Joseph	63
Kleinstueck, Frank S.	685
Klezl, Zdenek	391
Klineberg, Eric	95, 439, 510
Klooster, Klaas V.	490
Knight, Reginald Q.	353, 494
Knott, Patrick	248, 523, 683
Kobayashi, Sho	723
Kobayashi, Tetsuya	476, 557, 680
Koca, Kenan	570
Koester, Linda	24, 48, 80, 267, 268, 275, 316, 348, 406, 541, 613
Koivusalo, Antti	62
Kojima, Atsushi	567
Koller, Heiko	40, 79, 80, 392, 475, 477, 509, 529, 553, 623
Kono, Hitoshi	254, 712
Kopjar, Branko	5, 7, 38, 106, 119, 119, 294, 540
Koptan, Wael	58, 59, 100, 290, 419, 431, 449, 519, 624, 645
Korkmaz, Fatih	219, 400
Korn, Gundobert	392
Korovessis, Panagiotis	609
Koshimune, Koichiro	709
Koski, Tyler	1D, 664, 686
Kostial, Pat	443
Kostuik, John P.	98, 320
Kotani, Toshiaki	370, 583, 659
Kotani, Yoshihisa	266, 357, 380, 516, 647
Kotwal, Suhel	346, 381, 511, 667
Krajbich, Ian M.	577
Krajbich, Joseph I.	576, 577
Krebs, Stefan	374
Krengel, Walter F.	730
Kretzer, Ryan M.	488
Kruk, Peter	132
Kryl, Jan	260, 391
Krzak, Joseph	231
Kuhns, Craig	413, 504
Kulkarni, Preethi M.	129, 280, 298, 378, 448, 722
Kuong, Evelyn E.	74
Kuraishi, Shugo	657
Kurakawa, Takuto	426
Kurklu, Mustafa	682
Kwon, Brian K.	2A, 4A, 442, 450, 469, 579, 735
Kyllönen, Krister	340
La Marca, Frank	580, 706
La Rosa, Guido	545
Labelle, Hubert	1A, 2B, 1, 34, 71, 259, 296, 462, 582, 716, 718
Labrom, Robert D.	85
Lafage, Renaud	322
Lafage, Virginie	90, 94, 95, 96, 250, 251, 313, 318, 322, 439, 440, 502, 505
Laheri, Vinod	327
Lai, Sue Min	666
Lam, Clarrie K.	735
Lam, Tsz-ping	82, 213, 569, 571
Lambat, Manish	124
Lamos, Nora	685
Lange, Jeffrey	386, 483
Lao, Lifeng	679
Lapinsky, Anthony S.	483
Larson, A. Noelle	86, 265, 284, 345, 395
Lauryssen, Carl	279
Lavine, Steve	394
Le, Jason T.	390, 396, 474, 482, 721
Lebl, Darren R.	13, 88, 117, 289, 346, 381, 511, 576, 667
Ledonio, Charles Gerald T.	86, 265, 284, 345, 395
Lee, Amy I.	531
Lee, Chong C.	394
Lee, Choon Sung	262
Lee, Christopher	22
Lee, Chul-Woo	215
Lee, Dong-Chan	590
Lee, Dong-Ho	3, 56, 262, 275
Lee, Jae H.	442, 579, 735
Lee, June Kyu	245, 355, 376, 662, 732
Lee, Jung Sub	295, 566, 649
Lee, Kwong Man	33, 82, 213, 569, 571
Lee, Mark C.	719
Lee, Michael J.	37, 387
Lee, Samantha M.	13, 117
Lee, Sang-Ho	215
Lee, Seung-Won	356
Lee, Soo Eun	110, 111, 414, 637, 698, 743
Legakis, Julie	703
Legatt, Alan	16, 736
Lehman, Ronald A.	102, 263, 296, 366, 384, 456, 496, 518, 554, 669, 671, 734
Lehmann, Charles L.	542
Lehmen, Jeffrey A.	224, 398, 399, 489, 504, 610, 695
Lenke, Lawrence G.	2C, 3C, 2, 3, 24, 51, 80, 89, 133,

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
	259, 263, 267, 268, 275, 296, 316, 342, 348, 362, 366, 406, 427, 446, 496, 503, 541, 613
Leong, Julian J.	306
Leroux, Julien	34
Letko, Lynn J.	130, 486
Leveque, Jean-Christophe	394
Lewis, Stephen	2B, 409, 461, 656, 707
Li, Ming	228, 277, 301, 432, 497, 618, 626
Li, Tao	116, 127, 218, 589, 644
Li, Weishi	512
Liao, ChenDi	569
Lieberman, Isador	4C, 5B, 485
Lim, Dong Hwan	590
Lim, Dong-Ju	54, 99
Lim, Jong Min	295, 566, 649
Lin, Chia-Ying	580
Line, Breton	502, 505
Liu, Catherine	441
Liu, Gabriel	424, 425, 498
Liu, Hong	45
Liu, Jiaming	309
Liu, Jie	735
Liu, John C.	686
Liu, Zhen	220
Lolli, Francesco	247, 304, 452, 700
Londino, Joanne A.	654
Long, Andrea	210
Lonner, Baron S.	1, 225, 227, 250, 271, 283, 297, 300, 310, 313, 326, 431, 505, 665, 681
Lozano-Calderon, Santiago A.	405
Lucio, John	398
Ludwig, Steven	3D, 4D, 17
Luhmann, Scott J.	24, 342
Luk, Keith D.	74
Lumawig, Jose Miguel T.	583
Luna, Jeffrey T.	508
Lurie, Jon D.	463
Luszczyk, Myles	547
Ma, Weiwei	220, 349, 658
Machida, Masafumi	712
Mackenzie, W.G. Stuart	89, 325
Mac-Thiong, Jean-Marc	34, 71, 296, 462
Maestretti, Gianluca	332
Magana, Sofia	409, 707
Mahar, Andrew T.	237, 279, 443
Maher, Cormac O.	594
Mahoney, Eric	389, 552
Makris, Christopher	25
Mangov, Andriy	527
Marchi, Luis	8, 115, 122, 240, 281, 282, 315, 333, 412, 692
Mardjetko, Steven M.	1D, 248, 416, 523, 683
Maredi, Elena	304, 452
Marino, James F.	672
Markova, Dessislava Z.	471
Marks, David S.	1B, 5C, 336
Marks, Michelle C.	61, 234, 241, 271, 297, 300, 373, 543, 616
Martikos, Konstantinos	247, 304, 452, 700
Martirosyan, Nikolay	125, 465
Maruenda, Jose I.	66, 433, 445, 500
Marulanda, German	18, 261
Masashi, Saito	712
Masato, Tanaka	467, 564, 599
Mason, Jonathan R.	46
Masrouha, Karim Z.	83
Massie, Jennie	237
Mather, Steven E.	690
Matsumoto, Hiroko	89, 90, 325, 338
Matsumoto, Morio	15, 36, 254, 335, 370, 428, 447, 501, 584, 659
Matsuno, Takeo	476
Matsuyama, Yukihiro	711, 723
Mayberry, Sharon K.	565
Mayer, Michael	79, 392, 475, 477, 509, 623
Mayle, Robert E.	578
Mazaki, Tetsuro	564
Mazda, Keyvan	205, 495, 522
Mazel, Christian	694
McAfee, Paul C.	118, 120, 202, 216
McCarthy, Richard E.	1B, 3B, 5C, 26, 26, 105, 339, 604, 651
McClung, Anna	273, 372, 423, 446, 568
McCormack, Bruce	558
McCullough, Frances	26, 26
McElroy, Mark	451
McLemore, Ryan	64, 67, 287, 354, 383, 458, 532, 663
Mehdian, Hossein	96, 226, 491, 507
Mehta, Jwalant S.	128, 226, 491, 507
Meier, Oliver	40, 79, 80, 477, 509, 529, 553, 623
Meissner, Jochen	375, 514
Melamed, Hooman M.	697
Melcher, Ingo	548
Mendelow, Michael J.	235, 283, 575, 681
Mendelsohn, Audra	686
Mendoza-Lattes, Sergio A.	103, 368, 403
Merino, Ignacio	381, 667
Mesfin, Addisu	83, 98, 112, 252, 484, 724

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Meyers, Bryan F.	113
Mezentsev, Andriy	527
Mhaidli, Hani	517
Mhatre, Devdatt	10
Mickelson, Jennie B.	134, 285, 678
Mielke, Cary H.	86, 284
Miladi, Lotfi	42
Milby, Andrew H.	592
Miller, Daniel J.	587
Miller, Larry E.	699
Min, Kan	128
Min, Woo-Kie	3, 133, 267, 275
Minami, Akio	266, 357, 380, 647
Minami, Shohei	335, 370, 583, 659
Mishiro, Takuya	24
Mistur, Rachel	52, 691
Miyamoto, Hiroshi	343, 426
Miyamoto, Takeshi	15
Miyanji, Firoz	234, 300
MIyasaka, Kazuyoshi	264
Mizuno, Shoichiro	709
Mo, Fred	117, 289, 468
Moal, Bertrand	322
Moazzaz, Payam	4
Mobasser, Jean-Pierre	742
Modhia, Urvij M.	123
Modi, Hitesh N.	236, 429, 430, 707
Mohamed, Ahmed S.	83, 244
Molina, Camilo A.	488
Molloy, Sean	1C
Montes, Elena	31, 32, 433, 585
Moraes, Osmar	38
Morales, Dianna C.	70, 230, 373, 431, 581
Moreau, Alain	33, 73
Moreau, Sebastien	205
Morelli, Daniele	562
Morgen, Søren S.	108
Morioka, Shigeta	567
Moroz, Paul J.	461, 656
Moskowitz, Alan	369
Moss, Isaac L.	416
Mossaad, Mohamed M.	244
Moulton, Andrew W.	405
Moumene, Missoum	515
Mukaiyama, Keijiro	422, 473, 625, 657
Mukhin, Michael	84
Mulpuri, Kishore	234
Mummaneni, Praveen V.	3D, 5A, 44, 441, 502
Mundis, Gregory M.	4, 23, 95, 319, 336, 339, 439, 480, 502, 666, 672
Murakami, Hideki	239, 595, 620
Murray, Gisela	352, 675, 701, 702
Murray, Heather	696
Murtagh, Ryan	18, 261
Mutchnick, Ian	358
Myung, Karen S.	22
Nabb, Colin E.	56
Nagahama, Ken	266, 357, 380, 516, 647
Nagaya, Shigeyuki	583
Nagineni, Vamsi V.	539
Nakai, Sadaaki	222
Nakakohji, Taku	650
Nakamichi, Kiyohiro	712
Nakamura, Hiroaki	455, 733
Nakamura, Masaya	15, 447
Nakamura, Yutaka	3, 80, 267, 275
Nakanishi, Kazuo	639
Namikawa, Takashi	91, 360, 661
Nandipati, Chaitanya	221
Narayanan, Unni G.	61, 543
Naresh-Babu, J.	269, 739
Nash, Rachel C.	103, 368, 403
Nassr, Ahmad N.	328
Natali, Colin	77
Navarro, Ramon	705
Nayak, Aniruddh	18, 261, 556, 737
Neal, Chris J.	361
Neiss, Geraldine I.	78
Nel, Louis	641
Nelson, Lesa M.	28, 30, 233
Nene, Abhay	292, 726
Nesnidal, Petr	260, 391
Neubauer, Philip	50, 616, 660, 724
Newell, Robyn	442
Newton, Peter O.	1D, 2B, 10, 61, 84, 221, 225, 227, 232, 234, 241, 259, 271, 297, 300, 326, 341, 401, 470, 543, 605, 616, 673
Ng, Bobby KW	82, 213, 569
Nguyen, Quynh T.	37
Nichols, Amy D.	441
Nicola, Hazem	97, 99, 731
Niki, Yasuo	15
Ning, Yuan	267
Nishida, Kotaro	426

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Nnadi, Colin	720, 720
Noel, Mariano A.	588, 643
Nohara, Ayato	264
Nohara, Yutaka	91, 360, 661
Noonan, Vanessa	593
Noordeen, Hilali H.	3B, 75, 77, 306
Noriega, David C.	612
Novicoff, Wendy	46
Nugent, Matthew	354
Nunez, Susanna	623
Nunn, Thomas	221
O'Brien, Michael F.	1D, 95
O'Shaughnessy, Brian A.	1D, 5D
Obeid, Ibrahim	522, 559
Odent, Thierry	42, 87
Oggiano, Leonardo	545
Ogihara, Nobuhide	422, 473, 625, 657
Ogilvie, James W.	28, 30
Ogon, Michael	375, 459, 514
Oguz, Erbil	570
Ohara, Tetsuya	264
Ohashi, Hideki	709
Ohlin, Acke	586
Ohnmeiss, Donna	201, 257, 334, 359, 485, 533
Okada, Eijiro	36, 402, 441, 501, 584
Okon, Elena B.	579
Olivar, Stephen J.	394
Oliveira, Leonardo	8, 115, 122, 240, 281, 282, 315, 333, 412, 692
Onay, Daniel	731
Ono, Takashi	574
Osei, Nana	77
Oshiba, Hiroyuki	422
Oshima, Yasushi	574
Otte, John F.	601
Owens, Roger K.	65
Oxland, Thomas	696
Ozaki, Toshifumi	564
Ozkan, Huseyin	682
Ozturk, Cagatay	12, 35, 55, 101, 219, 291, 302, 400
Pade, Kathryn	210
Padovani, Jean-Paul	87
Pahys, Joshua M.	47, 541, 613
Paik, Haines	263, 518, 554, 671
Pajulo, Olli T.	340
Pakarinen, Mikko P.	62
Paonessa, Kenneth J.	235, 283, 310, 517, 681
Papadopoulos, Elias C.	681
Papanastassiou, Ioannis	6, 114, 206
Paquette, Scott	450
Pardaev, Said	527
Parent, Stefan	11, 34, 71, 73, 258, 259, 296, 582, 716
Park, Choonkeun	590
Park, Don Y.	578
Park, Hoon-seok	117
Park, Moon Soo	3, 275
Park, So Eyun	735
Park, Soo-An	262
Patel, Archit	719
Patel, Tarak	460
Patel, Vishal C.	405
Patterson, G. Alexander	113
Patterson, Jason	64, 287
Patzkowski, Jeanne C.	102, 734
Pawar, Abhijit	462
Pawelek, Jeff	4, 23, 336, 339, 451, 480
Pekmezci, Murat	319
Pellise, Ferran	310, 431, 681
Peltonen, Jari	62, 340
Penneçot, Georges-françois	205
Persohn, Sylvain	694
Petcharaporn, Maty	241, 271, 297
Petilon, Julio	121
Petrenko, Dmytro	527
Pfeiffer, Ferris M.	413
Pflugmacher, Robert	6, 321
Phelps, Jeff	535
Phillips, Frank M.	118, 120, 202, 206, 216, 237
Pierce, Carol	604
Pierce, William	135
Pimenta, Luiz	5B, 8, 97, 115, 122, 240, 281, 282, 315, 333, 412, 602, 692
Pirnia, Nicholas	329
Piza Vallespir, Gabriel	31, 417, 445, 500, 705
Ploumis, Avraam	45
Plunet, Ward T.	735
Poe-Kochert, Connie	27, 238, 629, 717
Poitras, Benoit	71
Polly, David W.	86, 265, 284, 293, 345, 395, 508
Ponnappan, Ravi K.	328, 471
Poochoon, Joan	394
Potaczek, Tomasz	286, 573, 635
Potdar, Prabodhan P.	327
Poteet-Schwartz, K.	604
Prasad, Gautam R.	460

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Prodhan, Parthak	105
Protopsaltis, Themistocles	479
Pugely, Andrew	403
Pumberger, Matthias	289, 312, 346, 381, 511, 667
Puno, Rolando M.	358
Puri, Rehan	52
Purushothamdas, Sanjay	109, 549
Qian, Bangping	220, 349, 364, 434, 492, 520, 634
Qiu, Guixing	29, 303, 679
Qiu, Xu-sheng	658
Qiu, Yong	33, 220, 349, 364, 434, 492, 520, 571, 634, 658
Queinnec, Steffen	495
Quraishi, Nasir A.	109, 421, 549
Qureshi, Sheeraz A.	369
Rahm, Mark D.	517, 576
Rahman, Ra'Kerry K.	342
Rahman, Shayan	580, 706
Rahn, Kevin	630
Ramachandran Nair, Krishna Kumar	715
Ramadan, Mohamed O.	59, 100, 431, 624
Ramani, Easwar T.	622
Ramo, Brandon A.	305
Raso, V. James	353, 494
Rathi, Prasanna C.	727
Rawall, Saurabh	292, 726
Razi, Afshin E.	463
Reah, Christopher J.	118, 120, 202
Redding, Greg	25
Regidor, Ignacio	31, 32, 585
Reigrut, Julie	517
Reiley, Mark	223
Reis, Abiliio A.	387
Repantis, Thomas	609
Resch, Herbert	79, 392, 475, 509
Resnick, Daniel K.	457
Revella, Jan	64, 67, 287, 314, 354, 383, 532, 663
Reyes, Phillip M.	555
Reynolds, Richard A.	703
Rhines, Laurence	5
Ricart-Hoffiz, Pedro A.	43, 330, 479, 665
Richards, B. Stephens	2B, 5D, 89, 305, 362, 366
Richardson, Shawn	246
Ries, Zachary	103, 368
Riew, K. Daniel	2, 56, 542
Riina, Joseph	742
Rintala, Risto	62
Riordan, Anne	276
Riordan, Mary	231
Riouallon, Guillaume	87
Riquelme-García, Oscar	445
Ritumalta, Emelito V.	424, 425
Riviere, Paul	322
Robert, Andreas M.	374
Robinson, Stephanie	212
Rocha, Luiz E.	600
Rodgers, Jody A.	224, 398, 399, 489, 610, 695
Rodgers, William B.	224, 398, 399, 489, 610, 695
Rodts, Gerald E.	44
Rosenfeld, Samuel R.	544
Rosner, Michael	554, 686
Ross, David	135
Ross, Thomas	312
Rout, Rajesh	720
Roy-Beaudry, Marjolaine	716
Roye, Benjamin D.	325
Roye, David P.	89, 90, 325, 338, 587
Rudolf, Leonard	223
Ruehlman, Dana	481
Ruf, Michael	486
Rundell, Steve A.	256, 525
Rupp, Steve	394
Russo, Anthony	37
Ryan, Stewart	481
Sacramento Dominguez, Maria Cristina	283, 310, 681
Said, Galal Z.	419
Saiman, Lisa	325
Saito, Masashi	254
Saito, Toshiki	264
Salminen, Päivi M.	62
Sama, Andrew A.	346, 381, 667
Samagh, Sanjum P.	344
Samartzis, Dino	74
Samdani, Amer F.	20, 61, 63, 225, 234, 278, 288, 300, 326, 373, 453, 543, 687
Samocha, Yigal	201
Sancheti, Parag K.	710
Sánchez Márquez, José Miguel	81
Sánchez Pérez-Grueso, Francisco Javier	4B, 81, 283, 310, 490, 681
Sanders, James O.	83, 89, 229, 353, 427, 494
Sanpera, Ignacio	417, 445, 705
Santoni, Brandon G.	261, 556, 737
Santos, Edward Rainier G.	86, 265, 284, 293, 345, 395, 508
Sarier, Mercan	55, 219
Sarwahi, Vishal	16, 129, 280, 298, 378, 448, 636, 722, 736

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Sasao, Yutaka	567
Sasso, Rick C.	2A, 7, 106, 119, 119, 294
Sato, Michiyoshi	264
Saunders, James T.	597
Sawyer, Jeffrey R.	104, 714
Scerrati, Massimo	38
Schaser, Klaus-Dieter	548
Schätz, Christoph R.	374
Schechtman, Kenneth	6
Scheer, Justin K.	9
Schlechter, John	232, 544
Schmidt, John A.	627, 668, 670
Schmidt, Kenneth	67, 532
Schmit, Pierre.	513
Schmitz, Michael L.	604
Schoenfeld, Andrew J.	102, 734
Schroerlucke, Samuel	672
Schuller, Sébastien	466
Schulte, Caitlin	241
Schuster, James	5
Schwab, Frank J.	1C, 2C, 3C, 90, 94, 95, 96, 250, 251, 313, 318, 322, 439, 440, 502, 505, 665
Schwartz, David G.	676, 742
Schweitzer, Mark E.	640
Schwend, Richard M.	627, 668, 670
Schwender, James D.	45
Sears, William R.	464
Sehirlioglu, Ali	570, 682
Sehn, Jennifer K.	56
Seim, Howard B.	481
Sembrano, Jonathan N.	86, 265, 284, 293, 345, 395, 508
Seme, Steven J.	601
Sengupta, Dilip K.	353, 494
Senoo, Issei	476
Seo, Hyoung-Yeon.	420
Serhan, Hassan	10, 488
Sethi, Rajiv K.	394
Shaffrey, Christopher I.	3C, 7, 46, 92, 93, 94, 96, 106, 119, 119, 294, 439, 440, 502, 505, 666
Shafik, Fady S.	449, 519
Shah, Suken A.	3B, 4B, 5D, 61, 78, 128, 225, 227, 234, 271, 297, 300, 326, 480, 543, 601, 616
Shanti, Nael	52, 691
Shao, Xiang	220
Shaw, M.	306
Shawky, Ahmed	546
Sheha, Evan D.	90
Shen, Francis H.	46, 390, 396, 474, 482, 721
Shen, Jianxiong	29, 57, 309, 377, 679, 729
Shen, Michael	463
Shengru, Wang	60
Shih, Patrick	531
Shim, Jung Hyun	590
Shimamura, Tadashi	239, 595
Shimer, Adam L.	46, 390, 396, 474, 482, 721
Shin, Sang Hyun.	633
Shin, Seung Ho	590
Shiozaki, Yasuyuki	564
Shiraishi, Tateru	222
Shiratori, Virpi	623
Shitara, Toshiro.	370
Shizu, Naoyuki.	222
Shousha, Mootaz	107, 738
Shufflebarger, Harry L.	4B, 70, 225, 227, 230, 234, 271, 297, 300, 326, 373, 431, 581
Shugart, Robert	630
Shulman, Eric.	378
Shyam, Ashok K.	710
Sides, Brenda A.	3, 51, 133, 316, 342
Siljander, Matthew	683
Silva, Fernando E.	503
Simmons, James W.	337, 526
Simon, Roxanne	652
Sims, Gordon E.	129
Singh, Kern	347, 487
Sitte, Ingrid	553
Sivaraman, A.	77
Skaggs, David L.	22, 336, 451, 587
Skalli, Wafa	522, 559, 694
Skolasky, Richard L.	249, 252, 320, 408
Smith, Donald A.	352, 701
Smith, John T.	20, 134, 285, 453, 678
Smith, Justin S.	5D, 7, 92, 93, 94, 119, 251, 318, 439, 440, 502, 666
Smith, Micah W.	630
Smith, Robert L.	578
Smith, Timothy R.	531
Snyder, Laura	351
Söderberg, Marcus	586
Solomito, Matthew	719
Song, Ho Sup.	245
Song, Kit	25, 730
Son-Hing, Jochen P.	27, 238, 629
Sonoda, Masaru	583
Spanyer, Jonathon M.	365

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Spivak, Jeffrey M.	330
Sponseller, Paul	61, 225, 227, 326, 451, 543, 581, 587, 616
Spratt, Frank	490
Spratt, Kevin F.	353, 494
St. Amour, Edgar D.	604
Stallbaumer, Jeremy J.	133, 348
Stammers, Anthea M.	579
Standefer, Karen D.	135
Steffen, Jean-sebastien	522, 559
Steib, Jean-Paul	466, 694
Stein, Benjamin E.	660, 724
Steklov, Nikolai	672
Stephens, Frederick L.	686
Stewart, Joshua D.	668
Stoker, Geoffrey E.	2, 113, 478, 484, 542
Stout, Kary	630
Strauss, Kevin	627, 668, 670
Street, John	450, 483, 593, 696
Streijger, Femke	735
Stulik, Jan	260, 391, 725
Sturm, Peter	10, 20, 231, 276, 416, 453, 587
Sucato, Daniel J.	5C, 21, 89, 135, 229, 273, 362, 366, 372, 423, 427, 446, 496, 568
Sudo, Hideki	266, 357, 380, 516, 647
Sugarman, Etan P.	16, 298, 378, 448, 636, 736
Suh, Seung-Woo	236, 429, 430, 622
Suk, Se-Il	4C, 5C, 54, 99
Sun, Dong	651
Sun, Guang-quan	33
Sun, Wu	393
Sun, Xu	364, 492, 520, 634
Suresh, Cheekatla	269, 739
Suzuki, Akinobu	455, 733
Suzuki, Teppei	343, 370, 426, 659
Swamy, Ch V.	269, 739
Tadano, Shigeru	380, 516
Takahashi, Jun	422, 473, 625, 657
Takemoto, Steven	123, 317, 404, 441
Takeshita, Katsushi	335, 574
Takeuchi, Daisaku	91, 360, 661
Takigawa, Tomoyuki	709
Tam, Elisa MS	571
Tan, Gamaliel	38
Taneichi, Hiroshi	91, 335, 360, 661
Tang, Nelson L S	569
Tay, Bobby	402, 441
Tello, Carlos A.	588, 643
Terai, Hidetomi	455, 733
Terran, Jamie S.	225, 227, 250, 313, 326, 431
Tesiorowski, Maciej	286, 573, 635
Tetzlaff, Wolfram	579, 735
Tezer, Mehmet	12, 101, 291, 302
Than, Khoi D.	580, 706
Theodore, Nicholas	125, 351, 465
Thériault, Jérémie	259
Thomas, Jonathan	243, 418, 704
Thomas, Ronald L.	703
Thompson, George H.	1B, 27, 238, 336, 339, 451, 587, 629, 717
Thompson, Samantha	248
Thompson, Sara E.	664, 686
Thongtrangan, Issada	533
Thornhill, Beverly	129, 280, 298, 378, 448, 636, 722
Tigchelaar, Seth	579
Tikoo, Agnivesh	623, 655
Tillman, John	6
Ting, Terry T.	571
Toda, Kazukiyo	709
Tohmeh, Antoine G.	530
Tolhurst, Stephen	594
Tomlinson, Tucker	443
Topouchian, Vicken	42
Torii, Yoshiaki	567
Torode, Ian	19
Tortato, Simone	600
Toueg, Charles-William	71
Toy, Jason O.	41, 131, 324, 388, 415
Toyama, Yoshiaki	15, 36, 254, 428, 447, 501, 584
Toyoda, Hiromitsu	455, 733
Toyone, Tomoaki	38
Transfeldt, Ensor E.	296
Trask, John	513
Tribus, Clifford B.	96
Trivedi, Vikas	550, 563
Tropiano, Patrick	332
Tsuji, Taichi	264, 335, 370, 659
Tsuji, Takashi	15, 447
Turgeon, Isabelle	716
Turner, Alexander W.	602, 676
Turner, Anthony S.	481
Tuschel, Alexander	375, 459, 514
Tyler, Philippa A	76
Tyo, Risa	561, 606
Uchimura, Ruriko	239
Uehara, Masashi	473

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Ueno, Jun	567
Ugras, Ali A.	648
Umekoji, Hidemasa	488
Ungar, Benjamin	96, 322
Uno, Koki	335, 343, 370, 426, 659
Upasani, Vidyadhar V.	605, 673
Uranga, Martiniano	643
Urban, Michelle	416
Uribe, Juan S.	352, 675, 701, 702
Vaccaro, Alexander R.	3D, 5, 7, 106, 119, 119, 294, 471
Valdevit, Antonio	313
Vale, Fernando L.	352, 701
van Bosse, Harold J.	270, 536
van der Meulen, Marjolein	468
Van Meirhaeghe, Jan K.	206, 562
Vanaman, Monique	706
Vanconia, Brent	398
Vanderhave, Kelly	594
Ver, Mario R.	558
Verma, Kushagra	1
Vigna, Franco E.	603
Villanueva, Carlos	283
Villemure, Isabelle	258
Vishnubhotla, Srilakshmi	279
Vital, Jean-marc	522, 559
Vitale, Michael G.	20, 89, 90, 285, 325, 338, 427, 453, 587
Vommaro, Francesco	304, 452
Vrionis, Frank D.	6, 114, 206
Vyskocil, Tomas	725
Wahl, Melvin M.	611
Wakao, Norimitsu	711
Wakula, Yaroslav	73, 258
Waldhausen, John H.	25
Walick, Kristina	372
Wallendorf, Michael J.	133
Walter, Axel	466
Wang, Anthony C.	706
Wang, Bin	220, 349, 364, 492, 520, 634
Wang, Xiaoyu	11
Wang, Yingsong	116, 127, 218, 589, 644
Wang, Yipeng	29, 303
Wang, Yu	608, 617
Wang, Yuxiang	614
Wang, Zhi	450
Wang, Zijia	57
Ward, Kenneth	28, 30, 233
Warner, William C.	104, 714
Warren, Daniel T.	43, 250, 479
Watanabe, Hironobu	712
Watanabe, Kota	15, 36, 254, 335, 370, 428, 447, 501, 584, 659
Weber, Michael H.	49, 317, 319, 404, 441
Weidenbaum, Mark	4D
Weinstein, Stuart L.	83, 103, 368
Wells, Rosemary	361
Werle, Stephan	39
Werner, Brian C.	390, 396, 474, 482, 721
Whang, Peter G.	699
White, Klane K.	730
White, Michael	604
Whiteside, Barbara Y.	603
Wiater, Brett P.	547
Widmann, Roger F.	88
Wiedenhöfer, Bernd	490
Williams, Brendan A.	89, 90, 325, 338, 587
Williams, John I.	687
Williamson, J. Bradley	490
Wilson, Adam	46
Wilson, Kevin	669
Wilson, Lester F	76
Winters, Brain S.	78
Wollowick, Adam L.	16, 129, 280, 298, 378, 448, 636, 722, 736
Wong, Albert P.	531
Wong, Hee-Kit	424, 425, 498
Woo, Raymund	576
Wood, Kirkham B.	95, 502
Woodard, Eric J.	7, 119, 119, 294
Woods, Barrett I.	328
Wright, Bettye	235, 575
Wright, Timothy	13, 117
Wu, Tao	364, 520, 634
Wylie, Christopher	389, 552
Xie, Denghui	331
Xie, Jingming	116, 127, 218, 589, 644
Xu, Hongwen	331
Yadla, Sanjay	471
Yagi, Mitsuru	235, 320, 631
Yagoubi, Fatima	437
Yamamoto, Takuya	335
Yamane, Kentaro	639
Yamazaki, Ken	239, 335, 595, 620
Yanagida, Haruhisa	335
Yang, Benson P.	611
Yang, Changwei	618
Yang, Jae Hyuk	430, 622

Author Index

Presentation Number Key: 1C, 2E, 3B = Instructional Course Lectures; 1-135 = Paper/Podium Presentations; 200+ = E-Posters

Author	Presentation Number
Yang, Jun Young	245, 355, 376, 662, 732
Yang, Zhendong	116, 127, 218, 589, 644
Yao, Hai	454
Yassir, Walid K.	703
Yasuda, Tatsuya	723
Yaszay, Burt	132, 232, 326, 339, 341, 401, 480, 505, 605
Yaszemski, Michael J.	4D
Yazici, Muharrem	75, 451, 587
Yeo, Eui-Dong	356
Yeung, Hiu Yan	33, 82, 213, 569, 571
Yeung, Kelvin	74
Yim, Annie Po Yee	33
Yoon, Kang-Jun	215
Yoon, S. Tim	7, 106, 119, 119, 294
Yorgova, Petya	78
Yoshida, Satoshi	239, 595
Yoshihisa, Sugimoto	467, 564, 599
Yoshino, Hitohiro	595
Young, Benjamin	404
Yson, Sharon C.	265, 293, 345, 395, 508
Yu, Bin	29, 303
Yu, Fish WS	213
Yu, Keyi	377
Yu, Yang	520
Yukawa, Yasutsugu	38
Yurttas, Yuksel	682
Zarzycki, Daniel	128, 286, 573, 635
Zebala, Lukas P.	2, 47, 48, 406, 478, 541, 613
Zeller, Reinhard D.	461, 656
Zenner, Juliane	40, 79, 80, 392, 475, 477, 509, 529, 553, 623
Zerah, Michel	42
Zhang, Hong	21, 135
Zhang, Hongqi	307, 499, 598, 614
Zhang, Huina	580
Zhang, Jianguo	29, 729
Zhang, Kai	289, 468
Zhang, Wei	626
Zhang, Ying	116, 127, 218, 589, 644
Zhao, Wenyan	463
Zhao, Ying-Chuan	228, 301
Zhao, Zhi	116, 127, 218, 589, 644
Zhen, Xin	364
Zheng, Jie	348
Zheng, Zhao-Min	331
Zhou, Jian Wei	424, 425
Zhou, Qiang	38
Zhu, Feng	220, 434, 492, 520, 634
Zhu, Zezhang	220, 349, 364, 434, 492, 520, 634
Zigler, Jack E.	201, 257, 334, 359, 533
Zileli, Mehmet	38
Zonder, Jeffrey	6

About SRS

Founded in 1966, the Scoliosis Research Society is an organization of medical professionals and researchers dedicated to improving care for patients with spinal deformities. Over the years, it has grown from a group of 35 orthopaedic surgeons to an international organization of more than 1,000 health care professionals.

Mission Statement

The purpose of Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

Membership

SRS is open to orthopaedic surgeons, neurosurgeons, researchers and allied health professionals who have a practice that focuses on spinal deformity.

Active Fellowship (membership) requires the applicant to have fulfilled a five-year Candidate Fellowship and have a practice that is 20% or more in spinal deformity. Only Active Fellows may vote and hold elected offices within the Society.

Candidate Fellowship (membership) is open to all orthopaedic surgeons, neurosurgeons and to researchers in all geographic locations who are willing to commit to a clinical practice which includes at least 20% spinal deformity. Candidate Fellows stay in that category for five years, during which time they must demonstrate their interest in spinal deformity and in the goals of the Scoliosis Research Society. Candidate Fellows may serve on SRS committees. After five years, those who complete all requirements are eligible to apply for Active Fellowship in the Society. Candidate Fellowship does not include the right to vote or hold office.

Associate Fellowship (membership) is for distinguished members of the medical profession including nurses, physician assistants, as well as orthopaedic surgeons, neurosurgeons, scientists, engineers and specialists who have made a significant contribution to scoliosis or related spinal deformities who do not wish to assume the full responsibilities of Active Fellowship. Associate Fellows may not vote or hold office, but may serve on committees.

Programs and Activities of the SRS are focused primarily on education and research and include the Annual Meeting, the International Meeting on Advanced Spine Techniques (IMAST), Worldwide Regional Conferences, a Global Outreach Program, a Research Endowment Fund which provides grants for spine deformity research, and development of patient education materials.

Web Site Information

For the latest information on SRS meetings, programs, activities and membership please visit www.srs.org. The SRS Web site Committee works to ensure that the Web site information is accurate, accessible and tailored for target audiences. Site content is varied and frequently uses graphics to stimulate ideas and interest. Content categories include information for Medical Professionals, Patients/Public, and SRS Members.

For more information and printable membership applications, please visit the SRS Web site www.srs.org.

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Future Meeting Dates

Annual Meeting & Course

46th Annual Meeting & Course
September 14-17, 2011 • Louisville, Kentucky, USA

47th Annual Meeting & Course
September 5-8, 2012 • Chicago, Illinois, USA

International Meeting on Advanced Spine Techniques

19th IMAST
July 18-21, 2012 • Istanbul, Turkey

20th IMAST
July 2013 • TBD

Online Education

If you missed a recent SRS Annual Meeting or IMAST, and wish to review a particular presentation, videos of both meetings are available on the SRS Web site (www.srs.org) for SRS Members Only!

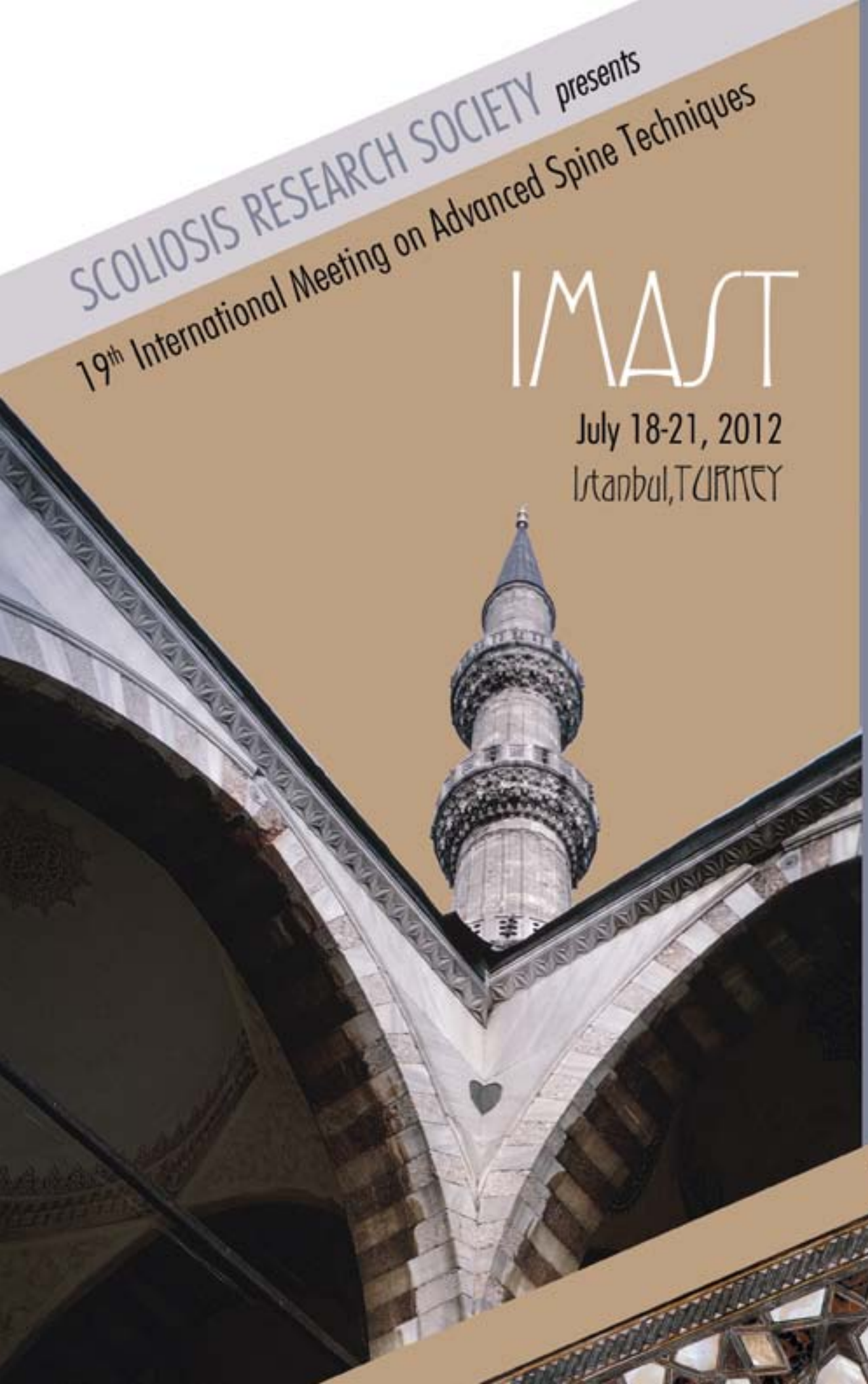
SCOLIOSIS RESEARCH SOCIETY presents

19th International Meeting on Advanced Spine Techniques

IMAST

July 18-21, 2012

Istanbul, TURKEY



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Abstract submission open
November 1, 2011

Abstract deadline
February 1, 2012

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