The Scoliosis Research Society presents

IMAST

17th International Meeting on Advanced Spine Techniques

July 21-24, 2010 • Toronto, Canada • Sheraton Centre Toronto

IMAST Chair
Todd J. Albert, MD

IMAST Past-Chair
Lawrence G. Lenke, MD

IMAST Committee
Khaled Kebaish, MD
Praveen Mummaneni, MD
Michael F. O'Brien, MD
B. Stephens Richards, III, MD
Yutaka Sasao, MD
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Final Program

Jointly sponsored by the Scoliosis Research Society and Medical Education Resources

Corporate Partners

We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2009.

Support levels are based on total contributions throughout the year and include the Annual Meeting, IMAST, Global Outreach Scholarships, Edgar Dawson Memorial Scholarships, SRS Traveling Fellowships and the Research Endowment Fund.

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IMAST2010

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Future Educational Events

Worldwide Conference
September 12-13, 2010 • Acapulco, Mexico

45th Annual Meeting & Course
September 21-24, 2010 • Kyoto, Japan

18th International Meeting on Advanced Spine Techniques
July 13-16, 2011 • Copenhagen, Denmark

46th Annual Meeting & Course
September 14-17, 2011 • Louisville, Kentucky, USA

19th International Meeting on Advanced Spine Techniques
July 2012 • Istanbul, Turkey (tentative)

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Welcome

Dear Colleagues,

On behalf of the IMAST Committee and the Scoliosis Research Society Board of Directors, it is my pleasure to welcome you to Toronto, Canada and the 17th International Meeting on Advanced Spine Techniques (IMAST).

We are excited to welcome you to a country that has recently played host to the world's finest athletes and witnessed some of the most dramatic scenes in Olympic history. In just 16 short years of its own history, IMAST has established itself as the "gold-medal favorite" among spine meetings worldwide and one of the Scoliosis Research Society's leaders in the education arena.

The IMAST program continues to evolve, and we're pleased to announce that we've incorporated suggestions from last year's delegates to further strengthen the scientific program. Top notch Instructional Course Lectures and intriguing Hands-On Demonstrations will continue to be important players, and we've revised the schedule to allow for unencumbered, uninterrupted attention to the interactive educational program components.

As always, our goal is to feature a balanced representation of the developments in the spinal deformity field and to collaborate with our Corporate Partners to showcase related products and techniques.

We hope you enjoy the meeting and your time in Toronto. If you have any questions, the SRS staff at the Registration Desk would be happy to assist you.

WELCOME,

Todd J. Albert, MD
IMAST Committee Chair

CME Information

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

Delegates should log onto the SRS website 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.

Fundamentals Sessions

During the concurrent sessions of the program, a special "Spine Fundamentals" track will be offered. These sessions are specifically geared toward the challenges and interests of surgeons with limited access to comprehensive training, and will be taught by expert lecturers from around the world.

Instructional Course Lectures (ICLs)

There will be 5 sessions of ICLs highlighting the latest in surgical techniques and technologies. Each session will feature 5 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 400 E-Posters available for your review at the E-Poster computer kiosks in 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 45-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. Each ICL will be immediately followed by an HOD, where companies with products relevant to the preceding ICL topic will be on hand to demonstrate and discuss their innovations. 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 Lower Concourse of the Sheraton Centre Toronto.

NEW this year! – Hands-On Workshops (HOWs) will return to the IMAST program. 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. Lunch or snacks will be available as noted in the program.

Internet Access

Delegates without laptops may access complimentary Internet kiosks in the Exhibit Hall. In addition, complimentary wired and wireless internet access is available in the Sheraton Link area of the lobby for hotel guests. Guests are limited to 1-hour intervals. Internet packages are also available for purchase in the guestrooms which include wireless access in the lobby, Bistro, Traders, pool and food court areas of the Sheraton. Single or multiple day packages are available at prices ranging from $16.95 + GST to $42.95 + GST CAD.

General Information

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

K2M

COMPLEX SPINE
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Meeting-at-a-Glance

	Wednesday, July 21, 2010	Thursday, July 22, 2010	Friday, July 23, 2010	Saturday, July 24, 2010
Morning	8:00 – 12:00 Exhibit Set-Up SRS Committee Meetings	7:00 – 16:15 Registration Open 7:00 - 7:50 Breakfast and Exhibit Viewing 7:50 – 9:15 General Sessions 9:15 – 9:45 Refreshment Break & Exhibit Viewing 9:45 – 10:45 Instructional Course Lectures 1A-E 10:45 – 11:30 Hands-On Demonstrations 1A-E* 11:30 – 12:15 Lunch and Exhibit Viewing Hands-On Workshops* 12:15 – 12:30 Walking Break	6:30 – 7:15 SRS Membership Information Session* 7:00 – 16:15 Registration Open 7:00 – 7:30 Breakfast and Exhibit Viewing 7:30 – 8:30 Instructional Course Lectures 3A-E 8:30 – 9:15 Hands-On Demonstrations 3A-E* 9:15 – 11:15 Concurrent & Spine Fundamentals Sessions 11:15 – 11:30 Walking Break 11:30 – 12:30 Instructional Course Lectures 4A-E	7:00 – 9:30 Registration Open 7:00 – 7:30 Breakfast and Exhibit Viewing 7:30 – 8:30 Instructional Course Lectures 5A-E 8:30 – 9:15 Hands-On Demonstrations 5A-E* 9:15 – 11:15 Concurrent & Spine Fundamentals Sessions 11:15 – 11:30 Walking Break 11:30 – 13:20 General Session
Afternoon	12:00 – 15:30 Exhibitor Orientation Meeting/Lunch	12:30 – 13:30 Instructional Course Lectures 2A-E 13:30 – 14:15 Hands-On Demonstrations 2A-E* 14:15 – 15:00 Hands-On Workshops* 15:00 – 15:15 Walking Break 15:15 – 16:15 Concurrent & Spine Fundamentals Sessions 16:15 Adjourn	12:30 – 13:15 Hands-On Demonstrations 4A-E* 13:15 – 14:00 Lunch and Exhibit Viewing Hands-On Workshops* 14:00 – 14:15 Walking Break 14:15 – 15:15 Concurrent & Spine Fundamentals Sessions 15:15 – 16:15 Roundtable Case Discussions 16:15 Adjourn	13:20 Adjourn
Evening	17:00 – 19:30 Registration Opens Welcome Reception *Supported by Medtronic*	Free Evening	19:00 – 22:00 Course Reception *Supported by Medtronic and Synthes Spine*	

**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, Instructional Course Lectures, Hands-On Demonstrations, and new this year, Hands-On Workshops, all lead by an international and multidisciplinary faculty. IMAST is jointly-sponsored by SRS and MER.

Learning Objectives

At the completion of this program, participants should be able to:

1. 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.
2. Analyze the indications and potential complications for various spine fixation systems including spinal arthroplasty.
3. Recognize emerging technology that has the potential to improve patient outcomes for specific indications and populations.
4. Understand when it may be appropriate to use biologic options to enhance spinal fusion.

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 Medical Education Resources (MER) and the Scoliosis Research Society(SRS). MER is accredited by the ACCME to provide continuing medical education for physicians.

CME Credit Designation

Medical Education Resources designates this educational activity for a maximum of 13.5 *AMA PRA Category 1 Credits*™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Disclosure and Conflicts of Interest

It is the policy of Medical Education Resources to insure balance, independence, objectivity, and scientific rigor in all of its educational activities. In accordance with this policy, MER identifies conflicts of interest with its instructors, content managers, and other individuals who are in a position to control the content of an activity. Conflicts are resolved by MER 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 will be included in the final program.

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 proceedings 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 condision.

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 Medical Education Resources, Inc. 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.

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.

Language

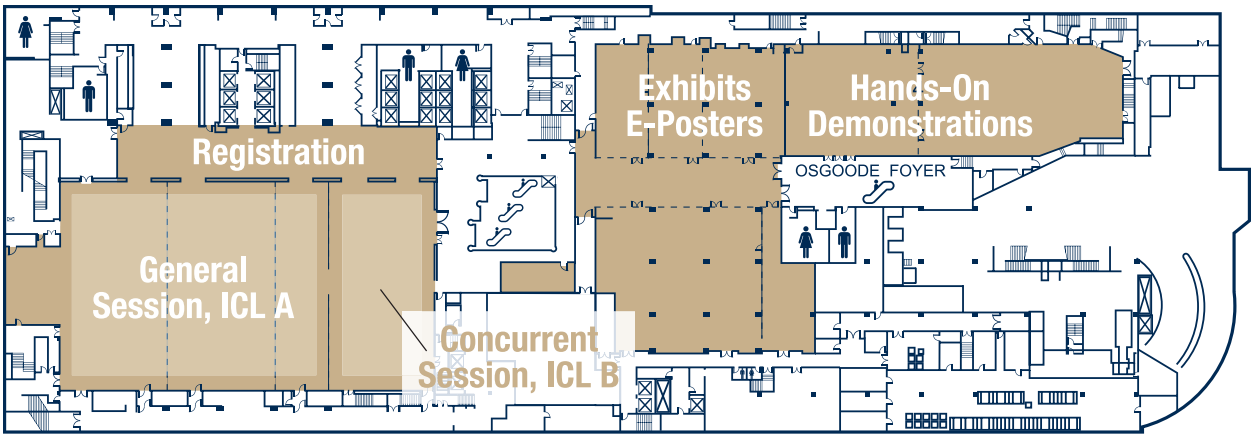
Presentations and course materials will be provided in English.

No Smoking Policy

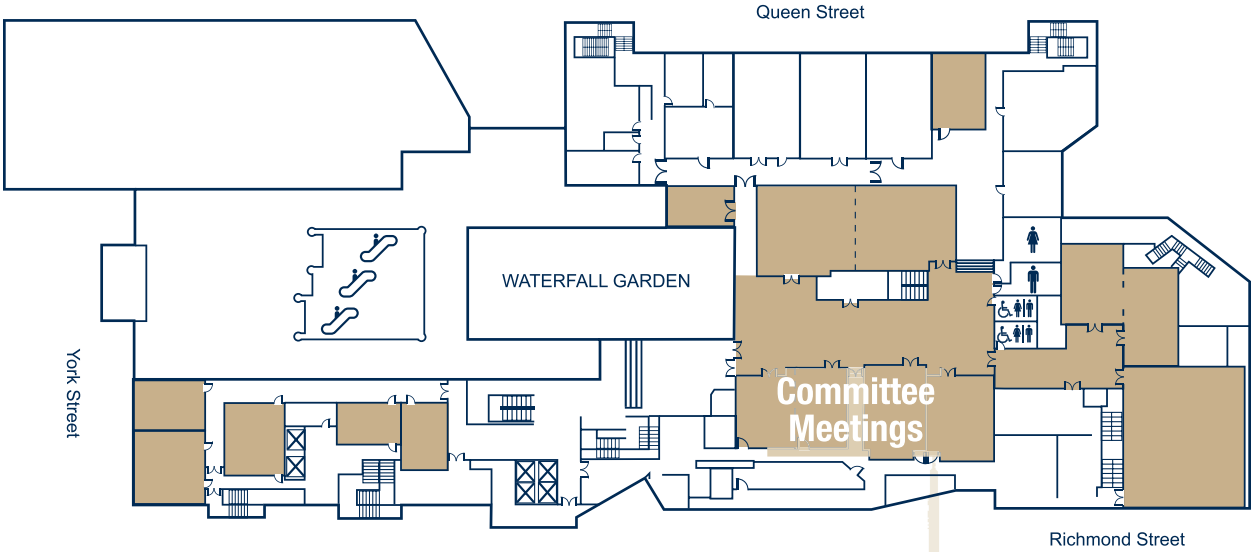
Smoking is not permitted during any IMAST activity or event.

Sheraton Centre Toronto Floorplans

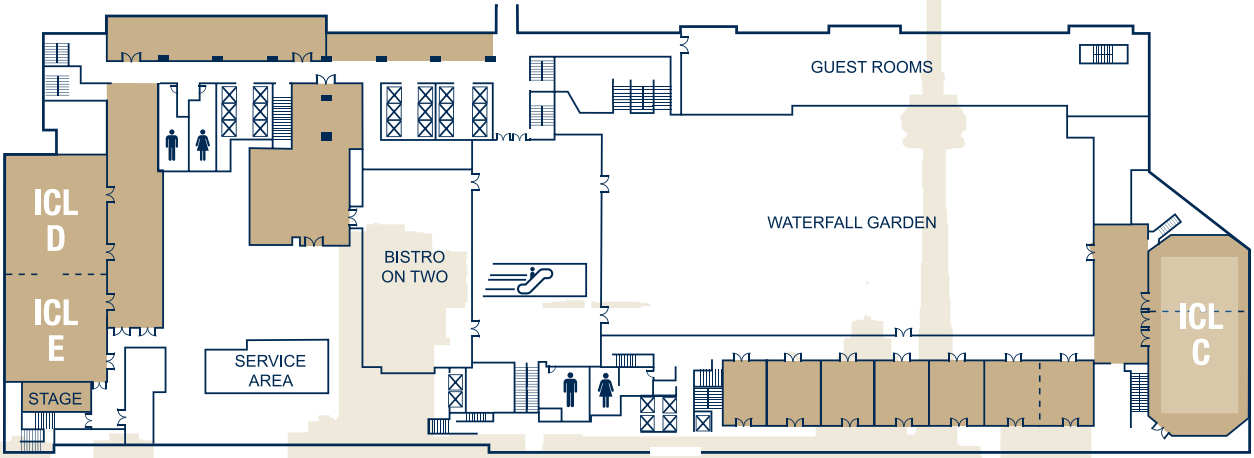
Lower Concourse



Mezzanine Level



Second Level



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(d) Speaker's Bureau; (e) Other Financial Support

Faculty Affiliations & Disclosures

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Meeting Agenda

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

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Meeting Agenda

Wednesday, July 21, 2010

17:00 – 19:30
Registration Opens
Lower Concourse, Sheraton Centre Toronto

Welcome Reception
Sheraton Hall, Lower Concourse
Supported by a grant from Medtronic

Thursday, July 22, 2010

7:00 – 16:15 **Registration Open**

7:00 – 14:30 **E-Posters & Exhibits Open**

7:00 – 7:50 **Breakfast & Exhibits Viewing**
Sheraton Hall, Lower Concourse

7:50 – 9:15 **General Session #1: DISC REPLACEMENT & ADOLESCENT IDIOPATHIC SCOLIOSIS**
Grand Ballroom Center/West, Lower Concourse
Moderators: Praveen V. Mummaneni, MD
Daniel J. Sucato, MD, MS

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

8:00 Paper # 1: FDA IDE Prospective Randomized Comparison Of Three Lumbar Artificial Disc Replacements (ADR) With Minimum Three Year Follow Up
Kenneth A. Pettine, MD; Lukas Eisermann, BS

8:04 Paper # 2: Direct Comparison of Two Lumbar Total Disc Replacement Devices: Results from a Prospective, Randomized, Multicenter FDA-Regulated Trial
Richard D. Guyer, MD; Kenneth A. Pettine, MD; Dom Coric, MD; Pierce D. Nunley, MD; David Musante, MD

8:08 Paper # 3: Lumbar Disc Arthroplasty vs. Anterior Lumbar Interbody Fusion: Five-Year Outcomes for Patients in an IDE Study
Matthew F. Gornet; Randall F. Dryer, MD; John H. Peloza, MD

8:12 Discussion

8:20 Paper # 4: Complications with rhBMP-2 in Posterolateral Spine Fusion Associated with Dural Tear
Steven D. Glassman, MD; Jeffrey L. Gum, MD; Charles H. Crawford, MD; Christopher B. Shields, MD; Leah Y. Carreon, MD, MSc

8:24 Paper # 5: Does Duration of Symptoms Influence the Outcome of Treatment of Lumbar Spinal Stenosis (SS) or Degenerative Spondylolisthesis (DS)?
Kristen E. Radcliff, MD; Jeffrey A. Rihn, MD; Emily Blood, PhD; Wenyan Zhao, M.S.; Alan Hilibrand, MD; D. Greg Anderson, MD; Alexander R. Vaccaro, MD, PhD; Todd J. Albert, MD; James N. Weinstein, DO, MS

8:28 Paper # 6: Assessment of the Incremental Cost-Utility of Surgery Compared to Medical Management for the Treatment of Hip, Knee and Spine Osteoarthritis
Y. Raja Rampersaud, MD, FRCSC; Peggy Tso; Kevin R. Walker, BSc; Brendan Eagen, MASc; Stephen J. Lewis, MD, MSc, FRCSC; Rajiv Gandhi, MS, MD, FRCSC; Roderrick Davey, MD, FRCSC; Nizar Mahomed, MD, ScD, FRCS(C); Peter C. Coyte, PhD

8:32 Discussion

8:40 Paper # 7: Beyond the Learning Curve: Does the Accuracy of Pedicle Screw Placement Improve with Experience in AIS Patients: A CT-Based Analysis of 1356 Pedicle Screws
Etan P. Sugarman, MSIV; Vishal Sarwahi, MD; Adam L. Wollowick, MD; Melanie Gambassi, NP; Terry Amaral, MD

Meeting Agenda

Thursday, July 22, 2010 (continued...)

8:44 Paper # 8: Asymmetric Pedicle Subtraction Osteotomy: A Useful Tool for Severe Scoliotic Deformities
Mohammad M. El-Sharkawi, MD; Wael Koptan, MD; Yasser ElMiligui, MD, FRCS

8:48 Paper # 9: Clinical and Radiographic Factors that Distinguish Between the Best and Worst Outcomes of Scoliosis Surgery for Adults 18-45 Years Old
Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Steven D. Glassman, MD; Leah Y. Carreon, MD, MSc; Frank J. Schwab, MD; Virginie C. Lafage, PhD; Sigurd H. Berven, MD; Keith H. Bridwell, MD

8:52 Discussion

9:00 **Keynote Address**
Introduction
Lawrence G. Lenke, MD
SRS President-Elect

Opportunity and Reception in a Culture of Research
Richard E. McCarthy, MD
SRS President

9:12 **Preview of the 45th Annual Meeting & Combined Course and 18th IMAST**

9:15 – 9:45 **Refreshment Break & Exhibit Viewing**
Sheraton Hall, Lower Concourse

9:45 – 10:45 **Instructional Course Lectures 1A-E**

1A - Cervical Deformities
Grand Ballroom Center/West, Lower Concourse
Moderator: Alexander R. Vaccaro, MD

9:45 – 9:55 Overview of Cervical Spine Surgical Complications in Spinal Deformity
Alexander R. Vaccaro, MD

9:55 – 10:05 Prevention and Contemporary Management of Intraoperative Vertebral Artery Injury
Praveen Mummaneni, MD

10:05 – 10:15 Surgical Management Pearls in Severe Coronal and Sagittal Plane Cervical Deformities
Alan S. Hilibrand, MD

10:15 – 10:45 Case Presentations and Discussion

1B – Spondylolisthesis
Grand Ballroom East, Lower Concourse
Moderator: John R. Dimar, II, MD

9:45 – 9:57 The Importance of Sagittal Balance and Its Integration into a New Classification of High Grade L5-S1 Spondylolistheses
Hubert Labelle, MD

9:57 – 10:09 Current Treatment Recommendations For L4-L5 Degenerative Spondylolistheses in the Aging Population
John R. Dimar, II, MD

10:09 – 10:21 Recommendations for the Treatment of Isthmic Spondolysis and Low to Moderate Grade L5-S1 Spondylolistheses
J. Abbott Byrd, MD

10:21 – 10:32 The Benefit of Reduction vs. In Situ Fusion in the Treatment of L5- S1 High Grade Spondylolistheses
Lawrence G. Lenke, MD

10:32 – 10:45 Discussion

Meeting Agenda

Thursday, July 22, 2010 (continued...)

1C – Early Onset Scoliosis I
Civic Ballroom, Second Floor
Moderator: Richard E. McCarthy, MD

This basic discussion of early onset scoliosis (EOS) will include an in-depth analysis of the problems and pathology related to EOS.

9:45 – 9:50	Overview and Treatment Classification System *Richard E. McCarthy, MD*
9:50 – 10:00	Why do we Treat EOS? • Respiratory problems-methods of evaluation • Chest wall defects-Which are significant? *David S. Marks, FRCS*
10:00 – 10:10	Non-Operative Treatment-Casts and Braces • Spinal growth-How best to measure • Reason for Concern *Ahmet Alanay, MD*
10:10 – 10:25	Who Should be Treated Surgically and When? • Preoperative evaluation • Anterior release vs. traction • What criteria do we sue to measure success? *George H. Thompson, MD*
10:25 – 10:45	Case Studies/Discussion

1D – Adult Deformity I: Surgical Management of Lumbar Degenerative Deformity
Dominion Ballroom North, Second Floor
Moderator: Sigurd H. Berven, MD

9:45 – 9:57	Introduction to an Evidence-Based Approach to Adult Degenerative Deformity *Sigurd H. Berven, MD*
9:57 – 10:09	Operative Strategies: How High, How Low, When to Do Less *Sean Molloy, MBBS, MSc, FRCS, DC*
10:09 – 10:21	Adjacent Segment Complications Above and Below Fusions for Degenerative Scoliosis *Khaled Kebaish, MD*
10:21 – 10:33	Predicting Outcomes in Adult Deformity *Frank J. Schwab, MD*
10:33 – 10:45	Case Discussions

1E – Principles and Practice in the Treatment of Kyphotic Problems
Dominion Ballroom South, Second Floor
Moderator: Christopher I. Shaffrey, MD

9:45 – 9:55	Evaluation and Management of Scheuermann's Kyphosis *Peter O. Newton, MD*
9:55 – 10:05	Evaluation and Management of Congenital Kyphosis *Michael Ruf, MD*
10:05 – 10:15	Evaluation and Management of Post-Traumatic Kyphosis *Michael F. O'Brien, MD*
10:15 – 10:25	Evaluation and Management of Latrogenic Kyphosis *Chistopher I. Shaffrey, MD*
10:25 – 10:45	Discussion

10:45 – 11:30 **Hands-On Demonstrations 1A-E***
Osgoode Ballroom, Lower Concourse
See "Exhibits and Hands-On Sessions" section for more information.

11:30 – 12:15 **Hands-On Workshops***
See "Exhibits and Hands-On Sessions" section for more information.

11:30 – 12:15 **Lunch & Exhibit Viewing**
Sheraton Hall, Lower Concourse

12:15 – 12:30 **Walking Break**

Meeting Agenda

Thursday, July 22, 2010 (continued...)

12:30 – 13:30 **Instructional Courses Lectures 2A-E**

2A – Options in Cervical Motion
Grand Ballroom Center/West, Lower Concourse
Moderator: Todd Albert, MD

12:30 – 12:42	Indications for ACF/ CDR	*Todd J. Albert, MD*
12:42 – 12:54	Cervical Adjacent Segment Disease – Is it the Fusion?	*Alan S. Hilibrand, MD*
12:54 – 13:06	Is Disc Regeneration Possible?	*Brian K. Kwon, MD, PhD, FRCSC*
13:06 – 13:18	Results of IDE Studies	*Rick C. Sasso, MD*
13:18 – 13:30	Discussion and/or Cases	

2B – Lumbar Posterior Motion Sparing
Grand Ballroom East, Lower Concourse
Moderator: Justin S. Smith, MD, PhD

12:30 - 12:42	Overview of Posterior Pathology and Radiographic Findings	*James J. Yue, MD*
12:42 - 12:54	An Evidence-Based Review of Dynamic Stabilization in the Spine	*Justin S. Smith, MD, PhD*
12:54 - 13:06	Facet Replacement and Facet Resurfacing- Clinical Experience	*Luiz Pimenta, MD*
13:06 - 13:18	Dynamic Scoliosis Systems	*Jean-Charles Le Huec, MD*
13:18 - 13:30	Discussion	

2C – Adolescent Idiopathic Scoliosis I: Classification and Fusion Level Selection
Civic Ballroom, Second Floor
Moderator: Peter O. Newton, MD

This session will focus on the keys to appropriate assessment of patients with Adolescent Idiopathic Scoliosis, so as to make the best decisions regarding surgical fusion. The important features of the curve patterns that dictate fusion level selection will be the primary goal of this ICL. A case-based panel discussion will include topics such as: classification, assessing flexibility, selective fusions, and choosing the upper and lower levels for fusion.

Panelists: Randal R. Betz, MD
Kenneth M.C. Cheung, MD
Hubert Labelle, MD
Peter O. Newton, MD
B. Stephens Richards, III, MD

2D – Adult Deformity II: Use of Osteotomies in Adult Spinal Deformity
Dominion Ballroom North, Second Floor
Moderator: Lawrence G. Lenke, MD

12:30 – 12:35	Introduction	*Lawrence G. Lenke, MD*
12:35 – 12:45	Indications, Options and Pre-Op Planning of Osteotomies	*Frank J. Schwab, MD*
12:45 – 12:55	PSO- Technique, Results, Complications	*Sigurd H. Berven, MD*
12:55 – 13:05	Anterior/Posterior Approach with Osteotomies	*Oheneba Boachie-Adjei, MD*
13:05 – 13:15	Post VCR for Severe Adult Deformity	*Lawrence G. Lenke, MD*
13:15 – 13:30	Discussion & Case Presentation	

Meeting Agenda

Thursday, July 22, 2010 (continued...)

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

Dominion Ballroom South, Second Floor
Moderator: Jacob M. Buchowski, MD, MS

12:30 – 12:35 Introduction and Epidemiology
Jacob M. Buchowski, MD, MS

12:35 – 12:50 Acute Presentation and Evaluation
- Evaluation of patients (clinical, radiographic, and oncologic)
- Staging
- Immediate management (steroids, role for radiation, biopsy, indications for immediate surgery)

Mark Weidenbaum, MD

12:50 – 13:05 Surgical Management of Metastatic Spine Disease
- Indications for surgery/patient selection (oncologic spinal instability, neurologic compromise, intractable pain, need for histologic diagnosis)
- Timing of surgery
- Techniques (intralesional vs. resection, approach, embolization, monitoring)
- Complications
- Outcomes

Steven C. Ludwig, MD

13:05 – 13:20 Novel /Minimally Invasive Techniques
- Vertebroplasty/kyphoplasty
- Percutaneous fixation
- Stereotactic radiosurgery/IMRT

Michael W. Groff, MD

13:20 – 13:30 Discussion
Jacob M. Buchowski, MD, MS

13:30 – 14:15 **Hands-On Demonstrations 2A-E***
Osgoode Ballroom, Lower Concourse
See "Exhibits and Hands-On Sessions" section for more information.

14:15 – 15:00 **Hands-On Workshops***
See "Exhibits and Hands-On Sessions" section for more information

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15:00 – 15:15 **Walking Break**

15:15 – 16:15 **Concurrent Sessions #2 A&B & Spine Fundamentals Session**

Concurrent Session #2A: WHITECLOUD CLINICAL SCIENCE NOMINEES & ADOLESCENT IDIOPATHIC SCOLIOSIS

Grand Ballroom Center /West, Lower Concourse
Moderators: Christopher I. Shaffrey, MD
Khaled Kebaish, MD

15:15 *Paper # 10: Metanalysis of Class I and II Data on Results of Anterior Cervical Decompression and Fusion
Kenneth A. Pettine, MD; Lukas Eisermann, BS
**Whitecloud Award nominee – Best Clinical Paper*

15:19 *Paper # 11: Correlation of Early Pain and Long-Term Functional Results from a Multi-Center, Prospective, Randomized, Controlled FDA-IDE Vertebroplasty Trial
Hyun W. Bae, MD
**Whitecloud Award nominee – Best Clinical Paper*

15:23 *Paper # 12: Combined Results of the Three US IDE Randomized Cervical Arthroplasty Trials with Two Years of Follow-Up
Cheerag D. Upadhyaya, MD; Jau-ching Wu, MD; Regis W. Haid, MD; Vincent C. Traynelis, MD; Bobby Tay, MD; Dom Coric, MD; Gregory Trost, MD; Praveen V. Mummaneni, MD
**Whitecloud Award nominee – Best Clinical Paper*

15:27 Discussion

Meeting Agenda

Thursday, July 22, 2010 (continued...)

15:35 *Paper # 13: Posterior Surgery Only Assisted by Big-Weight Halo-Femoral Traction for the Treatment of Adolescent Idiopathic Scoliotic Curves More Than 100°
Hongqi Zhang, MD; Chaofeng Guo; Di Zhao; Ling-Qiang Chen; Mingxing Tang
**Whitecloud Award nominee – Best Clinical Paper*

15:39 *Paper # 14: Minimally Invasive Posterior Spinal Instrumentation For Pediatric Spinal Deformity: One Year Follow-Up with CT Scans of First 30 Cases
Atiq Durrani, MD; Rasesh Desai; Vivek Sharma, MD; Alvin H. Crawford, MD
**Whitecloud Award nominee – Best Clinical Paper*

15:43 *Paper # 15: Age- and Sex-Related Changes in Sagittal Sacropelvic Morphology and Balance in Asymptomatic Adults
Jean-Marc Mac-Thiong, MD, PhD; Pierre Roussouly, MD; Eric Berthonnaud, PhD; Pierre Guigui
**Whitecloud Award nominee – Best Clinical Paper*

15:47 Discussion

15:55 Paper # 16: Body Image Disturbance Questionnaire-Scoliosis Version: Responsiveness to Change Associated with Surgical Treatment
Baron S. Lonner, MD; Suken A. Shah, MD; Tracey Bastrom, MA; Phedra Penn, MS; Joshua D. Auerbach, MD

15:59 Paper # 17: Revision Surgery for AIS Results in SRS Scores Comparable to Primary Surgery Patients
Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; Lawrence G. Lenke, MD; Charles E. Johnston, MD; James O. Sanders, MD; John B. Emans, MD; Mark A. Erickson, MD; Leah Y. Carreon, MD, MSc; Spinal Deformity Study Group

16:03 Paper # 18: A New Posterior Scoliosis Correction Technique Using Pedicle Screws to Restore Thoracic Kyphosis
Manabu Ito, MD, PhD; Kuniyoshi Abumi, MD; Toshiaki Kotani; Yuichiro Abe, MD; Hideki Sudo; Shigeki Ohshima, PhD; Akio Minami, MD, PhD

16:07 Discussion

Concurrent Session #2B: WHITECLOUD BASIC SCIENCE NOMINEES & OTHER BASIC SCIENCE

Grand Ballroom East, Lower Concourse
Moderators: Brian K. Kwon MD, PhD, FRCSC
Kenneth M.C. Cheung, MD

15:15 *Paper # 19: In a Rat Model of Spinal Arthrodesis and SCI, rhBMP-2 Use Increases Inflammation and Glial Scarring while Limiting Long-Term Functional Recovery
Anton E. Dmitriev, PhD, MSc; Suzanne Farhang, BSc; Ronald A. Lehman, MD; Geoffrey Ling, MD, PhD; Aviva Symes
**Whitecloud Award nominee – Best Basic Science Paper*

15:19 *Paper # 20: Progressive Spinal Deformity Correction via an Anterior Based Tether in a Porcine Scoliosis Model: A Detailed Radiographic Analysis
Ashish Patel, MD; Frank J. Schwab, MD; Virginie C. Lafage, PhD; Benjamin Ungar; Jean-Pierre C. Farcy, MD
**Whitecloud Award nominee – Best Basic Science Paper*

15:23 *Paper # 21: Facet Joint Biomechanics at the Treated and Adjacent Levels After Total Disc Replacement
Sergiu Botolin, MD, PhD; Christian Puttlitz, PhD; Todd Baldini, MS; Anthony Petrella, PhD; Evalina L. Burger, MD; Celeste Abjornson, PhD; Vikas V. Patel, MD
**Whitecloud Award nominee – Best Basic Science Paper*

15:27 Discussion

15:35 *Paper # 22: Allograft Mesenchyemal Stem Cells for Anterior Cervical Disectomy and Fusion
Vivek Mohan, MD, MS; Cary Templin, MD; Mark A. Lorenz, MD; Michael R. Zindrick, MD
**Whitecloud Award nominee – Best Basic Science Paper*

Meeting Agenda

Thursday, July 22, 2010 (continued...)

15:39 *Paper # 23: Effect of Metallic Wear Debris on Annulus Fibrosus Chondrocytes
Edward R. Anderson, MD; Garrick W. Cason, MD; Kevin Baker, MS; Carly A. Gratopp, BS; Harry N. Herkowitz, MD
**Whitecloud Award nominee – Best Basic Science Paper*

15:43 *Paper # 24: Effect of TNF-Alpha and IL-1-Beta on Rat Intervertebral Disc in Organ Culture: An Atraumatic Model to Analyze Degenerative Disc Disease
Ravi K. Ponnappan, MD; Dessislava Z. Markova, PhD; Todd J. Albert, MD; D. Greg Anderson, MD; Irving M. Shapiro, PhD; Makarand V. Risbud, PhD
**Whitecloud Award nominee – Best Basic Science Paper*

15:47 Discussion

15:55 Paper # 25: The Effect on Pedicle Screw Pullout Strength of Optimizing Pedicle Fill Using a Tool to Size the Pedicle
David H. Clements, MD; David H. Clements, BS; Charles Colip, BS; Randal R. Betz, MD; Mehdi Shafieian; Kurosh Darvish, PhD

15:59 Paper # 26: Association Between FokI Polymorphism in Vitamin D Receptor Gene and Susceptibility to Spinal Tuberculosis in Chinese Han Population
Hongqi Zhang, MD; Ang Deng, MD; Chaofeng Guo; Yuxiang Wang, MD

16:03 Paper # 27: Novel Bioresorbable Cement for Percutaneous Vertebral Fracture Treatment
Aron Rosenberg, MS; Noel R. Camacho; Jerry Chang, PhD; Andrew T. Mahar, MS; Kieran Murphy, MD

16:07 Discussion

Fundamentals Session: Adolescent Idiopathic Scoliosis/Deformity
Civic Ballroom, Second Floor
Moderator: Daniel J. Sucato, MD, MS

15:15 – 15:16 Introduction
Daniel J. Sucato, MD, MS

15:16 – 15:25 Classification and Fusion Levels for AIS
Lawrence, G. Lenke, MD

15:26 – 15:29 Questions/Discussion

15:30 – 15:39 Surgical Strategies for AIS Deformity Correction
Peter O. Newton, MD

15:40 – 15:44 Questions/Discussion

15:45 – 16:54 Complications in AIS surgery
B. Stephens Richards, III, MD

15:55 – 15:59 Questions/Discussion

16:00 – 16:15 Case Presentations

16:15 **Adjourn**

Meeting Agenda

Friday, July 23, 2010

6:30 – 7:15 **SRS Membership Information Session**
Grand Ballroom East, Lower Concourse
Speakers: B. Stephens Richards, III, MD, Vice President
Mark Weidenbaum, MD, Fellowship Committee Chair

Join us for breakfast and to learn more about the Scoliosis Research Society:
- How to Apply
- Benefits of Membership
- Leadership Opportunities
- Scholarships
- Networking
- Education

7:00 – 16:15 **Registration Open**

7:00 – 13:15 **E-Posters and Exhibits Open**

7:00 – 7:30 **Breakfast and Exhibit Viewing**
Sheraton Hall, Lower Concourse

7:30 – 8:30 **Instructional Course Lectures 3A-E**

3A – Cervical Trauma
Grand Ballroom Center/West, Lower Concourse
Moderator: Rick C. Sasso, MD

7:30 – 7:40 Latest Developments in Spinal Cord Regeneration
Brian K. Kwon, MD, PhD, FRCSC

7:40 – 7:50 Timing of Reduction for Subaxial Dislocations
Todd J.Albert, MD

7:50 – 8:00 Subaxial Cervical Fixation and Biomechanics
Michael Ruf, MD

8:00 – 8:10 Occipitocervical Fixation and Biomechanics
Rick C. Sasso, MD

8:10 – 8:30 Case Discussions

3B – Lumbar Posterior Fusion Options/ Instrumentation (Degenerative)
Grand Ballroom East, Lower Concourse
Moderator: Christopher Bono, MD

7:30 – 7:35 Introduction
Christopher Bono, MD

7:35 – 7:45 Posterior/Posterolateral Lumbar Fusion and Pedicle Screw Instrumentation for Degenerative Disorders
- Who does simple posterior fusions anymore?
- What is a true posterior or posterolateral fusion
- Attention to detail, decortication
- Pedicle screw insertion technique (basic)
- Outcomes of PLF for various degenerative disorders

Christopher Bono, MD

7:45 – 7:55 Posterior Lumbar Interbody Fusions
- Who "needs" a PLIF or TLIF?
- Why do a PLIF when you can do a TLIF?
- One cage, two cages -Unilateral or bilateral
- Does the type of cage matter?
- Results of PLIF/TLIF broken down by diagnoses (e.g. spondylolisthesis versus discogenic low back pain)

Richard Guyer, MD

7:55 – 8:05 Multi-Level Fusion for Degenerative Scoliosis
- Who is the right patient?
- Selecting levels
- Polyaxial screws versus monoaxial screws for deformity correction
- Reduction maneuvers (rod reducers, reduction screws, etc)
- Results of adult lumbar deformity surgery

Sigurd H. Berven, MD

Meeting Agenda

Friday, July 23, 2010 (continued...)

8:05 – 8:15 Stabilization and Fusion with or without Reduction of High-Grade Isthmic Spondylolisthesis
- What adult patient is a candidate for a reduction?
- Reduction versus In situ fusion
- How proximal do you go? To the horizontal vertebrae? Stop at a non-degenerative level?
- Trans-osseous fibular strut or cage (sacrum into L5)
- S1 to L5 screws (skewering technique)
- Technique of reduction and interbody fusion from all posterior approach
- Results of the various procedures

Ensor E. Transfeldt, MD

8:15 – 8:30 Discussion

3C – Early Onset Scoliosis II

Civic Ballroom, Second Floor
Moderator: Richard E. McCarthy, MD

This instructional course will build on EOS 1 and discuss surgical options, treatment methods, and complications.

7:30 – 7:35 Overview and Classification System
Richard E. McCarthy, MD

7:35 – 7:45 Distraction Techniques: Spine
- Advantages and disadvantages
- When to lengthen and how
- Complications

Behrooz Akbarnia, MD

7:45 – 7:55 Distraction Techniques: Other
- Turkey distraction techniques
- When to use internal traction
- Complications

Azmi Hamzaoglu, MD

7:55 – 8:05 Growth Guidance Systems: Rib-to-Spine Fixation
- Spine, Rib-to-spine techniques
- Complications

Richard E. McCarthy, MD

8:05 – 8:15 Tethering Techniques-Staples, Bands
- Outcome measures-How best to measure success short-term and long-term
- What is the endpoint?

Hilai Noordeen, FRCS

8:15 – 8:30 Discussion

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

Dominion Ballroom North, Second Floor
Moderator: Frank J. Schwab, MD

7:30 – 7:35 Introduction
Frank J. Schwab, MD

7:35 – 7:45 Lumbo-Sacral Fusion Extended Proximally: At What Point is Enhanced Pelvic Fixation Necessary?
Chistopher I. Shaffrey, MD

7:45 – 7:55 Long Fusion from the Thoracic Spine Extending to the Lumbar Spine: When is Sacro-Pelvic Fixation Necessary?
Oheneba Boachie-Adjei, MD

7:55 – 8:05 Pelvic Fixation Options and Variations on Iliac Anchorage
Khaled Kebaish, MD

8:05 – 8:15 Enhanced Fusion Options for Sacro-Pelvic Fusion: Graft Options, Interbody Supplementation and Biologics
Lawence G. Lenke, MD

8:15 – 8:30 Discussion & Case Presentations
Frank J. Schwab, MD

Meeting Agenda

Friday, July 23, 2010 (continued...)

3E – Thoracolumbar Trauma
Dominion Ballroom South, Second Floor
Moderator: Steven C. Ludwig, MD

7:30 – 7:42 Update on Thoracolumbar Classification Systems: Do They Impact our Treatment?
Alexander Vacarro, MD

7:42 – 7:54 Thoracolumbar Decompressive Techniques: When Anterior, When Posterior, Does it Need to be Done?
Praveen V. Mummaneni, MD

7:54 – 8:06 The Surgical Management of Posttraumatic Spinal Deformity
Jacob M. Buchowski, MD, MS

8:06 – 8:18 MIS Applications for Thoracolumbar Spine Trauma
Steven C. Ludiwg, MD

8:18 – 8:30 Discussion & Case Presentations

8:30 – 9:15 **Hands-On Demonstrations 3A-E***
Osgoode Ballroom, Lower Concourse
See "Exhibits and Hands-On Sessions" section for more information.

9:15 – 11:15 **Concurrent Sessions #3A&B and Spine Fundamentals Session**

Concurrent Sessions #3A: ADULT SCOLIOSIS & KYPHOSIS
Grand Ballroom Central/West, Lower Concourse
Moderators: David W. Polly, Jr., MD
Sigurd H. Berven, MD

9:15 Paper # 28: Minimally Disruptive Treatment of Adult Scoliosis from a Lateral Retroperitoneal Approach: Perioperative Results
Robert E. Isaacs, MD; Solas Degenerative Study Group

9:19 Paper # 29: Multilevel MIS Reconstruction of Adult Degenerative Scoliosis
Stefan Renaud, DO; Connie G. Chon, RA; Reginald Q. Knight, MD; Jeffrey S. Roh, MD

9:23 Paper # 30: Patient Satisfaction Following XLIF for Adult Scoliosis
W. B. Rodgers, MD; Jody A. Rodgers, MD, FACS; Solas Degenerative Study Group

9:27 Discussion

9:35 Paper # 31: Is the Less Invasive Far Lateral Approach a Safe Way to Reconstruct the Anterior Spinal Column in Advanced Adult Deformity Surgery? A Minimum Two Year Follow-Up Study
Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Pooria Salari, MD; Ramin Bagheri, MD

9:39 Paper # 32: Long Term, Two Year Clinical and Functional Outcomes of Minimally Invasive Surgery for Scoliosis
Neel Anand, MD; Rebecca Rosemann, MS, PA-C; Eli Baron, MD

9:43 Paper # 33: Evaluation of Lumbar Deformity After Decompression Surgery for Degenerative Lumbar Scoliosis
Naobumi Hosogane, MD; Hitoshi Kono; Hironobu Watanabe; Kiyohiro Nakamichi; Masashi Saito

9:47 Discussion

9:55 Paper # 34: Acute Proximal Junctional Failure Following Long Posterior Fusion for Spinal Deformity: Risk Factors and Radiographic Analysis Comparing Thoracolumbar to Upper Thoracic Failures
Richard Hostin, MD; Shay Bess, MD; Robert A. Hart, MD; Breton Line, BSME; Christopher P. Ames, MD; Khaled Kebaish; Douglas C. Burton, MD; Virginie C. Lafage, PhD; Michael F. O'Brien, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Kirkham B. Wood, MD; International Spine Study Group

9:59 Paper # 35: Common Mathematical Formulas Fail to Predict Postoperative Sagittal Alignment: Confirmation of a Need for More Advanced Equations
Justin S. Smith, MD, PhD; Shay Bess, MD; Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Richard Hostin, MD; International Spine Study Group

Meeting Agenda

Friday, July 23, 2010 (continued...)

10:03 Paper # 36: Computerized Planning of Multilevel Smith-Petersen Osteotomies (SPO) and Pedicle Subtraction Osteotomies (PSO)
Nicolas Aurouer, MD; Ibrahim Obeid; Olivier Gille; Jean M. Vital

10:07 Discussion

10:15 Paper # 37: Fellowship and Practice Composition Impact Surgical Decision Making in Patients with Adult Lumbar Degenerative Scoliosis: Spinal Deformity vs. Degenerative Spine Surgeons
Themistocles Protopsaltis, MD; Ashish Patel, MD; Baron S. Lonner, MD; John Bendo, MD

10:19 Paper # 38: Proximal Junctional Kyphosis in Primary Adult Deformity Surgery - PJK of 20 Degrees as a Critical Angle
Matthew M. Kang, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Lukas P. Zebala, MD; Joshua M. Pahys, MD; Samuel K. Cho, MD; Woojin Cho, MD, PhD; Ian G. Dorward, MD; Christine Baldus, RN MHS

10:23 Paper # 39: Characterization of Osteopenia/Osteoporosis in Adult Scoliosis: Does Bone Density Affect Surgical Outcome?
Mitsuru Yagi, MD, PhD; Oheneba Boachie-Adjei, MD; Akilah B. King, BA

10:27 Discussion

10:35 Paper # 40: Impact of Upper Fusion Level on Outcome in the Setting of Adult Spinal Deformity: Effectiveness of the Clinical Impact Classification in Guiding Treatment
Jean-Pierre C. Farcy, MD; Frank J. Schwab, MD; Virginie C. Lafage, PhD; Ashish Patel, MD; Steven D. Glassman, MD; Keith H. Bridwell, MD

10:39 Paper # 41: AP Spinal Fusion in Adult Deformity Surgery: Length of Staging and Perioperative Complications
Michael D. Tseng, MD; Anthony F. De Giacomo, MS; Amanda Tencza, MD; Sigurd H. Berven, MD; Shane Burch, MD; Christopher P. Ames, MD; Dean Chou, MD; Praveen V. Mummaneni, MD; Bobby Tay, MD; Sheri Rocha, BS; Vedat Deviren, MD; Rondall K. Lane, MD; Steven Takemoto, PHD; Serena S. Hu, MD

10:43 Paper # 42: Alignment Failures Following Thoracic Pedicle Subtraction Osteotomies
Virginie C. Lafage, PhD; Shay Bess, MD; Frank J. Schwab, MD; Eric Klineberg, MD; Richard Hostin, MD; Douglas C. Burton, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group

10:47 Discussion

10:55 Paper # 43: Results of Surgical Treatment for Scheuermann's Kyphosis Using Combined Front-Back Approach & Pedicle-Screw Constructs: A Base for Benchmark Comparisons through Analysis of 111 Cases
Heiko Koller, MD; Oliver Meier; Luis Ferraris, MD; Axel Hempfing; Marianne Umstätter; Rene Schmidt; Juliane Zenner, MD

10:59 Paper # 44: Radiographic Comparison of Lateral Fusion (LLIF) vs. ALIF vs. TLIF vs. Posterior Fusion: Analysis of Segmental Sagittal Contour Change
Jonathan N. Sembrano, MD; Amit K. Sharma, MD; Ryan D. Horazdovsky, MD; Bieta Azmoudeh, BS; Edward Rainier G. Santos, MD; David W. Polly, MD

Meeting Agenda

Friday, July 23, 2010 (continued...)

11:03 Paper # 45: Risk-Benefit Assessment of Surgery for Adult Scoliosis: An Analysis Based on Patient Age
Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Steven D. Glassman, MD; Sigurd Berven, MD; Christopher Hamill, MD; William C. Horton, MD; Stephen L. Ondra, MD; Frank Schwab, MD; Charles A. Sansur, MD; Ketih H. Bridwell, MD
** 2009 Russell A. Hibbs Award Recipient – Best Clinical Science Paper*

11:07 Discussion

Concurrent Session #3B: EARLY ONSET SCOLIOSIS & CONGITAL DEFORMITY

Grand Ballroom East, Lower Concourse
Moderators: Peter O. Newton, MD
B. Stephens Richards, III, MD

9:15 Paper # 46: Management of Thoracic Insufficiency Syndrome (TIS) in Patients with Jeune Syndrome Using Expandable Prosthetic Titanium Rib
Robert M. Campbell, MD; Ajeya P. Joshi, MD; James W. Simmons, DO; Vishwas Patil, MD; Kent Reinker, MD; Will Koeck, MD; Hari Athreya; James Schmitz, BSC

9:19 Paper # 47: 3D Analysis of Congenital Scoliosis and Hemivertebrae
Jean-Sébastien Steffen; Ludovic Humbert, PhD; Raphael Vialle, MD, PhD; Jean M. Vital; Jean Dubousset; Wafa Skalli, PhD

9:23 Paper # 48: Is Vertebral Column Resection the Only Effective Treatment Option for Correction in Adolescent Patients with Complex Congenital Thoracic Kyphoscoliosis: The Safety and Efficacy of Posterior All Pedicle Screw Instrumentation Combined with Multiple Chevron and Concave Rib Osteotomies
Z Deniz Olgun, MD; H Gokhan Demirkiran, MD; Mehmet Ayvaz, MD; Ahmet Alanay, MD; Muharrem Yazici, MD

9:27 Discussion

9:35 Paper # 49: Bilateral 'Percutaneous' Rib-to-Pelvis VEPTR Technique for the Management of Early Onset Scoliosis: An Alternative to 'Growing Rods'?
John T. Smith, MD

9:39 Paper # 50: Neurocentral Synchondrosis Screws to Create and Correct Experimental Deformity
Hong Zhang, MD; Daniel J. Sucato, MD, MS

9:43 Paper # 51: Surgical Management of Early Onset Scoliosis and Kyphosis by Proximal Fixation with a Novel Four Rib Construct
AlaaEldin A. Ahmad, MD; Richard H. Gross, MD

9:47 Discussion

9:55 Paper # 52: Simultaneous Vertebral Column Resection and Growing Rods for Severe Early Onset Spinal Deformity
Ashley Goldthwait, BS; John B. Emans, MD; Peter O. Newton, MD

9:59 Paper # 53: Factors Influencing the Decision for Surgical Intervention in Early Onset Scoliosis
Pooria Salari, MD; Jeff Pawelek, BS; Gregory M. Mundis, MD; Paul D. Sponseller, MD; Oheneba Boachie-Adjei, MD; Richard M. Schwend, MD; Patrick Bosch, MD; Laurel C. Blakemore, MD; Behrooz A. Akbarnia, MD

10:03 Paper # 54: Single Growing Rods: Outcome of 23 Cases with Minimum Two Year Follow-Up After Definitive Fusion
Najma Farooq, FRCS(Tr & Orth); Subhamoy Chatterjee, FRCSEd(Tr&Orth); Stewart Tucker, FRCS; Hilali H. Noordeen, FRCS

10:07 Discussion

10:15 Paper # 55: CT Lung Volume Studies are Still Necessary to Document Volume Changes in Early-Onset Scoliosis (EOS)
Anna McClung, RN; Charles E. Johnston, MD; Salah Fallatah, MD, FRCS(C)

Meeting Agenda

Friday, July 23, 2010 (continued...)

10:19 Paper # 56: Increased Rates of Anchor Failure can be Predicted by an Early Onset Scoliosis Severity Score
Sumeet Garg, MD; Anna McClung, RN; Charles E. Johnston, MD

10:23 Paper # 57: Pediatric Posterior-Only Vertebral Column Resection Successfully Treats Congenital Spinal Dysgenesis and Dislocation
Ashley Goldthwait, BS; John B. Emans, MD; Lawrence G. Lenke, MD

10:27 Discussion

10:35 Paper # 58: Posterior Hemivertebra/Bar Resection and Segmental Instrumentation in the Treatment of Congenital Scoliosis at the Cervicothroracic Junction
Lynn J. Letko, MD; Jurgen Harms, MD

10:39 Paper # 59: Posterior Instrumentation Results of Congenital Scoliosis
Tolga Ege; Serkan Bilgic, MD; Omer Ersen; Yuksel Yurttas; Erbil Oguz; Ali Sehirlioglu

10:43 Paper # 60: Can Pedicle Screws Eliminate the Need for Hemivertebrae Excision?
Vishal Sarwahi, MD; Adam L. Wollowick, MD; Etan P. Sugarman, MSIV; Melanie Gambassi, NP; Terry Amaral, MD

10:47 Discussion

10:55 Paper # 61: Safety and Accuracy of Pedicle Screw Placement in Young Children with Scoliosis
Feng Zhu; Yong Qiu, MD; Bin Wang, MD; Yang Yu; Zezhang Zhu, MD; Bangping Qian; Xu Sun, MD, PhD

10:59 Paper # 62: Progression in Patients with Combined Congenital Scoliosis and Rib Anomalies
Noriaki Kawakami, MD; Taichi Tsuji, MD; Katsushi Takeshita, MD; Manabu Ito, MD, PhD; Haruhisa Yanagida, MD; Shohei Minami; Koki Uno, MD, PhD; Morio Matsumoto, MD; Kota Watanabe

11:03 Paper # 63: Effect of Anterior Vertebral Instrumentation and Fusion on Spinal Canal Dimension in Children Ages One and Two Years
Hazem B. Elsebaie, FRCS , MD; Hossam Salah, MD, FRCS; Mootaz Salaheldine, MSc Ortho; Hilali H. Noordeen, FRCS; Behrooz A. Akbarnia, MD

11:07 Discussion

Fundamentals Session: ADULT DEFORMITY
Civic Ballroom, Second Floor
Moderator: Khaled Kebaish, MD

9:15 – 9:25 Adult Deformities, Etiology and Classification
Frank Schwab, MD

9:25 – 9:35 Sagittal Plane Deformity in Adults: Surgical Options
Lawrence G. Lenke, MD

9:35 – 9:45 Adjacent Segment Problems: How to Prevent and Treat?
David Cohen, MD

9:45 – 9:55 Surgical Correction of Deformities at the Lumbosacral Junction: When and How
Khaled Kebaish, MD

9:55 – 10:05 Outcome and complications; how do you manage patients' expectations?
Sigurd Berven, MD

10:05 – 10:15 Cases and discussion

11:15 – 11:30 **Walking Break**

Meeting Agenda

Friday, July 23, 2010 (continued...)

11:30 – 12:30 **Instructional Courses Lectures 4A-E**

4A – Infection and Post-Infectious Deformity
Grand Ballroom Center/West, Lower Concourse
Moderator: Steven C. Ludwig, MD

11:30 – 11:42	Prevention of Postoperative Spinal Wound Infections *Steven C. Ludwig, MD*
11:42 – 11:54	Do We Need to Remove the Instrumentation in the Face of a Postoperative Wound Infection? *Brian K. Kwon, MD, PhD, FRCSC*
11:54 – 12:06	Surgical Management of Postinfectious Thoracolumbar Spinal Deformity *Oheneba Boachie-Adjei, MD*
12:06 – 12:18	Management of Cervical Disciitis, Osteomyelitis and Epidural Abcess *Azmi Hamzaoglu, MD*
12:18 – 12:30	Discussion & Case Presentation

4B – Lumbar Anterior Fusion Options/ Instrumentation (Including Lateral Anterior Approaches)
Grand Ballroom East, Lower Concourse
Moderator: Luiz Pimenta, MD

11:30 – 11:42	Anterior Lumbar Interbody Fusion ALIF: Pros and Cons *James J. Yue, MD*
11:42 – 11:56	Importance of Sagittal Plane Alignment Avoiding Adjacent Level Disease *Ensor E. Transfeldt, MD*
11:56 – 12:06	XLIF Approach Advantages in Comparison to Other Approaches for Fusion *Luiz Pimenta, MD*
12:06 – 12:30	Discussion

4C – Adolescent Idiopathic Scoliosis II: Correction Techniques for Simple to Severe Curves
Civic Ballroom, Second Floor
Moderator: David W. Polly, Jr., MD

11:30 – 11:40	Selection of Anchor Types • Risk benefit ratio • Capacity for correction • Cost *David W. Polly, Jr., MD*
11:40 – 11:50	Correction Mechanics Primary and Secondary • Translation • Cantilever • Compression • Distraction • Direct vertebral derotation *Harry L. Shufflebarger, MD*
11:50 – 12:00	Osteotomies- When and How Many • Smith Peterson (Ponte) • Pedicle subtraction • Vertebral column resection *Se-Il Suk, MD*
12:00 – 12:10	How Much Correction is Enough? How do you Judge how Much Correction in Order to Achieve Balance in Double and Triple Curves? Thoracic Sagittal Plane Alignment- What is Acceptable? *Randal R. Betz, MD*
12:10 – 12:30	Discussion & Case Presentations

Meeting Agenda

Friday, July 23, 2010 (continued...)

4D – Adult Deformity IV: Non-Fusion and MIS Alternatives in Adult Scoliosis
Dominion Ballroom North, Second Floor
Moderator: Isadore H. Lieberman, MD, MBA, FRCSC

11:30 – 11:42	Less Invasive Paracoccygeal Approaches and the Use of Navigation and Percutaneous Pedicle Screw Systems in the Treatment of Adult Deformity *Neel Anand, MD*
11:42 – 11:56	Less Invasive Direct Lateral and Far Lateral Approaches for Adult Deformity *Kamal N. Ibrahim, MD, FRCS(C), MA*
11:56 – 12:06	Use of Bone Substitutes, BMP, DBM in the Setting of MIS Adult Scoliosis Surgery *Jacob M. Buchowski, MD, MS*
12:06 – 12:18	Non-Fusion Alternative for the Adult Deformity Population: What are the Options and What is Their Role? *Isadore H. Lieberman, MD, MBA, FRCSC*
12:18 – 12:24	Case Presentation
12:24 – 12:30	Discussion

4E – The Osteoporotic Spine: Fixation Challenges and Solutions
Dominion Ballroom South, Second Floor
Moderator: Michael J. Yaszemski, MD, PhD

11:30 – 11:40	Fixation Problems in the Osteoporotic Spine *Mark Weidenbaum, MD*
11:40 – 11:50	Biomechanical Evaluation and Instrumentation Strategies *Sigurd H. Berven, MD*
11:50 – 12:00	Strategies and Results of Cement Augmentation *Kenneth MC Cheung, MD*
12:00 – 12:10	Medical Treatment of Osteoporosis Prior to Spinal Reconstructive Surgery *Michael J. Yaszemski, MD, PhD*
12:10 – 12:30	Panel Discussion: Solutions to Case Presentations

12:30 – 13:15 **Hands-On Demonstrations 4A-E***
Osgoode Ballroom, Lower Concourse
See "Exhibits and Hands-On Sessions" section for more information.

13:15 – 14:00 **Hands-On Workshops***
See "Exhibits and Hands-On Sessions" section for more information.

13:15 – 14:00 **Lunch & Exhibit Viewing**

14:00 – 14:15 **Walking Break**

14:15 – 15:15 **Concurrent Sessions #4A & B & Spine Fundamentals**

Concurrent Session #4A: CERVICAL DEGENERATIVE & DEFORMITY
Grand Ballroom Center/West, Lower Concourse
Moderators: Rick C. Sasso, MD
Mohammed Mossaad, MD

14:15	Paper # 64: Crossing the Cervico-Thoracic Junction in Multilevel Posterior Cervical Fusions Reduces the Rate of Symptomatic Adjacent Segment Breakdown *Joshua D. Auerbach, MD; Jennifer K. Sehn, BS; Woojin Cho, MD, PhD; Andrew H. Milby, BS; Charles H. Crawford, MD; Brian A. O'Shaughnessy, MD; Michael S. Chang, MD; K. Daniel Riew, MD*
14:19	Paper # 65: The Role of the Interspinous and Supraspinous Ligaments in Preventing Proximal Junctional Kyphosis *Patrick J. Cahill, MD; Amer F. Samdani, MD; Wenhai Wang, PhD; Jahangir Asghar, MD; George R. Baran, PhD*
14:23	Paper # 66: Biomechanical Analysis of Osteotomy Type (OWO, CWO) and Rod Diameter for Treatment of Cervicothoracic Kyphosis *Justin K. Scheer, BS; Jessica A. Tang; Vedat Deviren, MD; Jennifer Buckley, PhD; Murat Pekmezci, MD; Robert T. McClellan, MD; Christopher P. Ames, MD*
14:27	Discussion

Meeting Agenda

Friday, July 23, 2010 (continued...)

14:35 Paper # 67: Treatment Techniques for Operative Correction of Proximal Junctional Kyphosis of the Upper Thoracic and Cervical-Thoracic Spine
Jamal McClendon, MD; Brian A. O'Shaughnessy, MD; Patrick A. Sugrue, MD; Frank L. Acosta, MD; Tyler Koski, MD; Stephen L. Ondra, MD

14:39 Paper # 68: Correlation Between Cervical Spine Sagittal Alignment and Clinical Outcomes after ACDF
Jeffrey L. Gum, MD; Steven D. Glassman, MD; Lonnie R. Douglas, BS; Leah Y. Carreon, MD, MSc

14:43 Paper # 69: Comparison of Prognostic Value of MRI Classifications of Signal Intensity Change for Cervical Spondylotic Myelopathy
S. Rajasekaran, PhD; Ashwin Avadhani, MS Orth; Ajoy Shetty, MS Orth

14:47 Discussion

14:55 Paper # 70: Surgical Treatment of Cervical Degenerative Disc Disease with Myleradiculopathy: Two-Level Anterior Discectomy vs. One-Level Anterior Corpectomy
Ahmet Alanay, MD; Kursat Ganiyusufoglu; Selhan Karadereler; Mehmet Aydogan; Cagatay Ozturk, MD; Azmi Hamzaoglu, MD

14:59 Paper # 71: Prognostic Factors in the Surgical Management of Cervical Spondylotic Myelopathy
Christopher G. Furey, MD; Henry Bohlman, MD

15:03 Paper # 72: Hybrid Surgical Technique Combining Fusion and Disc Arthroplasty for the Treatment of Multilevel Cervical Degenerative Disc Disease
Mehmet Aydogan; Cagatay Ozturk, MD; Mehmet Tezer; Selhan Karadereler; Ahmet Alanay, MD; Azmi Hamzaoglu, MD

15:07 Discussion

Concurrent Session #4B: SPONDYLOLISTHESIS & LUMBAR DEGENERATIVE

Grand Ballroom East, Lower Concourse

Moderators: John R. Dimar, II, MD
J. Abbott Byrd, III, MD

14:15 Paper # 73: Reliability of the SDSG Classification of Lumbosacral Spondylolisthesis
Jean-Marc Mac-Thiong, MD, PhD; Luc Duong; Stefan Parent, MD, PhD; Michael T. Hresko, MD; John R. Dimar, MD; Mark Weidenbaum, MD; Hubert Labelle, MD

14:19 Paper # 74: Operative Treatment of Isthmic Spondylolisthesis in Children up to the Age of 12 Years: A Long-Term, Retrospective Comparative Study with Matched Cohorts
Tuomas Jalanko; Ilkka Helenius, MD, PhD; Ville Remes, MD, PhD; Pekka Tervahartiala; Timo A. Yrjonen; Mikko S. Poussa; Dietrich K. Schlenzka, MD

14:23 Paper # 75: Radiological and Clinical Outcome of Non-Surgical Management for Pediatric High Grade Spondylolisthesis: Comparison with Surgical Management
Étienne Bourassa-Moreau, Bsc; Jean-Marc Mac-Thiong, MD, PhD; Hubert Labelle, MD

14:27 Discussion

14:35 Paper # 76: Complications in the Surgical Treatment of Spondylolisthesis
Michael T. Hresko, MD; Mark Weidenbaum, MD; Courtney W. Brown, MD; Hubert Labelle, MD

14:39 Paper # 77: Biomechanical Analysis of Risk Progression in Spondylolisthesis
Carl-Eric Aubin, PhD, P.Eng; Amandine Sevrain, MA,Sc.; Hubert Labelle, MD

14:43 Paper # 78: Adult Isthmic Spondylolisthesis: Posterior Lumbar Interbody Fusion (PLIF) vs. Posterolateral Fusion (PLF)
Francesco Lolli; Giovanni Barbanti Brodano; Mario Di Silvestre, MD; Tiziana Greggi, Head; Alfredo Cioni

Meeting Agenda

Friday, July 23, 2010 (continued...)

14:47 Discussion

14:55 Paper # 79: Mini-Invasive Instrumented Transforaminal Interbody Fusion for Low Grade Degenerative Instability of Lumbar Spine
Petr Vanek; Karel Saur

14:59 Paper # 80: A Comparison of MIS Fusion to Open Fusion for Degenerative Lumbar Disorders: A Systematic Review
Doron Rabin, MD; Sooyong Chua; Shawn Liu, BSc (Hons); Oma Persaud, MSc; Y. Raja Rampersaud, MD, FRCSC

15:03 Paper # 81: Marked Improvement in Patients Treated with Vertebroplasty after Painful Osteoporotic Compression Fractures
Hyun W. Bae, MD; Linda EA Kanim, MA; Nupur Gupta, MPH; Michael Kropf, MD; Timothy Davis, MD; Rick B. Delamarter, MD

15:07 Discussion

Fundamentals Session: LUMBAR DEGENERATIVE
Civic Ballroom, Second Floor
Moderator: Jacob M. Buchowski, MD, MS

14:15 – 14:20 Introduction
Jacob M. Buchowski, MD, MS

14:20 – 14:35 Approach to Degenerative Disc Disease
- Nonoperative
- Fusion (Anterior, Posterior, Anterior/Posterior)
- Arthroplasty
- Nucleus replacement

Neel Anand, MD

14:35 – 14:55 Approach to Degenerative Spondylolisthesis
- Nonoperative
- Decompression
- Decompression and Fusion
- Decompression and Dynamic Stabilization
- Interspinous Process Device

Praveen Mummaneni, MD

14:55 – 15:10 Approach to Lumbar Spinal Stenosis
- Nonoperative
- Decompression
- Decompression and Fusion
- Decompression and Dynamic Stabilization
- Interspinous Process Device

Christopher Bono, MD

15:10 – 15:15 Discussion

Meeting Agenda

Friday, July 23, 2010 (continued...)

15:15 – 16:15 **Round Table Case Discussions**

Cervical Reconstruction
Grand Ballroom Center/West, Lower Concourse
Moderator: Rick C. Sasso, MD
Panelists: Praveen V. Mummaneni, MD
Luiz Pimenta, MD

Lumbar Degenerative
Grand Ballroom East, Lower Concourse
Moderator: Richard Guyer, MD
Panelists: Neel Anand, MD
Isador H. Lieberman, MD, MBA, FRCSC
John R. Dimar, II, MD

Pediatric Deformity
Civic Ballroom, Second Floor
Moderator: Randal R. Betz, MD
Panelists: Suken A. Shah, MD
Behrooz A. Akbarnia, MD
Richard E. McCarthy, MD
Peter O. Newton, MD

Adult Deformity
Dominion Ballroom North, Second Floor
Moderator: Sigurd H. Berven, MD
Panelists: Lawrence G. Lenke, MD
David W. Polly, Jr., MD
Frank J. Schwab, MD
Se-Il Suk, MD

Tumor / Trauma / Infection
Dominion Ballroom South, Second Floor
Moderator: Steven C. Ludwig, MD
Panelists: Jacob M. Buchowski MD MS
James J. Yue, MD
Brian K. Kwon, MD, PhD, FRCSC

16:15 **Adjourn**

19:00 – 23:00 **Course Reception**
Hockey Hall of Fame (30 Yonge Street)

Meeting Agenda

Saturday, July 24, 2010

7:00 – 9:30 **Registration, E-Posters and Exhibits Open**

7:00 – 7:30 **Breakfast & Exhibit Viewing**

7:30 – 8:30 **Instructional Course Lectures 5A-E**

5A – Cervical Degenerative Techniques

Grand Ballroom Center/West, Lower Concourse

Moderator: Jacob M. Buchowski, MD, MS

7:30 – 7:35 Introduction
Jacob M. Buchowski, MD, MS

7:35 – 7:50 Cervical Spondylosis
- Natural history
- Clinical and radiographic evaluation
- Treatment of axial neck pain

Jacob M. Buchowski, MD, MS

7:50 – 8:05 Treatment of Cervical Radiculopathy
- Pathophysiology of cervical radiculopathy
- Nonoperative treatment
- Operative treatment (anterior vs. posterior, fusion vs. non-fusion)

Jeffrey A. Goldstein, MD

8:05 – 8:20 Treatment of Cervical Myelopathy Pathophysiology of cervical myelopathy
- Nonoperative treatment
- Operative treatment (anterior vs. posterior, fusion vs. non-fusion)

Christopher Bono, MD

8:20 – 8:30 Discussion
Jacob M. Buchowski, MD, MS

5B – Lumbar Disc Replacement

Grand Ballroom East, Lower Concourse

Moderator: Richard Guyer, MD

7:30 – 7:45 Indications Ten Years Later
- Discussion of FDA indications
- Discussion of advanced indications
- Discussion special indications

John R. Dimar, II, MD

7:45 – 8:00 Lessons Learned from the Five Year US IDE Studies
- Review five data for Charite, Prodisc, Maverick
- Are these results significantly better than fusion?
- Will be see increasing percentage of usage versus fusion?

James J. Yue, MD

8:00 – 8:15 Difficulty with Adoption Ten Years Later in the US
- Patient issues
- Cost of TDR vs. fusion
- Insurance issues

Richard Guyer, MD

8:15 – 8:30 New Advancements in Arthroplasty Third Generation Show Absorbing TDR
- Lateral TDR
- Advantages and disadvantages of various TDR strategies

Luiz Pimenta, MD

Meeting Agenda

Saturday, July 24, 2010 (continued...)

5C – Adolescent Idiopathic Scoliosis III
Civic Ballroom, Second Floor
Moderator: Daniel J. Sucato, MD, MS

7:30 – 7:38	Selecting Posterior Fusion Levels for AIS *Richard E. McCarthy, MD*
7:38 – 7:40	Discussion
7:40 – 7:48	Use of Pedicle Screws and DVR for AIS *Se-Il Suk, MD*
7:48 – 7:50	Discussion
7:50 – 7:58	When is an Anterior Approach Appropriate for AIS *David S. Marks, FRCS*
7:58 – 8:00	Discussion
8:00 – 8:08	Intraoperative Neuromonitoring and Responses to Critical Changes *Daniel J. Sucato, MD, MS*
8:08 – 8:10	Discussion
8:10 – 8:30	Case Presentations

5D - Treatment of Vertebral Compression Fractures
Dominion Ballroom North, Second Floor
Moderator: Isadore H. Lieberman, MD, MBA, FRCSC

7:30 – 7:42	The Most Recent Literature Supporting Vertebral Augmentation *Steven C. Ludwig, MD*
7:42 – 7:54	PMMA Alternatives and New Cement Technologies for Osteoporotic Fractures *David W. Polly, Jr., MD*
7:54 – 8:06	Role of Vertebral Augmentation in Trauma and for Pedicle Screw Augmentation *Michael W. Groff, MD*
8:06 – 8:18	Vertebral Augmentation for Osteolytic Fractures *Isadore H. Lieberman, MD, MBA, FRCSC*
8:18 – 8:30	Discussion

5E - Adult/Pediatric Deformity: My Worst Complication and How I Treated It
Dominion Ballroom South, Second Floor
Moderator: Lawrence G. Lenke, MD

7:30 – 7:35	Introduction *Lawrence G. Lenke, MD*
7:35 – 7:43	My Worst Complication *B. Stephens Richards, III, MD*
7:43 – 7:51	My Worst Complication *Khaled Kebaish, MD*
7:51 – 7:59	My Worst Complication *Peter O. Newton, MD*
7:59 – 8:07	My Worst Complication *Steven J. Lewis, MD, MSc, FRCSC*
8:07 – 8:15	My Worst Complication *Lawrence G. Lenke MD*
8:15 – 8:30	Discussion & Summary

8:30 – 9:15 **Hands-On Demonstrations 5A-E***
Osgoode Ballroom, Lower Concourse
See "Exhibits and Hands-On Sessions" section for more information.

Meeting Agenda

Saturday, July 24, 2010 (continued...)

9:15 – 11:15 **Concurrent Sessions #5A & B and Spine Fundamentals Session**

Concurrent Session #5A: ADOLESCENT IDIOPATHIC SCOLIOSIS & COMPLICATIONS

Grand Ballroom Center/West, Lower Concourse

Moderators: Jacob M. Buchowski, MD, MS
Ahmet Alanay, MD

9:15 Paper # 82: Restoration of Thoracic Kyphosis in the Treatment of Adolescent Idiopathic Scoliosis Using a Sagittal Adjusting Screw
Kamran Z. Hassan, FRCS; John A. Ferguson, FRACS

9:19 Paper # 83: Adding Fusion to the Thoracic Curve in Lenke 5 Curves - Risks and Benefits
Robert Lark, MD; Burt Yaszay, MD; Tracey Bastrom, MA; Peter O. Newton, MD; Harms Study Group United States

9:23 Paper # 84: Rod Strength: Is it an Important Factor in Coronal and Sagittal Realignment after Surgery for Adolescent Idiopathic Scoliosis?
Suken A. Shah, MD; Peter O. Newton, MD; Baron S. Lonner, MD; Harry L. Shufflebarger, MD; Tracey Bastrom, MA; Michelle C. Marks, PT, MA; Harms Study Group

9:27 Discussion

9:35 Paper # 85: Vertebral Coplanar Alignment for Correction of Thoracic Scoliosis: Techniques and Clinical Results
Yong Qiu, MD; Feng Zhu; Bin Wang, MD; Yang Yu; Zezhang Zhu, MD; Bangping Qian; Xu Sun, MD, PhD

9:39 Paper # 86: Correction of Moderate (<70-degree) Lenke 1A and 2A Curve Patterns: Comparison of Hook, Hybrid and All-Pedicle Screw Systems at Two-Year Follow-Up
Scott J. Luhmann, MD; Lawrence G. Lenke, MD; Mark A. Erickson, MD; Keith H. Bridwell, MD; B. Stephens Richards, MD

9:43 Paper # 87: Radiographic Assessment of Shoulder Position in 619 AIS Patients: Can T1 Tilt be Used as an Intraoperative Proxy to Determine Postoperative Shoulder Balance?
Scott J. Luhmann, MD; B. Stephens Richards, MD; Charles E. Johnston, MD; Daniel J. Sucato, MD, MS; Lori A. Karol, MD

9:47 Discussion

9:55 Paper # 88: The Use of Low Dose Tranexamic Acid Reduces Blood Loss and Blood Transfusions in Adolescent Idiopathic Scoliosis Surgery
Lukas P. Zebala, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Colin E. Nabb, BS; Scott J. Luhmann, MD; Samuel K. Cho, MD; Joshua M. Pahys, MD; Matthew M. Kang, MD; Woojin Cho, MD, PhD; Brenda Sides, MA

9:59 Paper # 89: Selective Thoracic Fusion in Lenke 1C Curves: Prevalence and Criteria
Charles H. Crawford, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; John B. Emans, MD; Michael G. Vitale, MD, MPH; Mark A. Erickson, MD; James O. Sanders, MD; Keith H. Bridwell, MD

10:03 Paper # 90: Cross-Ethnicity Comparisons of the Scoliosis Research Society Outcomes Instrument in Adolescent Idiopathic Scoliosis
Lee J. Morse, MD; Noriaki Kawakami, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; James O. Sanders, MD; Mohammad Diab, MD

10:07 Discussion

Meeting Agenda

Saturday, July 24, 2010 (continued...)

10:15 Paper # 91: Does More Complete Thoracic Apical Vertebral Derotation Really Help with the Rib Prominence?
Peter O. Newton, MD; Krishna C. Ravi; Tracey Bastrom, MA; Burt Yaszay, MD

10:19 Paper # 92: Direct Vertebral Body Derotation: How Much Correction of the Rib Hump Can Be Expected?
Steven W. Hwang, MD; Amer F. Samdani, MD; Baron S. Lonner, MD; Peter O. Newton, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Randal R. Betz, MD; Patrick J. Cahill, MD

10:23 Paper # 93: Direct Vertebral Body Derotation, Thoracoplasty or Both: Which is Better with Respect to Inclinometer and SRS-22 Scores?
Steven W. Hwang, MD; Amer F. Samdani, MD; Peter O. Newton, MD; Baron S. Lonner, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Patrick J. Cahill, MD; Randal R. Betz, MD

10:27 Discussion

10:35 Paper # 94: A Simple and Effective Method for Directing the Sagittal Placement of Thoracic Pedicle Screws without Intraoperative Imaging
Kenneth M. Cheung, MD; Tarek A. El-fiky, MD; Dino Samartzis, DSc, PhD, MSc; Wai Yuen Cheung, MD; Yatwa Wong; Keith D. Luk, MD

10:39 Paper # 95: Comparison of Traction Radiographs Taken Under General Anesthesia with Conventional Flexibility Graphies in AIS Patients: Which is Better?
Azmi Hamzaoglu, MD; Ahmet Alanay, MD; Cagatay Ozturk, MD; Levent Ulusoy; Selhan Karadereler; Mehmet Tezer

10:43 Paper # 96: Factors Predicting Coronal Decompensation of Lenke 1 Curves Following Selective Fusion
Michael G. Vitale, MD, MPH; Daniel J. Miller, BS; Daniel J. Sucato, MD, MS; John B. Emans, MD; Mark A. Erickson, MD; James O. Sanders, MD; Lawrence G. Lenke, MD; B. Stephens Richards, MD

10:47 Discussion

10:55 Paper # 97: Do Contiguous Multilevel Pedicle Screws Offer Added Curve Correction over Alternate Level Screw Strategy in AIS Patients when Curve Flexibility is Taken into Account?
Kenneth M. Cheung, MD; Dino Samartzis, DSc, PhD, MSc; Keyi Yu, MD; Deepa Natarajan, MBBS; Wai Yuen Cheung, MD; Yatwa Wong; Jianxiong Shen, MD; Keith D. Luk, MD; Guixing Qiu

10:59 Paper # 98: Sagittal Plane Changes According to the Thoracic Kyphosis Change Following Posterior Segmental Spinal Instrumented Fusion of Adolescent Idiopathic Scoliosis
Yongjung J. Kim, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Oheneba Boachie-Adjei, MD; Munish C. Gupta, MD; Jean-Luc Clement, MD; Thomas D. Cha, MD, MBA; Samuel K. Cho, MD

11:03 Paper # 99: Comparison of Different Weights in the Use of Intra-Operative Skull-Skeletal Traction for Correction of Adolescent Idiopathic Scoliosis
Sooyong Chua; Doron Rabin, MD; Ahmed Al-Jahwari, MD; Sarah Bacon; Randolph J. Gray, MD, FRACS; Reinhard D. Zeller, MD; Sofia Magana; Stephen J. Lewis, MD, MSc, FRCSC

11:07 Discussion

Meeting Agenda

Saturday, July 24, 2010 (continued...)

Concurrent Session #5B: COMPLICATIONS & MONITORING

Grand Ballroom East, Lower Concourse

Moderators: Suken A. Shah, MD
Mark Weidenbaum, MD

9:15 Paper # 100: What Dose of Interbody rhBMP-2 is Optimal for TLIF? Large Study Complications and Outcomes
Jason Datta, MD; Dennis Crandall, MD; Ryan McLemore, PhD; Jan Revella, RN; Michael S. Chang, MD; Terrence Crowder, MD

9:19 Paper # 101: Transforaminal Lumbar Interbody Fusion with rhBMP-2 followed Four Years: A Large Series with Diagnosis-Based Outcomes and Complications
Dennis Crandall, MD; Eric Huish, BS; Ryan McLemore, PhD; Jan Revella, RN; Jason Datta, MD; Michael S. Chang, MD; Terrence Crowder, MD

9:23 Paper # 102: Comparison of the Incidence of Radiculitis and Radiographic Adverse Event Following Minimally Invasive Lumbar Transforaminal Interbody Fusions (MIS-TLIF) With and Without the Use of Bone Morphogenetic Protein (BMP)
Randolph J. Gray, MD, FRACS; Y. Raja Rampersaud, MD, FRCSC

9:27 Discussion

9:35 Paper # 103: Perioperative Neurologic Events from a Multicenter Consecutive Series of Pediatric Vertebral Column Resection: Nature, Frequency and Outcomes
Suken A. Shah, MD; Daniel J. Sucato, MD, MS; Peter O. Newton, MD; Harry L. Shufflebarger, MD; John B. Emans, MD; Paul D. Sponseller, MD; Geraldine Neiss, PhD; Petya Yorgova; Lawrence G. Lenke, MD

9:39 Paper # 104: Clinical Outcomes and Complications Following Spinal Deformity Correction with Smith-Petersen Osteotomies
Ian G. Dorward, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Woojin Cho, MD, PhD; Matthew M. Kang, MD; Linda Koester

9:43 Paper # 105: The Impact of Obesity on the Incidence of Adverse Events Following Spine Surgery
Frederick H. Cheng; Caitlyn E. Paget, BASc; Angela M. Sarro, RN, MN; Rosalie Magtoto, RN,BScN, MN; Mary Ann Neary, Speech-Language Pathology; Stephen J. Lewis, MD, MSc, FRCSC; Eric Massicotte, MD, FRCSC; Michael G. Fehlings, MD, PhD; Y. Raja Rampersaud, MD, FRCSC

9:47 Discussion

9:55 Paper # 106: Prospective Analysis of Primary Pyogenic Infection of the Spine in Intravenous Drug Users
John Street, MD, PhD; Brian Lenehan, MD; Michael Boyd, MD; Marcel F. Dvorak, MD; Brian K. Kwon, MD, PhD, FRCSC; Scott Paquette, MD; Charles G. Fisher, MD, MHSc

9:59 Paper # 107: Spine Adverse Events Severity System (SAVES-V2): Multicenter Development with Inter-Intra Observer Reliability Assessment
Y. Raja Rampersaud, MD, FRCSC; Paul Anderson, MD, FRCSC; Charles G. Fisher, MD, MHSc; John R. Dimar, MD

10:03 Paper # 108: Assessment of Factors Predictive Of Post-Operative Infection in 941 Spinal Deformity Patients
Kushagra Verma, MS; Baron S. Lonner, MD; Laura E. Dean, BA; David Vecchione; Antonio Valdevit, MSc; Kathryn E. Kean, BA

10:07 Discussion

Meeting Agenda

Saturday, July 24, 2010 (continued...)

10:15 Paper # 109: Incidence and Risk Factors of DVT and PE Following Major Spinal Surgery
Leah Schulte; Joseph R. O'Brien, MD, MPH; Warren Yu, MD

10:19 110. Prospective Side by Side Comparison of Hydroxyapatite Coated Collagen Matrix vs. Iliac Crest Autograft in Lumbar Arthrodesis
Clyde T. Carpenter, MD

10:23 Paper # 111: Outcomes of Revision vs. Primary Transforaminal Interbody Fusion in 282 Patients
Michael S. Chang, MD; Dennis Crandall, MD; Jan Revella, RN; Ryan McLemore, PhD; Jason Datta, MD; Terrence Crowder, MD

10:27 Discussion

10:35 Paper # 112: XLIF at L4-5 and the Protective Effect of Prophylactic Dexamethasone
W. B. Rodgers, MD; Edward J. Gerber, PA-C; Jody A. Rodgers, MD, FACS

10:39 Paper # 113: Complications Associated with Axial Lumbar Interbody Fusion
Emily M. Lindley, PhD; Matthew McCullough; Courtney W. Brown, MD; Evalina L. Burger, MD; Vikas V. Patel, MD

10:43 Paper # 114: Complications in 783 XLIF Surgeries
W. B. Rodgers, MD; Edward J. Gerber, PA-C; Jody A. Rodgers, MD, FACS

10:47 Discussion

10:55 Paper # 115: Can Intraoperative Spinal Cord Monitoring Reliably Help Prevent Paraplegia during Posterior VCR Surgery?
Samuel K. Cho, MD; Lawrence G. Lenke, MD; Shelly Bolon, BS, CNIM; Joshua M. Pahys, MD; Woojin Cho, MD, PhD; Matthew M. Kang, MD; Lukas P. Zebala, MD; Linda Koester

10:59 Paper # 116: Dual Motor Monitoring Using Transcranial Motor Evoked Potentials and Neurogenic MEP's During Spinal Deformity Surgery May Offer the Best of Both for Challenging Deformity Surgery
Daniel J. Sucato, MD, MS; Jessica Wingfield, BA; Anna McClung, RN; Steven Sparagana, MD; Patricia Rampy, MS

11:03 Paper # 117: Prompt Response to Critical Spinal Cord Monitoring Changes During Vertebral Column Resection Results in a Low Incidence of Permanent Neurologic Deficit
Daniel J. Sucato, MD, MS; Suken A. Shah, MD; Lawrence G. Lenke, MD; Peter O. Newton, MD; John B. Emans, MD; Harry L. Shufflebarger, MD; Paul D. Sponseller, MD

11:07 Discussion

Meeting Agenda

Saturday, July 24, 2010 (continued...)

Fundamentals Session: CERVICAL SPINE
Civic Ballroom, Second Floor
Moderator: Praveen Mummaneni, MD

9:15 – 9:20	Introduction/Present Case of Cervical Myelopathy with a Straight Spine *Praveen V. Mummaneni, MD*
	DEBATE:
9:20 – 9:30	Posterior Cervical Decompression and Fusion is the Best Treatment Option *Richard C. Sasso, MD*
9:30 – 9:40	Posterior Cervical Laminoplasty is the Best Treatment Option *Michael F. O'Brien, MD*
9:40 – 9:45	Discussion and Present Case 2: Paracentral Herniated Disc with Radiculopathy *Praveen Mummaneni, MD*
9:45 – 9:55	Anterior Decompression and Fusion or Anterior Arthroplasty is the Best Treatment Option *Christopher I. Shaffrey, MD*
9:55 – 10:05	Posterior Cervical Foraminotomy is the Best Treatment *Brian K. Kwon, MD, PhD, FRCSC*

11:15 – 13:20 **General Session #6: MISCELLANEOUS & COMPLICATIONS**
Grand Ballroom Center/West, Lower Concourse
Moderators: Ensor E. Transfeldt, MD
Christopher Bono, MD

11:15	**Presentation of Whitecloud Awards**
11:20	Paper # 118: Cost-Effectiveness of Total Disc Replacement vs. Lumbar Fusion *Alexander Tuschel, MD, MSc, MBA; Michael Meissl; Michael Ogon*
11:24	Paper # 119: Cost Comparison of Total Disc Replacement vs. Fusion in Patients with Insurance Denial for Disc Replacement *Donna Ohnmeiss, PhD; C. Shane Hume, DO; Scott L. Blumenthal; Richard D. Guyer, MD; Jack E. Zigler, MD*
11:28	Paper # 120: Comparison of Radiographic Findings of Total Disc Replacement vs. Anterior Cervical Fusion: 24-Month Follow-Up from a Prospective, Randomized, Controlled, Multicenter Trial *David Musante, MD; Richard D. Guyer, MD; Dom Coric, MD; Charley Gordon; Pierce D. Nunley, MD; Cameron N. Carmody, MD*
11:32	Discussion
11:40	Paper # 121: Does an Electronic Conductivity Device Contribute to the Safety of Pedicle Screw Insertion in Scoliosis Surgery? *Elisha Ofiram; Akiva S. Korn, MMedSc; Dror Ovadia, MD*
11:44	Paper # 122: Prospective, Randomized, Controlled, Multicenter FDA IDE Trial Comparing Cervical Total Disc Replacement to Anterior Cervical Fusion: 24-Month Follow-Up *David Musante, MD; Richard D. Guyer, MD; Dom Coric, MD; Charley Gordon; Pierce D. Nunley, MD; Cameron N. Carmody, MD*
11:48	Paper # 123: Relationship between Global Range of Motion and Clinical Outcomes in Lumbar Disc Arthroplasty Patients *Megan Gornet; John H. Peloza, MD; Elizabeth A. Jones, MD; John A. Hipp, PhD; Francine W. Schranck, BSN*
11:52	Discussion
12:00	Paper # 124: Demographics, Clinical and Radiographic Results of Kyphoplasty. Follow Up from Two Weeks to Five Years *Vivek Mohan, MD, MS; Fernando Techy, MD; Robert C. Ryu, MD; Charles C. Paik, MD; Anis Mekhail, MD*

Meeting Agenda

Saturday, July 24, 2010 (continued...)

12:04 Paper # 125: Post-Operative Improvement In Health Related Quality Of Life: A National Comparison Of Surgical Treatment For Focal (1-2 Level) Lumbar Spinal Stenosis Compared To Total Joint Replacement For Osteoarthritis (OA)
Y. Raja Rampersaud, MD, FRCSC; Eugene K. Wai, MD, MSc, CIP, FRCSC; Edward Abraham, MD, FRCSC; David I. Alexander, MD, FRCSC; Roderrick Davey, MD, FRCSC; Marcel F. Dvorak, MD; Joel Finkelstein, MD, FRCSC; Charles G. Fisher, MD, MHSc; Rajiv Gandhi, MS, MD, FRCSC; Stephen J. Lewis, MD, MSc, FRCSC; Nizar Mahomed, MD, ScD, FRCS(C); William Oxner, MD FRCSC; Albert Yee, MD, FRCSC

12:08 Paper # 126: Identifying Predictors of Worsening ODI Scores after Lumbar Spine Fusion
Jeffrey D. Stimac, MD; Leah Y. Carreon, MD, MSc; Steven D. Glassman, MD

12:12 Discussion

12:20 Paper # 127: Instrumented Lumbar Corpectomy and Spinal Reconstruction Comparing rhBMP-2/Compression Resistant Matrix (CRM), rhBMP-2/ Absorbable Collagen Sponge (ACS)/Ceramic Granules Mixture and Autograft in Two Different Devices- A Sheep Study
David G. Schwartz, MD; Jeffrey M. Toth, PhD; Jean-Pierre Mobasser, MD; Joseph Riina, MD; Eric Potts; Shane Rose; Kathy Flint, MSN

12:24 Paper # 128: The Use of a Bipolar Sealer For Haemostasis in Spinal Surgery
Viviana F. Paliotta, MD

12:28 Paper # 129: Metabolic Syndrome (MetS) Increases the Risk of Prevalent Spine Osteoarthritis
Rajiv Gandhi, MS, MD, FRCSC; Kenneth Woo; Y. Raja Rampersaud, MD, FRCSC

12:32 Discussion

12:40 Paper # 130: Spine Surgery at an Ambulatory Surgery Center
Kenneth A. Pettine, MD; Lukas Eisermann, BS

12:44 Paper # 131: The 15-Year Evolution of the Thoracoscopic Anterior Release: Does it Still Have a Role?
Rattalerk Arunakul; Alexander B. Peterson; Eric S. Varley, DO; Peter O. Newton, MD

12:48 Paper # 132: Scoliosis Surgery in Patients with Adolescent Idiopathic Scoliosis Does Not Alter Lung Volume: A Three-Dimensional CT Based Study
Terry Amaral, MD; Etan P. Sugarman, MSIV; Adam L. Wollowick, MD; Beverly Thornhill, MD; Vishal Sarwahi, MD

12:52 Discussion

13:00 Paper # 133: Instrumenting Proximal to the Left Bending Stable Vertebra in Lenke IA and IB Adolescent Idiopathic Scoliosis Predicts Adding On
Hossam Salah, MD, FRCS; Hazem B. Elsebaie, FRCS, MD; Ahmed Ezz

13:04 Paper # 134: Melatonin Modulates the Proliferation and Differentiation of Human Growth Plate Chondrocytes
Guangquan Sun, PhD; Hiu Yan Yeung; Wei-jun Wang; Kwong-man Lee, PhD; Zhen Liu; Yong Qiu, MD; Jack C. Cheng, MD

13:08 Discussion

13:16 **Adjourn**

Paper Abstracts

The Scoliosis Research Society
gratefully acknowledges DePuy Spine,
for their overall support of the 17th IMAST.

DePuy
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Paper Abstracts

1. FDA IDE Prospective Randomized Comparison Of Three Lumbar Artificial Disc Replacements (ADR) With Minimum Three Year Follow Up

Kenneth A. Pettine, MD; Lukas Eisermann, BS
United States

Summary: This is class I data comparing three lumbar ADR.

Introduction: To establish safety and efficacy between the Maverick™ (M), Charité ™(C), and Kineflex™ (K) A.D.R.'s. Follow up on three ADR's performed by two surgeons, at one I.D.E. site were reviewed.

Methods: ODI, VAS, and patient satisfaction were evaluated at pre-op and post-op visits.Indications for surgery were similar to lumbar fusion. There were 25 Maverick, 31 Charité, and 35 Kineflex patients. The majority of A.D.R.'s were performed at L5-S1 vs. L4-L5 (M) 19 to 6, (C) 19 to 12 and (K) 28 to 7. Inclusion/exclusion criteria will be discussed. Success was defined as an improvement of 15 or more points in Oswestry Disability Index (ODI) with no revision or device removal and no major device related adverse events.

Results: Re-operations included: (M) 1 infection , (C) 3 implant complications (K) 1 implant complication. These cases will be presented. ODI results for all groups: Pre-op = (M) 57.6, (C) 63.8, and (K) 61.1; One-year post-op = (M) 16.3, (C) 27.3, and (K) 20.4; Three-year post-op = (M) 14.6 ($p<0.001$), (C) 20.5 ($p<0.001$), and (K) 19.3 ($p<0.001$)

VAS results for all groups: Pre-op = (M) 74.1, (C) 85, (K) 83.9; One year post-op = (M) 27.9, (C) 31.4, and (K) 27.3; Three-year post-op = (M) 20.5 ($p<0.001$), (C) 33.8 ($p<0.001$), and (K) 26.9 ($p<0.001$)

Clinical success was met in (M) 90%, (C) 83.5%, (K) 90.5% of patients. Patients with a VAS less than 2 occurred in (M) 68%, (C) 29%, (K) 47%. Patients with an ODI less than 10 occurred in (M) 67% (C) 33%, (K) 52%.

Patient satisfaction at three-year follow up was (M) 96%, (C) 84%, and (K) 91%.

Conclusion: All three ADR's demonstrated safety with a trend to more device related complications with (C) 3 compared to (M) 1 and (K) 1. They all showed efficacy with a statistically significant improvement in ODI and VAS at three year follow-up ($p<0.001$). F.D.A. clinical success was (M) 90%, (C) 83.8%, (K) 90.5%.

Significance: This is the only class one data comparing three ADR's from one IDE site.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

2. Direct Comparison of Two Lumbar Total Disc Replacement Devices: Results from a Prospective, Randomized, Multicenter FDA-Regulated Trial

Richard D. Guyer, MD; Kenneth A. Pettine, MD; Dom Coric, MD; Pierce D. Nunley, MD; David Musante, MD
United States

Summary: This study provided a prospective randomized comparison of two lumbar TDR devices in 457 patients with single-level painful disc degeneration. Both groups improved significantly with no differences between groups and there was a high patient satisfaction rate. These results support that TDR provides favorable and consistent results in appropriately selected patients.

Introduction: Randomized trials have reported total disc replacement (TDR) to produce results similar or superior to lumbar fusion. Reported results for various TDRs appear to be similar, but differences in study design and outcome measures pose challenges in definitively comparing devices. The purpose of this study was to perform a direct comparison of two lumbar TDRs in a prospective, randomized trial.

Methods: TDR was performed in 457 patients from 21 sites (261 subjects in the investigational group (Kineflex Disc; metal-on-metal design, 204 randomized and 57 non-randomized training cases), and 196 in the control group (Charité Artificial Disc, metal with polyethylene core; 190 randomized and 6 non-randomized training cases)). All patients were treated for single-level symptomatic disc degeneration of at least 6 months duration. Outcome measures were the Oswestry Disability Index (ODI), visual analog scale (VAS) assessing pain intensity, patient satisfaction, re-operation, and overall success defined to be at least 25% improvement in ODI scores, no re-operation, and no major adverse events. Patients were randomly assigned to the investigational or control group. Data were collected prospectively pre-operatively and at 6 weeks, and 3, 6, 12, and 24 months post-operatively.

Results: There were no significant differences between the groups when comparing operative time, blood loss, or length of hospital stay. Both groups improved significantly on Oswestry and VAS scores ($p<0.01$; see table) with no differences between the groups. Success rates were similar (75.5% investigational vs. 73.5% control). At 24-month follow-up, 94.1% of the investigational group and 91.9% of controls were satisfied with outcome. Re-operation was performed in 5.4% of the investigational group and 6.6% of controls.

Conclusion: This prospective, randomized, controlled study comparing two TDRs, the first to the authors' knowledge, found the devices produced very similar clinical outcomes. Both groups improved significantly by 6 weeks post-operative and remained improved throughout follow-up with a high patient satisfaction rate.

Significance: This study supports that TDR produces favorable outcomes and consistent results between devices in appropriately selected patients.

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3. Lumbar Disc Arthroplasty vs. Anterior Lumbar Interbody Fusion: Five-Year Outcomes for Patients in an IDE Study

Matthew F. Gornet; Randall F. Dryer, MD; John H. Peloza, MD
United States

Summary: Up to 5-year interim outcomes in the continuation of the Maverick® IDE trial resulted in improved physical function, reduced pain, and greater patient satisfaction.

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Introduction: The 2-year FDA IDE trial demonstrated the clinical outcomes superiority of lumbar disc arthroplasty (LDA) using Maverick when compared with anterior interbody fusion (ALIF) with INFUSE®/LT-CAGE®. This presents 5-year interim outcomes (follow-up at 5 years is ongoing) for patients in the continuation of the Maverick trial.

Methods: A prospective RCT at 31 centers. 405 investigational (LDA) and 172 control (ALIF) patients with single-level disc disease (L4-S1). ODI, SF-36, back and leg pain, neuro status, and work status were assessed, as well as disc height, angular motion, and fusion success.

Results: Mean improvement for ODI, SF-36 PCS, back pain and leg pain was significant ($p<0.001$) vs pre-op for both groups at all follow-up intervals. ODI improvement was noteworthy for both LDA (n=370/138) and ALIF (n=261/99) groups (LDA 33.8/34.9 points; ALIF 29.2/29.9 points) at 24/60 months respectively, surpassing reported mean ODI improvements for all devices in previous IDE studies for LDA. At each follow-up beyond 3 months, >80% of LDA patients and >70% of ALIF patients reported ODI improvement of at least 15 points. Statistical superiority was concluded for LDA at all intervals, including 24 months for ODI ($p= 0.004$), SF-36 PCS ($p=0.009$), back pain scores ($p=0.022$), and patient satisfaction ($p=0.003$). At 5 years, LDA statistical superiority is concluded for ODI ($p=0.009$), SF-36 PCS ($p=0.002$) and patient satisfaction ($p=0.043$). LDA patients returned to work 21 days sooner. At both 2 and 5 years, >70% of patients in each group were working. At 5 years post-op, 87.0% of LDA patients said they would have the surgery again, vs. 82.7% for ALIF ($p=0.190$). Seven second surgeries in 4 additional patients occurred at the index level after 24 months in both the LDA group and the ALIF group, although more than twice as many LDA patients were followed. There was no second surgery after 36 months in the LDA group.

Conclusion: Consistent with the 2-year IDE study outcomes, treatment of single-level lumbar degenerative disease with the Maverick Disc resulted in outstanding clinical outcomes at 5 years after surgery, including Oswestry and SF-36 PCS, resulting in improved physical function, reduced pain, and greater patient satisfaction.

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4. Complications with rhBMP-2 in Posterolateral Spine Fusion Associated with Dural Tear

Steven D. Glassman, MD; Jeffrey L. Gum, MD; Charles H. Crawford, MD; Christopher B. Shields, MD; Leah Y. Carreon, MD, MSc
United States

Summary: In a propensity matched cohort of patients who had a dural tear which was repaired during decompression and posterolateral lumbar spine fusion using rhBMP-2/ACS, there were no significant differences in any HRQOL parameter between the groups with or without a dural tear at either one or two years postoperatively. The data suggests that the presence of a repairable dural tear is not necessarily an impediment to the use of rhBMP-2 in posterolateral fusion.

Introduction: Potential complications related to ectopic bone formation, as with TLIF, have always been a concern with the use of bone morphogenetic proteins. Complications related to the proinflammatory effects of rhBMP-2, such as swelling and edema in the cervical spine, have also been observed. A recent animal study reports "in the presence of a SCI and/or dural tear, rhBMP-2 diffuses intrathecally and activates a signaling cascade in all major CNS cell types, which may increase glial scarring and impact neurologic recovery". This observation generates concerns for the much more common scenario of a dural tear associated with lumbar decompression and fusion.

Methods: From a consecutive series of 1037 patients who underwent decompression and posterolateral lumbar spine fusion using rhBMP-2/ACS between 2003 and 2006, intraoperative dural tear was reported in 58 cases (5.6%). These 58 cases were propensity score matched to a group without dural tear, based on age, smoking status, number of surgical levels and pre-operative ODI, SF-36 PCS, SF-36 MCS and back and leg pain scores. The patients with a dural tear were then compared to the matched cohort with regards to 2 year patient based outcome measures. Particular attention was given to indices of leg pain which might reflect an influence of rhBMP-2 on neurologic function or impaired neurologic recovery.

Results: Statistically significant improvement was observed in all HRQOL measures, except SF-36 MCS, at both one and two years postoperatively in both groups. There were no significant differences in any HRQOL parameter between the groups with or without a dural tear at either one or two years postoperatively. In particular, the leg pain improvement, 2.2 points in the group with a dural tear and 2.4 points in the group without a dural tear, was statistically equivalent.

Conclusion: The data suggests that the presence of a repairable dural tear is not necessarily an impediment to the use of rhBMP-2 in posterolateral fusion. Further studies are needed to address the less common clinical scenario of BMP use in conjunction with spinal cord injury. Finally, avoidance of BMP use may still be prudent in the setting of an unrepairable dural tear.

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5. Does Duration of Symptoms Influence the Outcome of Treatment of Lumbar Spinal Stenosis (SS) or Degenerative Spondylolisthesis (DS)?

Kristen E. Radcliff, MD; Jeffrey A. Rihn, MD; Emily Blood, PhD; Wenyan Zhao, M.S.; Alan Hilibrand, MD; D. Greg Anderson, MD; Alexander R. Vaccaro, MD, PhD; Todd J. Albert, MD; James N. Weinstein, DO, MS
United States

Summary: Patients with SS with > 12 months of symptoms had worse outcomes relative to those with < 12 months. Patients with DS did not have different outcomes according to duration of symptoms.

Introduction: The purpose of this study was to determine if the duration of symptoms affects outcome of treatment of SS or DS.

Methods: An analysis was performed on patients enrolled in the Spine Patient Outcomes Research Trial (SPORT) for the treatment of SS or DS. A comparison was made between SS patients with symptoms ≤12 months (n=405) and >12 months (n=227). A comparison was also made between DS patients with symptoms ≤12 months

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(n=397) and >12 months (n=204). Baseline patient characteristics and standardized outcomes were measured at follow-up time intervals up to 4 years. The difference in improvement with surgical versus nonsurgical treatment (treatment effect) was determined at each follow-period. The authors would like to acknowledge funding from the following sources:The National Institute of Arthritis and Musculoskeletal and Skin Diseases (U01-AR45444) and the Office of Research on Women's Health, the National Institutes of Health, and the National Institute of Occupational Safety and Health, the Centers for Disease Control and Prevention.

Results: At final followup, primary outcome measures were significantly worse in SS patients with symptoms > 12 months. Surgically treated SS patients with symptoms > 12 months had worse SF36 bodily pain (30.8 vs 23.8, p <0.007), SF36 Physical function (24.7 vs. 16.9, p < 0.002), and ODI scores (-22.3 vs. -16.2, p<0.002). Nonoperatively treated spinal stenosis patients with symptoms > 12 months had worse SF36 bodily pain (15.3 vs 6.2, p <0.019) and ODI scores (-10.3 vs. -4.6, p<0.049). There was a statistically significant increase in the rate of additional surgeries in the spinal stenosis patients with longer symptom duration (9% vs. 19%, p<0.01). Primary and secondary outcome measures within the DS group did not differ according to symptom duration. There was no significant difference in treatment effect according to symptom duration in either SS or DS groups.

Conclusion: Symptom duration > 12 months was associated with worse outcome of treatment of SS but not DS. Surgically treated patients with SS and DS had improved outcomes relative to nonoperatively treated patients.

Significance: This information may guide patients and physicians when counseling about the outcome of treatment.

6. Assessment of the Incremental Cost-Utility of Surgery Compared to Medical Management for the Treatment of Hip, Knee and Spine Osteoarthritis

Y. Raja Rampersaud, MD FRCSC; Peggy Tso; Kevin R. Walker, BSc; Brendan Eagen, MASc; Stephen J. Lewis, MD, MSc, FRCSC; Rajiv Gandhi, MS, MD FRCSC; Roderrick Davey, MD FRCSC; Nizar Mahomed, MD, ScD, FRCS(C); Peter C. Coyte, PhD
Canada

Summary: This prospective cohort study demonstrates that surgical management of primary OA of the spine, hip and knee is cost-effective and comparable from a health system perspective.

Introduction: The purpose of this study was to compare the incremental cost-utility of spinal decompression and decompression with fusion for spinal stenosis versus THA and TKA for primary OA.

Methods: An incremental cost-utility analysis from a health system perspective (direct cost) based on a observational, matched-prospective cohort study combined with retrospectively collected costs was performed. Patients who had undergone elective primary 1-2 level decompression with or without fusion for focal lumbar spinal stenosis (FLSS) were compared with a matched (age, sex, and time of surgery) cohort of patients who had undergone THA or TKA for primary OA. The primary outcome was incremental cost-utility ratio ($/QALY), determined by using perioperative costs and SF-6D utility scores. SF-6D was collected preoperatively and annually over a 5-year follow-up period. Utility was modeled over the lifetime, quality-adjusted-life-years (QALY) were determined. Surgical cost included total perioperative, in-patient rehabilitation, and revision cost for each cohort over 5 years. Cost per QALY gained was calculated by estimating mean incremental (surgery compared to medical management) lifetime costs and QALYs for each diagnosis group after discounting costs and QALYs at 3%. Sensitivity analyses were conducted to determine factors affecting the value of each type of surgery.

Results: The 5-year post-surgical incremental cost-utility ratio (ICUR) was $4,091/QALY for THA, $5,038/QALY for TKA, and $3,530/QALY for combined spine surgery groups(Table 1). Sensitivity analyses, adjusting for +25% revision rate and lower confidence interval utility score, discounted at 3% produced an ICUR of $5,198/QALY for THA, $6,865/QALY for TKA, $3,301/QALY for spinal decompression surgery, and $19,909/QALY for spinal decompression surgery with fusion.

Conclusion: The ICUR for focal spinal stenosis surgery is similar to those of THA and TKA for the treatment of OA over the lifetime. Surgical management of primary OA of the spine, hip and knee is cost-effective.

7. Beyond the Learning Curve: Does the Accuracy of Pedicle Screw Placement Improve with Experience in AIS Patients: A CT-Based Analysis of 1356 Pedicle Screws

Etan P. Sugarman, MSIV; Vishal Sarwahi, MD; Adam L. Wollowick, MD; Melanie Gambassi, NP; Terry Amaral, MD
United States

Summary: Accuracy of pedicle screw (PS) placement over time was analyzed in 67 AIS patients. There was a plateau effect that was noticed with PS placement initially. However, with increasing surgeon's confidence a decrease in accuracy was seen.

Introduction: PS placement in Adolescent Idiopathic Scoliosis (AIS) is challenging. Few studies have described the learning curve, which vary from 80-120 PS. The objective of this study was to document improvement in PS placement after a surgeon has already placed over 400 screws.

Methods: 104 patients with AIS were evaluated for screw placement between 2005-2009. 67 patients with postop CT-scans were included. Criteria by Kim et al. was utilized. Misplaced screws were divided into anterior, medial and lateral. Charts and X-rays were reviewed to calculate Cobb angle, kyphosis, levels fused, estimated blood loss (EBL), operative time, and complications. Preoperative CT-scans were reviewed for evaluation of pedicle morphology. Linear regression analysis was performed to calculate improvement in PS placement over time.

Results: A total of 1356 PS were placed in 67 patients. 1203 were properly placed. 153 were malpositioned. There were 47 PS found to be anterior, 15 medial, and 91 lateral. There was improvement in the

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incidence of lateral PS ($p<0.001$), while the incidence of medial PS was unchanged($p=0.374$). The incidence of anterior breach increased over time($p<0.001$). The EBL per fixation point decreased with time($p=0.013$), as did the avg. time for PS insertion($p<0.001$). The avg. number of PS placed per fusion did not increase over time($p=0.194$). There were no vascular or neurological complications. No PS required revision. We found no correlation between increasing kyphosis and malposition rate($p=0.46$). Overall, the PS malposition rate was 11.3%.

Conclusion: While improvements continue in the surgical time, PS insertion time, and the EBL per fixation point, the PS accuracy, even after considerable experience, does not improve significantly.

Significance: After the initial learning curve, a plateau effect seems to appear. However, with increasing surgeon confidence, and placement of larger and longer screws (6-0x40mm) in the upper thoracic spine, an increase in anterior violations were seen. While operative time, PS insertion time, and blood loss continues to improve, additional strategies need to be identified to improve accuracy of PS placement. Availability of portable, intraoperative CT- scanner (O-arm) may be a step in this direction.

8. Asymmetric Pedicle Subtraction Osteotomy: A Useful Tool for Severe Scoliotic Deformities

Mohammad M. El-Sharkawi, MD; Wael Koptan, MD; Yasser ElMiligui, MD, FRCS
Egypt

Summary: Asymmetric PSO is poorly reported in the literature for correcting severe scoliotic deformities. This prospective multicenter study proves its safety and effectiveness when compared to staged anterior release and posterior fixation and fusion.

Introduction: Different spinal osteotomies have been described to improve the correction power and to eliminate the need for anterior release, application of traction as well as staged surgeries in severe spinal deformities. Pedicle Subtraction Osteotomy (PSO) has been extensively applied for correcting kyphosis of various etiologies. However, the use of asymmetric PSO for correcting coronal plane deformities has been inadequately reported in the literature. The aim of this work is therefore to study the outcome and safety of using asymmetric PSO in treating severe scoliotic deformity.

Methods: Twenty-two patients (14 females and 8 males, age range 15-27 years) with severe rigid scoliosis that does not correct on bending to less than 50° were treated by asymmetric PSO and were prospectively followed for a minimum of 2 years. This group was compared to a historical group of 25 patients treated earlier by the same surgeons by staged anterior release and posterior fixation and fusion 2 weeks later. Preoperative Cobb angle ranged between 75°-145° in the asymmetric PSO and between 70°-150° in the staged group. Both groups were stabilized posteriorly with pedicle screws only.

Results: The total operative time and the duration of hospital stay were significantly shorter in the asymmetric PSO group. The amount of blood loss was also significantly less in the asymmetric PSO group. The average preoperative Cobb angle improved from 110° to 38° postoperatively in the asymmetric PSO group (65%), and from 102° to 50° in the staged group (50%). The difference between the two groups was statistically significant in favor of the PSO group. Complications were minimal in both groups.

Conclusion: Asymmetric PSO appears to be a very effective tool to correct severe coronal plane deformities. It also minimizes blood loss, operative time and the duration of hospitalization when compared to two-stage procedures.

9. Clinical and Radiographic Factors that Distinguish Between the Best and Worst Outcomes of Scoliosis Surgery for Adults 18-45 Years Old

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United States

Summary: Young adult scoliosis patients treated surgically with the worst outcomes are older, have more baseline pain and narcotic use, have greater body mass index, and have a higher prevalence of depression/anxiety and smoking, compared to those with the best outcomes. Except for modest associations with follow-up sagittal balance and Cobb angle, no other radiographic or surgical parameters distinguished between patients with the best and worst outcomes.

Introduction: It remains unclear why some adults with scoliosis markedly improve with surgery, while others fail to improve. Our objective was to assess for factors that differ between patients aged 18-45 yrs with the best and worst outcomes following surgery for scoliosis.

Methods: This is a secondary analysis of a prospective multicenter deformity database. Inclusion criteria included: age 18-45, Cobb angle >20°, no prior instrumentation and availability of outcomes measures (ODI or SRS-22) at minimum of two years following surgery. Patients were sorted based on each outcome measure at follow-up, and the best and worst ~15% were selected for comparison.

Results: For ODI, best (ODI=0) and worst (ODI>30) groups consisted of 19 (22%) and 15 (17%) patients, respectively. For SRS-22, best (SRS-22>4.5) and worst (SRS-22<3.1) groups consisted of 15 (17%) and 13 (15%) patients, respectively. Factors that were statistically significantly different between the best and worst groups are summarized in Table 1. This included higher pre-operative pain levels, narcotic use, greater body mass index, higher proportions of depression/anxiety and smoking. There was a trend towards differences in follow-up sagittal balance and Cobb angles between the groups. There was no statistically significant difference in pre-operative Cobb angle, pre-operative coronal or sagittal balance, comorbidities, occurrence of minor or major complications, operative time, estimated blood loss, and need for revision surgery between the two groups.

Conclusion: Compared with those having the best outcomes, younger adult scoliosis patients treated surgically with the worst outcomes are older, have more pain and narcotic use at baseline, have greater BMI, and have higher proportions of depression/anxiety and smoking. Except for modest associations with follow-up SB and Cobb angle,

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the factors that distinguished between the patients with the best and worst outcomes were not radiographic or surgical parameters.

*10. Metanalysis of Class I and II Data on Results of Anterior Cervical Decompression and Fusion

Kenneth A. Pettine, MD; Lukas Eisermann, BS
United States

Summary: This abstract is a metanalysis of all class I and class II data available from five FDA IDE studies involving ACDF. The five studies include: the BAK-C cage and Affinity cage filled with local reaming of autogenous bone, versus intervertebral allograft without plating (two studies). The Prestige artificial disc, ProDisc artificial disc, and the Bryan artificial disc versus intervertebral allograft with plating (three studies).

Introduction: ACDF is perceived by the spinal surgery community to be one of the most efficacious of all spinal surgeries. If asked, most spine surgeons would answer a one-level ACDF is associated with a 95% fusion rate and 95% excellent clinical results for relief of neck and arm pain. All of the literature quoted to support this assertion is class III or class IV data. The purpose of this paper is to determine what the clinical results are of anterior cervical discectomy and fusion (ACDF).

Methods: The studies were analyzed for similarities in patient indications and outcomes assessment tools utilized. Outcomes measures that were reported in the same or similar fashion across studies were compared. Measures that were common to the trials and could thus be compared included the neck disability index (NDI), reoperation rate, neurological success rate, and composite success rate.

Results: At two year follow up the BAK-C had a 12% reoperation rate, the BAK-C control allograft without plating had a 17.5% reoperation rate, the Affinity cage had a 9.2% reoperation rate, the Affinity allograft control without plating had an 18.1% reoperation rate. This resulted in an overall reoperation rate of 12.7% of ACDF without plating. The studies involving an allograft with plating included the Bryan control, which had a 4.1% reoperation rate, the Prestige control had a 19.9% reoperation rate, and the ProDisc control had an 8.5% reoperation rate for an overall reoperation rate of 9.5% of ACDF with plating.

Clinical success based on greater than 15 points improvement in neck disability index, no reoperation at index or adjacent level and no neurologic deterioration was achieved in all of the plated studies with a range of 67.8%-72.7% for an overall average of 70% success.

Conclusion: Based on a metanalysis of class I and class II data, the true results of ACDF are a 10% reoperation rate at two-year follow-up due to pseudoarthrosis, adjacent level degeneration or revision of the index surgical site and a 70% clinical success.

Significance: These results emphasize the importance in differentiating the validity of information gained from class I and II versus class III and IV data.

*11. Correlation of Early Pain and Long-Term Functional Results from a Multi-Center, Prospective, Randomized, Controlled FDA-IDE Vertebroplasty Trial

Hyun W. Bae, MD
United States

Summary: This abstract presents long-term functional results of a trial comparing two materials used to treat osteoporotic VCF's. Self-reported measures on pain and function were given at all visits. The measures indicated that Cortoss treated VCF patients exhibited better functional results than PMMA treated patients.

Introduction: Vertebroplasty (PVP) has become the treatment of choice for acute painful fractures, however, prospective, randomized, comparative data that includes functional outcomes on effects beyond 12 months after treatment are lacking. The purpose is to present the long-term functional results observed in a multi-center trial comparing two materials used to treat osteoporotic VCF's: PMMA (P) and Cortoss™ (C), a bioactive material recently cleared by FDA.

Methods: A prospective, randomized, controlled study of vertebral augmentation comparing C and P in 256 patients, 162 C and 94 P. Follow-up was done at 7 days, 1, 3, 6, 12, and 24 months. Self-reported Visual Analog pain Scale (VAS) and Oswestry Disability Index (ODI) function scales were administered at baseline and at each follow-up. Success for pain was defined ≥20 point decrease from baseline and a score ≤50mm, function needed to be maintained or improved. All patients were followed for a minimum of 24 months post procedure.

Results: Median age was 78 years; 74% were females. 24-month data were obtained for 84.4% and 80.5% of C and P patients. Average VAS pain scores improved in both groups from 78mm at baseline to 20.1mm (C) and 21.3mm (P) at 24-Months. Significantly more C than P patients were successful for pain at the 3-month interval ($p<0.05$). The mean ODI scores are presented in Table 1. At 24 months 96.7% of patients treated with C maintained or improved their function compared to 88.4% of P patients ($p<0.05$).

Conclusion: The results show that the effects of PVP in elderly VCF patients can be measured long term. C treated VCF patients exhibit better functional results than P treated patients, which may be due to the more pronounced effect on pain in the earlier stages following treatment.

*12. Combined Results of the Three US IDE Randomized Cervical Arthroplasty Trials with Two Years of Follow-Up

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United States

Summary: There have been three prospective, randomized, multi-center trials of cervical disc arthroplasty evaluating the PRESTIGE cervical disc, the BRYAN cervical disc, and the Pro-Disc C cervical disc. We have included non-published 24 month follow-up data from the PRESTIGE

* Whitecloud Award Nominee – Best Clinical Paper
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cervical disc trial. In total there were 605 investigational patients and 561 control patients. Cervical disc arthroplasty is a viable alternative to standard anterior cervical discectomy and fusion.

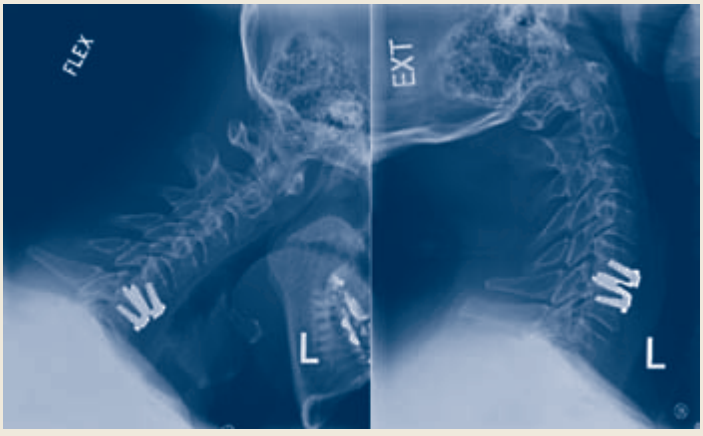
Introduction: There have been three prospective, randomized, multi-center trials of cervical disc arthroplasty evaluating the PRESTIGE cervical disc, the BRYAN cervical disc, and the Pro-Disc C cervical disc. The 24-month data from these randomized, controlled trials has been published and all have found that cervical disc replacement is a reasonable alternative to anterior cervical discectomy and fusion. We performed an analysis of these three trials with unpublished full 24-month follow-up from the PRESTIGE cervical disc trial.

Methods: All included studies had at least 24 months of available follow-up. Heller, et al. evaluated the BRYAN cervical disc enrolling 242 patients in the study arm and 221 in the control arm. Murray, et al. studied the ProDisc-C implant with 103 in the study group and 106 in the control group. Finally, Burkus, et al. studied the PRESTIGE disc with 276 patients in the investigational group and 265 in the control group; we had access to the full two year data set from the Prestige trial which has not yet been published. In total there were 605 investigational patients and 561 control patients.

Results: The trials were similar in the demographic variables of preoperative mean age, sex, neck disability index scores, SF-36 scores. The trials also had similar post-operative fusion rates (>90%) in the control arms, and maintenance of range of motion in the study arm (ranging from 6.5 - 9.36 degrees). The total secondary surgery rate was 3.1% for the combined arthroplasty cohort (19 revision/removal/reoperation) vs. 8.2% for the combined fusion cohort (46 revision/supplemental fixation/removal/reoperation). In an analysis of successful neurologic outcome, the relative risk was noted to be 1.08 (CI 1.03 - 1.12) favoring cervical disc arthroplasty.

Conclusion: Cervical disc arthroplasty is a viable alternative to standard anterior cervical discectomy and fusion. Reoperation rates are lower for the arthroplasty devices in the three randomized US IDE trials with two years of follow-up.

Significance: This is an analysis of the three largest cervical arthroplasty trials to date with full two 2-year follow-up.



PRESTIGE cervical disc, flexion/extension views.

*13. Posterior Surgery Only Assisted by Big-Weight Halo-Femoral Traction for the Treatment of Adolescent Idiopathic Scoliotic Curves More Than 100°

Hongqi Zhang, MD; Chaofeng Guo; Di Zhao; Ling-Qiang Chen; Mingxing Tang
China

Summary: With the usage of third-generation spinal instrumentation, the curve correction obtained from posterior spinal fusion had a significant improvement. However, the management of severe and rigid scoliosis remained a big challenge to spine surgeon. The purpose of this retrospective study was to assess the effectiveness of Halo-femoral traction after anterior spinal release in the management of severe idiopathic and congenital scoliosis.

Introduction: To investigate the feasibility and clinical efficacy of the treatment of adolescent idiopathic scoliotic curves more than 100° by posterior surgery only assisted by big-weight halo-femoral traction and posterior wide release.

Methods: From December 2003 to August 2006, A total of 121 patients with adolescent idiopathic scoliosis were treated, among which 29 patients with curves more than 100° and Risser's sign 3-5 were included in this study. According to treatment method, two groups were divided: 12 patients in Group A underwent combined anterior release followed by 2-week halo-femoral traction and then, posterior instrumentation, 17 patients in Group B underwent posterior sugery alone assisted by big-weight halo-femoral traction and posterior wide release. All patients were analyzed in general date, operation and radiographic material.

Results: 29 patients were all followed up for 12-38 months(mean 18m), with no death, spinal cord injury or other severe complications, except for 3 patients with bedsores and 1 patient with temporary severe pulmonary function impairment. All patients got bony fusion of the fixation segments within 12 months without screw(rod) breakage or pseudarthrosis.There were no statistically significant differences between the two groups in gender, age, type of AIS, preoperative coronal major curve values, major curve flexibility, or final-visit major curve correction rate($p>0.05$). While, the average operative time, blood loss and hospital stay in group B, were significantly less than those in group A ($p<0.01$).

Conclusion: To AIS with cobb>100° and Risser's sign 3-5, posterior surgery only assisted by big-weight halo-femoral traction and posterior wide release, can provide comparative correction rate to anterior-posterior surgery, with more less operative time, less blood loss and less hospital stay.

Significance: Preoperative traction could be one option to provide better correction of the rigid and severe spinal deformity and minimize neurological complications associated with forceful intra-operative distraction.

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

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*14. Minimally Invasive Posterior Spinal Instrumentation For Pediatric Spinal Deformity: One Year Follow-Up with CT Scans of First 30 Cases

Atiq Durrani, MD; Rasesh Desai; Vivek Sharma, MD; Alvin H. Crawford, MD
United States

Summary: Early results in 30 cases with scoliosis/kyphosis treated by minimally invasive (MIS) Posterior Spinal Instrumentation and fusion.

Introduction: To study the feasibility, safety, morbidity and efficacy of MIS Posterior spinal instrumentation and fusion for scoliosis/kyphosis and to assess the fusion at one year with CT scans.

Methods: A retrospective chart review of 30 patients treated by MIS posterior spinal instrumentation for either scoliosis or kyphosis from 11/01/07 through 12/31/08 was carried out after IRB approval. Patient demographics and perioperative data were reviewed. Preoperative and postoperative cobb angles were compared. CT scans with 3D reconstructions and radiographs at one year were reviewed to assess fusion by independent radiologists.

Results: There were 23 females and 7 males with a mean age of 16.6 years. There were 25 scoliosis and 5 Kyphosis patients. Three (2 kyphosis, 1 scoliosis) had an additional video assisted thoracoscopic release at the same stage. The mean preoperative and postoperative cobb angle were 51 and 17 degrees respectively. Mean levels of segments fused were 11 with a mean of 16 screws used per patient. The average duration of surgery was 4 hrs 57 minutes. The mean estimated blood loss was 261.5 ml. with a mean hospital stay of 3 days. Four patients had intraoperative spinal cord monitoring changes, 3 returned to baseline before the end of surgery. One patient had postoperative left leg weakness which resolved completely in two days.

At one year the mean Cobb angle was 19 degrees, a mean loss of 2 degrees. CT scan with 3D reconstructions showed robust fusion in all patients with no evidence of non-union in any as assessed by radiologists.

Conclusion: To our knowledge, this is first study identifying safety, feasibility and efficacy of fusion of MIS posterior spinal Instrumentation in treating spinal deformities in children and adolescents. CT scan and radiographic data at one year shows solid fusion with no loss of correction. Short term data suggests decreased morbidity of MIS Posterior spinal instrumentation for Pediatric spinal deformity with no loss of correction at one year.

Significance: The first study identifying the safety, feasibility and efficacy of fusion of MIS posterior spinal instrumentation in management of pediatric spinal deformities.

*15. Age- and Sex-Related Changes in Sagittal Sacropelvic Morphology and Balance in Asymptomatic Adults

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Canada

Summary: This study documents the age- and sex-related changes in sagittal sacropelvic morphology and balance in the normal adult population. The range of values corresponding to the mean ± 2 SD can provide invaluable information to clinicians about the normal range of values expected in 95% of the normal population. This large database can be used as a comparison for subjects with spinal pathologies.

Introduction: Many studies suggest the importance of the sagittal sacropelvic balance and morphology in spinal and hip disorders. There is still some debate concerning the relationships between sacropelvic parameters and age or sex in adults. This study investigates the normal age- and sex-related changes in sacropelvic morphology and balance in a white Caucasian adult population.

Methods: A sample of white Caucasian adults without spinal disorder consisting of 354 males and 355 females aged 37.9±14.7 and 35.7±13.9 years, respectively. Sacral slope (SS), pelvic tilt (PT), and pelvic incidence (PI) were assessed from a prospective cohort of 709 asymptomatic adults without spinal pathology (Figure). The ratio between the parameters (SS/PI, PT/PI, PT/SS) were also calculated. For all parameters, the range of values corresponding to the mean ± 2 standard deviations (SD) was provided. Parameters were compared between males and females using Student t tests, while the relationships between the parameters and age were assessed using Pearson's coefficients.

Results: There was no significant difference in PI, SS, PT, PT/PI, SS/PI, or PT/SS between males and females. The mean ± 2SD range was 32°-74°, 0°-27°, and 24°-55° for PI, PT and SS, respectively. The mean ± 2SD range was greater than 0.5 for SS/PI and less than 0.5 for PT/PI. PI was not related to age in either sex group. PT, SS, PT/PI, SS/PI, and PT/SS presented only weak correlation coefficients ($r \leq 0.21$) with respect to age.

Conclusion: The current study presents the largest cohort of asymptomatic adults in the literature dedicated to the evaluation of sagittal sacropelvic morphology and balance. The range of values corresponding to the mean ± 2 SD can provide invaluable information to clinicians about the normal range of values expected in 95% of the normal population.

Significance: The reported results constitute a strong database that can be used as a comparison for subjects with spinal disorders, as many clinicians now recognized the importance of assessing sacropelvic balance and morphology when evaluating the spine.

PI = PT + SS

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16. Body Image Disturbance Questionnaire-Scoliosis Version: Responsiveness to Change Associated with Surgical Treatment

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United States

Summary: The Body Image Disturbance Questionnaire-Scoliosis Version (BIDQ-S) is a validated self-report instrument that assesses body image-related distress and impairment in adolescent idiopathic scoliosis (AIS). We demonstrate the BIDQ-S's responsiveness to surgical correction of deformity and found significant correlations between BIDQ-S improvement (pre to post-op) and magnitude of major curve correction. The BIDQ-S is a useful clinical tool to assess psychological effects of AIS deformity, enabling more complete patient evaluation.

Introduction: A scoliosis-specific version of the Body Image Disturbance Questionnaire (BIDQ-S) was previously validated as a tool to assess body image-related distress and impairment in adolescent idiopathic scoliosis (AIS). The purpose of this study was to 1) measure the questionnaire's responsiveness to change associated with surgical treatment, and 2) determine whether pre-op BIDQ-S would impact change in SRS-22 outcomes, hypothesizing that patients with greater pre-op body image disturbance (BID) would improve less on the SRS-22 than patients with similar pre-op curve magnitude, but lower BID.

Methods: 25 patients (age 14.5, 72% F) with surgical AIS were enrolled. BIDQ-S and SRS-22 were completed pre-op and at 6-months post-op. Race, gender, height, weight, major Cobb, major scoliometer, and Lenke curve type were evaluated. Surgical data collected included age at surgery, major curve and scoliometer change and % correction. Pearson correlations, and a repeated measures ANOVA were calculated.

Results: There was a significant change in BIDQ-S from pre-op to post-op (1.49→1.10, $p=0.001$), Pre-op BIDQ-S significantly correlated with major Cobb angle ($p<0.001$). Post-op BIDQ-S did not significantly correlate with any of the parameters examined. Change in BIDQ-S significantly correlated with major curve improvement ($p<0.01$), ie., greater the decrease in Cobb angle, the greater the improvement in BIDQ-S. Higher pre-op BIDQ-S (greater BID) correlated with greater improvement in SRS pain and total score domains ($p<0.01$) and change in BIDQ-S significantly correlated with change in pain, function, and total score domains of the SRS-22 ($p<0.05$).

Conclusion: Our data suggests the BIDQ-S is responsive to surgical correction of AIS. Unlike the SRS-22, BIDQ-S improvement significantly correlates with the amount of major curve correction. The BIDQ-S is a valuable clinical outcome tool to assess AIS patients because it measures psychological effects of the deformity that are not adequately addressed by existing outcomes instruments. It quantifies the pathological quality of body image disturbance and patient improvement in this variable.

17. Revision Surgery for AIS Results in SRS Scores Comparable to Primary Surgery Patients

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United States

Summary: A multicenter database was used to compare patients undergoing primary surgery for AIS to those having revision surgery. The incidence of complications were comparable between groups. Those with revision surgery had had similar SRS scores to the primary patients at two year follow-up despite more frequent spinal cord monitoring changes intraoperatively and less correction of the main curve.

Introduction: The incidence of revision surgery for adolescent idiopathic scoliosis (AIS) has been recently reported from several institutions with some variability. There are no published studies which have analyzed the radiographic and clinical outcomes following revision AIS surgery.

Methods: A prospective multi-institution prospective database was reviewed. A group of AIS patients who had primary surgery were compared to those who underwent revision surgery. Radiographic, surgical and functional scores were compared for the two groups.

Results: There were 3317 patients in the primary group and 115 in the revision group. The most common reasons for revision were curve progression (23.2%), symptomatic instrumentation (20.5%), pseudoarthrosis (12.5%) and implant failure (7.1%). There were no differences in gender or BMI. The primary patients were younger (14.8 vs 16.4 years, $p<0.05$), had larger preoperative major curves (57.4° vs 45.5°, $p<0.05$), greater trunk shift (19.9 vs 15.3 mm, $p<0.05$) and had greater curve correction (62.6% vs 45.3%, $p<0.05$) at two years. The primary group had less preoperative thoracic kyphosis (22.2°vs 30.9°, $p<0.05$) but the revision group improved such that the thoracic kyphosis at two years (22.1° vs 22.9 °) was similar between the two groups. There were no differences in baseline SSEP or MEP, but there was a trend toward a higher incidence of critical changes in SSEP (1.2% vs 3.4%, $p=0.07$) and MEP (3.0% vs 5.9%, $p=0.09$) for the revision group. Preoperatively, the revision patients had lower SRS-30 Pain (4.07 vs 3.65, $p<0.05$) and Activity (4.09 vs 3.85, $p<0.05$) domain scores and a lower Total score (3.82 vs 3.66, $p<0.05$). At two years, the revision patients improved, such that their SRS scores were similar to the primary group.

Conclusion: Patients undergoing revision surgery for AIS improve their thoracic sagittal deformity, but have greater incidence of critical changes in SSEP and MEP. Despite worse preoperative pain and activity scores, patients undergoing revision AIS surgery demonstrate similar scores in these domains and total SRS-scores at two years.

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

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18. A New Posterior Scoliosis Correction Technique Using Pedicle Screws to Restore Thoracic Kyphosis

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Japan

Summary: A novel posterior scoliosis surgery using simultaneous double rod rotation technique is proposed and its clinical results are reported. This unique posterior surgery using two differently contoured rods and polyaxial screws has a benefit to sufficiently correct scoliosis in the coronal plane and to restore the sagittal profile of the spine.

Introduction: Although previous posterior correction techniques using pedicle screws (PSs) could achieve excellent scoliosis correction in the coronal plane, they had a tendency to decrease thoracic kyphosis. To solve these problems, a new posterior correction technique using pedicle screws has been developed not only for correcting scoliosis but also for creating thoracic kyphosis. The purposes of this study were to introduce the concept of this new posterior correction technique and to report its clinical results.

Methods: After placing polyaxial PSs at each level, two prebent 6mm diameter rods are placed on both sides of the curve. The rods should be bent according to the anticipated thoracic kyphosis and lumbar lordosis. The concave side rod should be bent more than the convex side rod for correction of thoracic curve. By simultaneously rotating the prebent 2 rods by 90 degrees, the concave side of the spine is pushed up more by the more bent rod and the convex side of the thoracic curve is pushed up less by the less bent rod. Thirty patients with adolescent idiopathic scoliosis (Lenke 1A:10pts, 1B:5, 1C:6, 3:6, 5:3) have been treated with this new technique. Operating time, blood loss, Cobb angle and thoracic kyphosis (T5-12) were analyzed.

Results: Average operation time was 287minutes. Average blood loss was 1130ml. Major curve changed from 62.7degrees to 18.6 (correction rate: 70.6%). Thoracic kyphosis changed from 13.7 degrees to 22.0(improved by 8.3 degrees). All patients showed improvement in thoracic kyphosis. Screw malposition was seen in 1 patient.

Conclusion: This new technique can restore thoracic kyphosis by rotating two differently contoured rods simultaneously. The key to create thoracic kyphosis and to control the rotational deformity is using different contours of the 2 rods. In spite of using polyaxial screws at all levels, correction rate was comparable to our previous technique using monoaxial PSs.

Significance: A novel posterior scoliosis surgery using pedicle screws is proposed. This new technique is able not only to achieve good correction of scolosis but also to efficiently create thoracic kyphosis.

† 19. In a Rat Model of Spinal Arthrodesis and SCI, rhBMP-2 Use Increases Inflammation and Glial Scarring while Limiting Long-Term Functional Recovery

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United States

Summary: rhBMP-2 application around the injured spinal cord increases initial intrathecal inflammation and reactive gliosis, correlating with decreased motor function in the acute post-injury period. rhBMP-2 use in patients with SCI may be contraindicated.

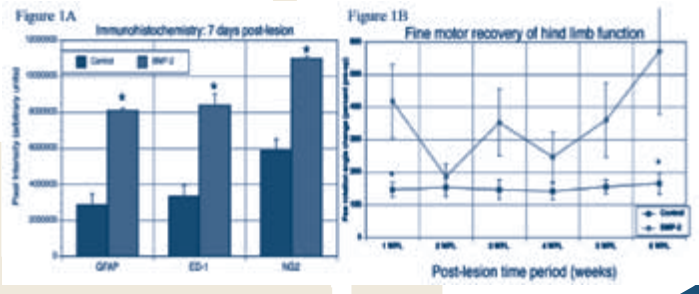
Introduction: Use of BMP-2 in spinal trauma presents a viable option that obviates the need for bone grafting and improves fusion. However, no basic science studies have evaluated the direct effects of the exogenous BMP-2 on the injured spinal cord. The objectives of this study were to evaluate the acute inflammatory response and long-term functional recovery in animals fused with rhBMP-2 following a spinal cord injury (SCI).

Methods: A total of fifty two (52) rats underwent a T10 dorsal hemisection SCI. 30min after SCI, either 43ug of rhBMP-2 (per side) or sterile water control was placed over T9-11 on a collagen sponge. An additional control group (rhAlbumin) was included to account for cross-species inflammatory response. Animals were then divided according to survival time-points: 1week (n=20) and 6weeks (n=32). Locomotor function was asses sed once weekly using BBB open field scale and footprint analysis. At the respective periods, spinal cords were collected and analyzed for inflammation, gliosis and inhibitory extracellular matrix (ECM) proteins using immunohistochemistry.

Results: At 1week significant changes in spinal cord lesion morphology were observed in the BMP-2 group. Reactive gliosis (GFAP), inflammation (ED-1) and ECM protein (NG2) concentration increased by 284%, 250% and 186%, respectively, compared to the controls ($p<0.05$) Figure 1. This correlated with functional deterioration in these animals as observed on the BBB scale and a greater change in the angle of paw rotation (relative to pre-op) ($p<0.05$). At 6 weeks, microCT revealed no cases of bone encroachment in the spinal canal in the BMP group. However, BMP-2 treated animals demonstrated greater fine-motor skill deficits (change in paw angle) compared to the control group ($p<0.05$) Figure 2. In addition, morphologic differences observed in the acute phase between the groups persisted at the 6 week survival time-point.

Conclusion: rhBMP-2 application around the injured spinal cord increases initial intraparenchymal inflammation and gliosis, correlating with decreased motor function.

Significance: Based on current findings BMP-2 may impede neurologic recovery following a SCI, as we observed exacerbated fine motor deficits in the BMP group; however, additional animal studies are necessary.



The FDA has not cleared the drug and/or medical device for the use described in

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this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

† 20. Progressive Spinal Deformity Correction via an Anterior Based Tether in a Porcine Scoliosis Model: A Detailed Radiographic Analysis

Ashish Patel, MD; Frank J. Schwab, MD; Virginie C. Lafage, PhD; Benjamin Ungar; Jean-Pierre C. Farcy, MD
United States

Summary: Non-fusion techniques for surgical correction of scoliosis in an immature spine have recently received substantial interest. Using the porcine scoliosis model, this study aims to investigate the impact of an anterior corrective convex spinal tether on radiographic alignment compared to a control group. Application of an anterior based convex staple-screw-tether construct in group 2 resulted in significant progressive correction of the coronal deformity (~ 50%) without significant sagittal plane re-alignment. Data from this study support the possibility of clinical techniques for non-fusion scoliosis correction

Introduction: Non-fusion techniques for surgical correction of scoliosis in an immature spine have recently received substantial interest. Using an established Porcine Scoliosis Model (PSM), this study aims to investigate the impact of an anterior convex spinal tether on radiographic alignment changes with growth (non-fusion)

Methods: This IACUC approved Study included 10 immature Yorkshire Pigs divided equally into 2 groups; tether release group (TR) and anterior corrective tether group (AC). All animals underwent scoliosis induction surgery (max. coronal Cobb: 17°-25°) at 12 weeks of age and progressed a mean 4.0°/week. Once >50° was noted, a second surgical intervention was pursued: TR had release of the inducing tether; AC had tether release and placement of a corrective device over the 5 apical vertebrae. Both groups were observed for an additional 16 weeks with bi-weekly radiographs. Student t-test was used to investigate radiographic differences between groups

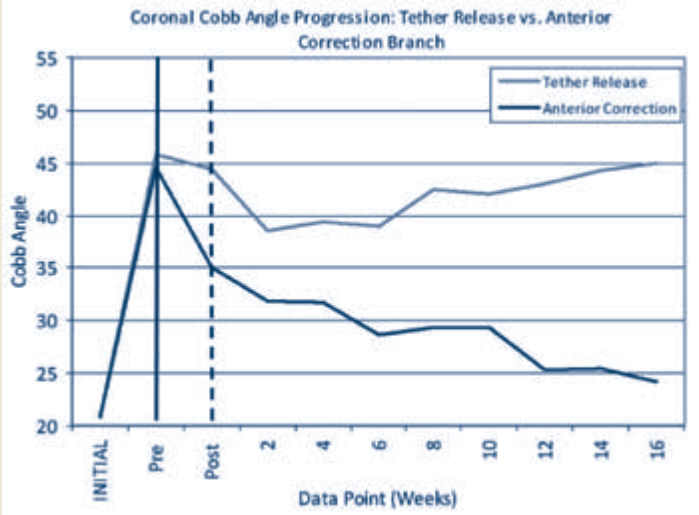
Results: No significant differences existed between TR and AC regarding; induced Cobb angle, days with deforming tether, or coronal and sagittal alignment before the 2nd intervention (all, $p>0.05$).

Coronal Plane:
Significant differences in Cobb angle between TR and AC animals were noted following the 2nd intervention (resp. 44.4°±2.2° and 35.0°±2.4°; $p=0.001$) and bi-weekly beyond 4 weeks ($p<0.01$). Final Cobb measurements were 45.0°±2.9° for TR and 24.4°±9.0° for AC ($p=0.001$).

Sagittal Plane:
No significant differences existed in sagittal alignment between TR and AC animals immediately following the 2nd intervention (resp. 14.4°±26.2° and 16.2°±10.2°; $p=0.88$) and at final follow up; 16.2°±20.9° and 21.2°±12.3° respectively ($p=0.65$)

Conclusion: Using the PSM, this study investigated radiographic differences between control and treatment groups. Application of a non-fusion anterior based convex staple-screw-tether resulted in significant progressive correction of the coronal spinal deformity (~ 50%) without significant sagittal plane re-alignment

Significance: Data from this study support the possibility of clinical techniques for non-fusion scoliosis correction in the immature spine through growth modulation.



† 21. Facet Joint Biomechanics at the Treated and Adjacent Levels After Total Disc Replacement

Sergiu Botolin, MD, PhD; Christian Puttlitz, PhD; Todd Baldini, MS; Anthony Petrella, PhD; Evalina L. Burger, MD; Celeste Abjornson, PhD; Vikas V. Patel, MD
United States

Summary: The present cadaveric biomechanics study investigated facet changes in contact pressure, peak contact pressure, force, peak force, and contact area at the facet joints after total disc replacement (TDR). In general, our findings suggest there is an increase in loading of the facet joints at the level of disc implantation and an overall unloading effect at the level above.

Introduction: TDR provides an alternative to fusion that is designed to preserve motion at the treated level and restore disc height. The effects of TDR on spine biomechanics at the treated and adjacent levels are not fully understood. We designed the present cadaveric biomechanics study to investigate facet changes in contact pressure, peak contact pressure, force, peak force, and contact area at the facet joints after TDR.

Methods: Seven fresh-frozen human cadaveric lumbar spines were potted at T12 and L5 and installed in a 6-DOF displacement-controlled testing system. Displacements of 15° flexion/extension, 10° right/left bending, and 10° right/left axial rotation were applied. Contact pressure, peak contact pressure, force, peak force and contact area for each facet joint were recorded at L2-L3 and L3-L4 both before and after TDR at L3-L4 (ProDisc-L, Synthes Spine). The data were analyzed with ANOVAs and t-tests.

Results: Axial rotation had the most impact on contact pressure, peak contact pressure, force, peak force, and contact area in intact spines. During lateral bending and axial rotation, TDR resulted in a significant increase in facet forces at the level of treatment and a decrease in contact pressure, peak contact pressure, and peak force at the level superior to the TDR. With flexion/extension, there was a decrease in peak contact pressure and peak contact force at the superior level.

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Conclusion: Our study demonstrates that rotation is the most demanding motion for the spine. We also found an increase in facet forces at the treated level after TDR. To our knowledge, we are the first to show a decrease in several biomechanical parameters after TDR at the adjacent superior level in a cadaveric model.

Significance: In general, our findings suggest there is an increase in loading of the facet joints at the level of disc implantation and an overall unloading effect at the level above. Future research is needed to further evaluate these findings; however, the present study contributes to a better understanding of biomechanical changes after total disc arthroplasty and the ability to predict long-term outcomes.

† 22. Allograft Mesenchyemal Stem Cells for Anterior Cervical Disectomy and Fusion

Vivek Mohan, MD, MS; Cary Templin, MD; Mark A. Lorenz, MD; Michael R. Zindrick, MD
United States

Summary: We investigated the use of non-structural mesenchymal stem cell (MSC) allograft, which are packed into a PEEK cage or fibular allograft for anterior cervical fusions. Based on early results, MSC may serve as a safer choice for anterior grafting with significant benefits in patients with a challenging fusion site or biology.

Introduction: Iliac crest autograft has been the gold standard for anterior cervical fusions, but major advancements in fusion technology has occurred with the addition of PEEK cages and BMP. However, new concerns over the use of BMP in the anterior cervical spine prompted an FDA warning. In this study, we examine the use of allograft MSC in anterior cervical fusions.

Methods: With Institutional Review Board approval, we reviewed prospectively collected data on 46 consecutive patients who underwent anterior cervical discectomy and fusion with allograft MSC and a PEEK interbody spacer for radiculopathy and/or myelopathy. Patients completed VAS and ODI questionnaires preoperatively and postoperatively for at least one year with concomitant radiographs taken to document progression towards fusion.

Results: We found excellent fusion rates using this combination in patients with and without risk factors for non-union. The fusion rate was 100% for one, 97.1% for two and 83.3% for three level procedures overall per patient. Bony fusion was radiographically apparent in most cases between 8 to 12 weeks on flexion-extension radiographs. No significant difference in time to fusion was seen between smokers and non-smokers. The VAS scores showed significant improvements at both 6 months and 1 year post-operatively ($p < 0.0001$). The ODI scores improved significantly at 6 months ($p = 0.015$) but not at 1 year ($p = 0.126$) post-operatively. Only six patients had mild postoperative neck swelling with dysphagia, and none were re-intubated.

Conclusion: Based on our short-term results, allograft stem cells are safe and effective for anterior cervical fusions with significant benefit in multiple level fusions and in smokers.

Significance: Allograft mesenchymal stem cells can provide significant benefit while maintaining a good safety profile in anterior cervical fusions.

† 23. Effect of Metallic Wear Debris on Annulus Fibrosus Chondrocytes

Edward R. Anderson, MD; Garrick W. Cason, MD; Kevin Baker, MS; Carly A. Gratopp, BS; Harry N. Herkowitz, MD
United States

Summary: Numerous retrieval studies have characterized the production of metallic wear debris by spine instrumentation. However, no studies have examined the effect of this wear debris on cells from the intervertebral disc. The purpose of this study was to investigate the effect of metallic wear debris on the viability and expression of pro-inflammatory cytokines by cells harvested from the annulus fibrosus.

Introduction: The biologic effects of wear debris have been characterized as they relate to inflammation, cell proliferation and bone resorption. However, the effect of wear debris on fibro-cartilagenous tissue, such as the intervertebral disc, has yet to be characterized. The purpose of this study was to characterize the response of annulus firbrosus chondrocytes of rabbits to metallic wear debris similar to that created by wear of spine instrumentation.

Methods: Lumbar discs were aseptically harvested from recently euthanized rabbits. Annulus fibrosus tissue was minced and incubated in a solution of defined minimum essential medium (DMEM) and collagenase at 37degC.

Cells were collected and cultured in 24-well plates in 1.0 mL of DMEM supplemented with ascorbic acid at a density of ~75,000 cells per well. After reaching confluence, media was replaced with media containing 0.1 mg/mL of CoCrMo, 316L stainless steel or Ti6Al4V wear particles, certified as endotoxin-free. Control cells received culture media alone.

Cell morphology was monitored by phase contrast microscopy at 24 hour intervals. The expression of TNF-a, IL-B, IL-6 and IL-8 were assayed by ELISA. Viability of the annulus fibrosus chondrocytes was compared after 14 days in culture by MTT assay.

Results: After 24 hours of culture, cells exposed to metal particles had entered a phagocytotic phase where wear debris was being actively taken up within the cell membrane. Chondrocytes exposed to 316L stainless steel became more spherical in shape, while CoCrMo- and Ti6Al4V-treated cells maintained an elongated fibrochondrocytic appearance. Elevations in inflammatory cytokines were noted to be both time and material-dependent. The MTT assay performed at 14 days showed a reduction in chondrocyte viability by 33.2%, 34% and 42% for Ti6Al4V-, CoCrMo- and 316L stainless steel-treated cells, respectively.

Conclusion: Observed changes in cell morphology, pro-inflammatory cytokine expression and cell viability suggests that metallic wear debris may have the potential to induce degenerative changes in adjacent disc tissue.

Significance: This is the first study to directly characterize the negative biologic effects of metallic wear debris on chondrocytes from the intervertebral disc.

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† 24. Effect of TNF-Alpha and IL-1-Beta on Rat Intervertebral Disc in Organ Culture: An Atraumatic Model to Analyze Degenerative Disc Disease

Ravi K. Ponnappan, MD; Dessislava Z. Markova, PhD; Todd J. Albert, MD; D. Greg Anderson, MD; Irving M. Shapiro, PhD; Makarand V. Risbud, PhD
United States

Summary: This study describes an atraumatic in vitro model for disc degeneration using a lower order animal. This model mimics cellular events associated with human degenerative disc disease at the earlier stages of degeneration. It allows for reproducible analysis of quantifiable effects at the cellular level using gene expression and histology.

Introduction: Intervertebral disc (IVD) degeneration occurs through a progressive and stepwise cascade of events that results from the alteration of cellular and extracellular matrix composition of the nucleus pulposus and anulus fibrosis. Early changes in human disc degeneration often occur at the cellular level without disruption of the native disc architecture. Currently available animal models require the induction of degeneration through traumatic disruption of the anulus. This study aims to create a reproducible atraumatic model to investigate cellular events associated with disc degeneration.

Methods: Lumbar intervertebral discs of mature rats were harvested and maintained in organ culture under optimized conditions. All discs were then chemically stressed using tumor necrosis factor alpha (TNF-alpha) and interleukin-1 beta (IL-1 beta) for 72hrs and 10 days. The stressed discs were then separated into anulus fibrosus and nucleus pulposus and analyzed by real-time quantitative reverse transcription-PCR (qRT-PCR) for effects on gene expression for matrix metalloproteinases, matrix proteins, metallopeptidase inhibitors, and nerve growth factor. Histological changes were also examined.

Results: The rat explanted disc-organ culture model was reproducible and consistent. Exposure of rat IVD organ culture to TNF-alpha and IL-1 beta induced measurable changes in gene expression at both 72 hour and 10 day time points compared to control. Gene expression for anabolic processes decreased while catabolic pathways were upregulated as measured by qRT-PCR. Degenerative effects were also evident histologically.

Conclusion: This study describes an atraumatic model to investigate cellular events associated with intervertebral disc degeneration using a rat IVD in organ culture.

Significance: This study describes an atraumatic in vitro model for disc degeneration using a lower order animal. This model mimics cellular events associated with human degenerative disc disease at the earlier stages of degeneration. It allows for analysis of effects at the cellular level using gene expression and histology. Differential analysis of anulus fibrosis and nucleus pulposus is also possible.

25. The Effect on Pedicle Screw Pullout Strength of Optimizing Pedicle Fill Using a Tool to Size the Pedicle

David H. Clements, MD; David H. Clements, BS; Charles Colip, BS; Randal R. Betz, MD; Mehdi Shafieian; Kurosh Darvish, PhD
United States

Summary: Pedicle screw fixation depends on the strength of the bone-screw interface. Optimizing pedicle fill improves pullout strength and the rigidity of the screw-vertebra structure due to screw threads engaging higher density bone of the pedicle margin. This was a cadaveric biomechanical study using a Pedicle Sizer tool to size the pedicle diameter and optimize pedicle fill. Screw pullout of optimally sized screws improved significantly compared to standard size screws in thoracic and lumbar vertebrae.

Introduction: Pedicle diameter is variable depending on age, location and presence of deformity. Pedicle screws have the highest resistance to pullout when they fill the pedicle and engage the margin. However, pedicle screw diameter is usually empiric with no objective measurement made of pedicle size. The purpose of this biomechanical study was to evaluate the increase in pullout strength of pedicle screws that are sized to fill the thoracic and lumbar pedicle compared to the "usual" size screw selected. A new tool to safely size the pedicle was used to select the screw diameter that safely and maximally filled the pedicle.

Methods: 20 adult (11 thoracic and 9 lumbar) cadaveric vertebrae were harvested intact. Each vertebrae had both pedicles cannulated and checked for breakthrough. For each vertebra first one pedicle was undertapped by 1 mm and instrumented with a 5 mm polyaxial screw in the thoracic and 6mm in the lumbar as a standard, then the opposite pedicle was sized with the tool, undertapped 1mm and the appropriate diameter screw inserted as indicated by the sizing. Pedicles were checked after screw insertion for breakthrough. All screws were a uniform length. Pullout testing was then performed with a Tinius Olsen Material Testing Machine. 40 screws were inserted and tested in 20 vertebrae.

Results: The thoracic 5mm screws had mean pullout strength of 708(SD +/-91)N and the sized screws (6 or 7mm) 1264(+/-196)N. The lumbar 6mm screws had a mean pullout of 1639(+/-621)N, the sized screws (7 or 8mm) 3070(SD+/-759)N. The ratio between pullout force and strengths of sizing method to standard method in each vertebra was calculated to minimize the effect of specimen variability. Pullout force ratio was 2.22+/-0.23, pullout strength ratio was 1.42+/-0.15 (P=0.009) which indicate the sizing method significantly increases rigidity of the screw-vertebra structure.

Conclusion: Sizing the pedicles resulted in a significant increase in screw pullout strength and screw-vertebra structural rigidity in the thoracic and lumbar vertebrae. The clinical significance of this study is the ability of the appropriately sized pedicle screws to safely allow better deformity correction by significantly increased resistance to pullout during instrumentation of the spine.

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26. Association Between FokI Polymorphism in Vitamin D Receptor Gene and Susceptibility to Spinal Tuberculosis in Chinese Han Population

Hongqi Zhang, MD; Ang Deng, MD; Chaofeng Guo; Yuxiang Wang, MD
China

Summary: This study included 110 patients with spinal TB and 102 volunteers as controls. FokI polymorphism in VDR gene was analyzed by polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) in the spinal TB group and the control group. There was a remarkable difference between groups in regard to the frequencies of the VDR-FokI genotypes ($p < 0.05$). The ff genotype may be the susceptible genotype of spinal TB.

Introduction: Studies have shown that the vitamin D receptor (VDR) gene polymorphisms may be associated with pulmonary tuberculosis (TB) and play important roles in the regulation of calcium in a variety of tissues including bone. To our knowledge, however, whether FokI polymorphism in VDR gene is associated with susceptibility to spinal TB is still unknown. We undertook this study to investigate the association between FokI polymorphism in VDR gene and susceptibility to spinal TB in Chinese Han population.

Methods: This study included 110 patients with spinal TB and 102 volunteers as controls. FokI polymorphism in VDR gene was analyzed by polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) in the spinal TB group and the control group. The frequencies of VDR-FokI genotypes in the two groups were compared using $\chi 2$ test.

Results: There was a remarkable difference between groups in regard to the frequencies of the VDR-FokI genotypes ($p < 0.05$). In the spinal TB group, the frequency of the ff genotype was 46.36%, which was remarkablely higher than the corresponding value for the control group (28.43%). Furthermore, the odds ratio (OR) was 2.176 ($p < 0.05$), and the 95% CI ranged from 1.236-3.832.

Conclusion: FokI polymorphism in VDR gene may be associated with the susceptibility to spinal TB in Chinese Han population. Furthermore, the ff genotype may be the susceptible genotype of spinal TB.

Significance: FokI polymorphism in VDR gene may be associated with the susceptibility to spinal TB in Chinese Han population. The ff genotype may be the susceptible genotype of spinal TB.

27. Novel Bioresorbable Cement for Percutaneous Vertebral Fracture Treatment

Aron Rosenberg, MS; Noel R. Camacho; Jerry Chang, PhD; Andrew T. Mahar, MS; Kieran Murphy, MD
Canada

Summary: PMMA is the gold standard for Percutaneous Vertebroplasty (PVP), but has significant drawbacks. A novel calcium phosphate cement (CPC) was developed to improve upon the safety, efficacy and ease of use. Cadaver and in-vitro characterization was performed to demonstrate the reduced risk of extravasation and thrombosis and enhanced deliverability.

Introduction: PMMA is the gold standard for treatment of painful vertebral fractures but significant drawbacks are associated with its use. A promising alternative, calcium phosphate cements (CPC), are biocompatible, resorbable and have extensive clinical history. Additionally, these CPCs can be used as delivery vehicles for bioactive molecules to accelerate healing and treat osteoporosis. However, CPC use has been limited due to reports of cardiovascular deterioration associated with cement extravisation leading to pulmonary embolism and thrombosis. In order to minimize these risks, a CPC was developed with enhanced viscosity, cohesiveness and improved radiographic visualization and which does not initiate a thrombotic response.

Methods: CPC was prepared by combining synthetic calcium phosphate, viscosity modifier (CMC) and contrast agent (Iohexol). In a cadaver study, the resulting cement was delivered transpedicularly into L2-5 and T10-12 either through 6”X11G needles or using an expandable vertebral stent and associated delivery system. PMMA was used as a control. Injection was performed by an interventional radiologist under high resolution fluoroscopy. Injections were graded for injection force, leakage, and cement dispersion. The spines were then imaged using CT to confirm fluoroscopic observations. For the in-vitro study, CPC cement was characterized relative to PMMA for injection force, time to injection, working time, viscosity, compressive strength, and heat release. Additionally, an in vitro assay of thrombosis, partial thromboplastin time, was also performed.

Results: CPC was easier to inject and visualize and exhibited improved resistance to leakage and dispersion relative to PMMA. CPC took less time to prepare, had longer working time and higher viscosity. CPC exhibited no damaging heat release and will remodel over time into new bone. CPC did not exhibit any tendency to initiate thrombosis.

Conclusion: This novel CPC exhibited improved safety, efficacy and ease of use relative to PMMA.

28. Minimally Disruptive Treatment of Adult Scoliosis from a Lateral Retroperitoneal Approach: Perioperative Results

Robert E. Isaacs, MD; Solas Degenerative Study Group
United States

Summary: In a prospective multicenter study of more than 100 patients with adult scoliosis, perioperative measures demonstrate the less invasive benefits of a lateral approach anterior column reconstruction, with minimal blood loss and shorter hospitalization than traditionally more morbid surgeries in this patient population. Complication rates were generally low, increasing with the extent of surgery, particularly adjunctive posterior procedures.

Introduction: Adult scoliosis presents a treatment challenge. Interbody(IB) and circumferential instrumented(INST) fusion are traditionally indicated for moderate/severe curves with multiplanar imbalance; but both anterior(ANT) and posterior(POST) IB approaches carry a high risk of complication, particularly in the elderly comorbid patient.

Methods: A prospective multicenter nonrandomized IRB-approved study was undertaken to evaluate XLIF as a less invasive treatment for adult

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scoliosis. The study follows the clinical and radiographic outcomes out to 2 yrs. For this report, peri-op data (inclusive of outcomes through the 6-wk post-op clinic visit) were evaluated.

Results: 107 patients (mean age 68 yrs; range 45-87) were enrolled. 28% had at least one comorbidity. 479 levels (mean 4.5/patient; range 1-9) from T11-S1 were treated, including both IB and INST procedures. 75.7% included posterior pedicle screws, 5.6% lateral fixation, 18.7% standalone. Mean operative time and blood loss were 178min (58min/level) and 50-100cc. Mean hospital stay was 2.9 days(unstaged), 8.1 days(staged; 16.5%), 3.8 days overall. 5 patients(4.7%) received a transfusion, 3(2.8%) required ICU, 1(0.9%) required rehabilitation services. Major complications occurred in 12 patients(11.2%): 2(1.9%) medical, 11(10.3%) surgical. Of procedures that involved only less invasive techniques (XLIF standalone or w/perc INST), 7.7% had one or more major complication. In those with open posterior INST, 20.7% had one or more major complication (p=0.04). All reoperations and deep wound infections (3) were associated with open posterior INST procedure.

Conclusion: Much of the morbidity in adult deformity surgery is minimized with less invasive techniques. The rate of major complications in this study (11.2%) compares favorably to that reported from other studies of degenerative deformity (ranging 20-66%), as well as from studies of fusion for degenerative disease in the elderly overall (21%).

Significance: This represents the single largest prospective study of degenerative scoliosis and the largest multicenter study of less invasive techniques applied to adult scoliosis.

29. Multilevel MIS Reconstruction of Adult Degenerative Scoliosis

Stefan Renaud, DO; Connie G. Chon, RA; Reginald Q. Knight, MD; Jeffrey S. Roh, MD
United States

Summary: Our institution has undertaken to correct symptomatic multilevel degenerative deformity, through minimally invasive and percutaneous techniques.

Introduction: Both interbody devices and posterior instrumentation have been applied using MIS techniques to treat adult degenerative conditions.Literature is building to support claims of decreased blood loss; shortened hospital stays, and better tolerated surgeries by using MIS.Despite this, there is little literature describing multilevel reconstruction of adult degenerative scoliotic deformity.We aim to outline an effective and reproducible MIS technique.

Methods: 16 patients (15 female,1 male) underwent one or two stage surgical reconstruction.Age ranged from 24-82(Mean age= 60).All surgeries were carried out by two of the contributing authors at one center.The surgical technique will be described in the body of the paper.Coronal and sagital Cobb angles were measured preop and postop.Operative times, EBL, transfusions, length of stay, complications; ODI and VAS were recorded.

Results: Preoperative coronal cobb range was 21-60°,average=44°. Postoperative coronal cobb angles ranged from 1-27°,average=14.°Average curve correction was 62‰.Preoperative Sagital Cobb angles measured from T12-S1 averaged 33°(range -15(kyphotic) to 70).Average post op angle =40°of lordosis(range 21-60).Estimated intraoperative blood loss for the combined surgeries averaged 270cc (150-650); for stage I average was 256cc (25-800); stage II 377cc(50-1200).

All surgeries together averaged 520cc blood loss (150-1900).

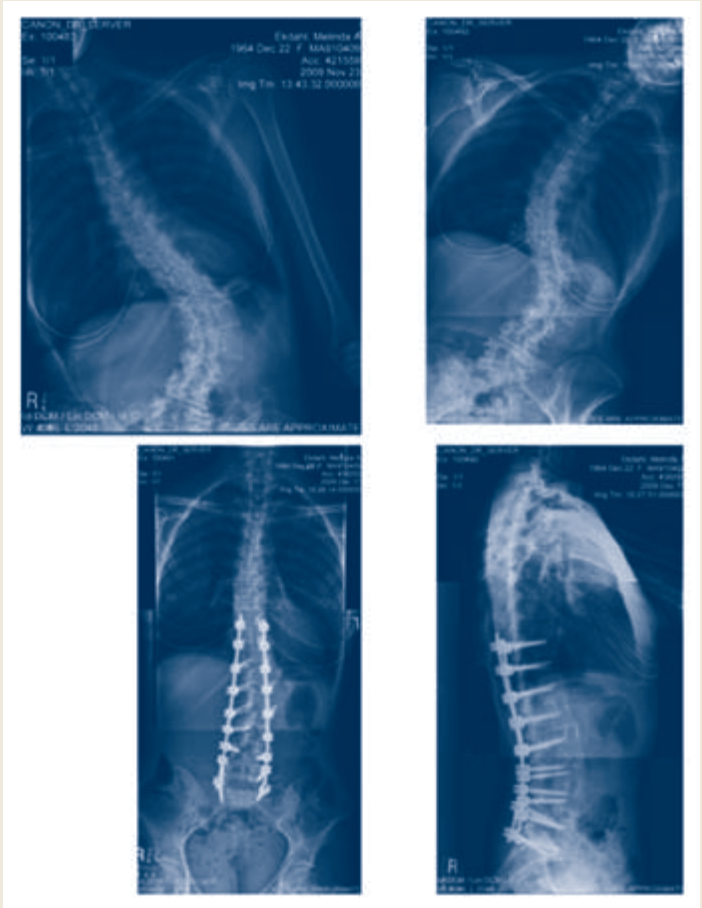
14 of 16 patients required perioperative transfusion. Of those requiring transfusion the average number of units of PRBC transfused was 1.9. The average transfusion for all patients in the study was 1.7 u PRBC.

Average hospital length of stay was 6.8 days (2-10).

Complications included one L3-4 durotomy, one ileus requiring NG tube placement, and one distal junctional kyphosis requiring reoperation 9 months later.

Conclusion: Large magnitude and symptomatic adult deformity can be treated using MIS.Overall patients tolerated to procedures well with only 1.7 units of PRBC transfusion, few complications, and short hospital stays.

Significance: To our knowledge, this is only the second paper describing multilevel reconstruction using entirely MIS techniques.This is a larger cohort than the previous published literature (Anand,et al), and corroborates their findings.



Preop and Postop images of a patient included in the study.

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30. Patient Satisfaction Following XLIF for Adult Scoliosis

W. B. Rodgers, MD; Jody A. Rodgers, MD, FACS; Solas Degenerative Study Group
United States

Summary: In a prospective multicenter study of more than 100 patients with adult scoliosis, high patient satisfaction underscores the less invasive benefits of a lateral approach anterior column reconstruction.

Introduction: Traditional surgical treatment of adult scoliosis via large open anterior and/or posterior procedures can be complicated by the severity of the deformity, extent of intervention, and significance of preexisting comorbidities. Less invasive approaches like XLIF may result in reduced perioperative morbidity and higher rates of patient satisfaction due to those minimally disruptive benefits.

Methods: A prospective multicenter nonrandomized IRB-approved study was undertaken to evaluate XLIF as a less invasive treatment for adult scoliosis. The study follows the clinical and radiographic outcomes out to 2 yrs. Of the 107 patients enrolled to date, 64 have completed 12-month follow-up, including self-reported measures of pain, function, general health, and satisfaction (at each postoperative clinic visit, patients were asked whether they were satisfied with their outcomes and whether they would elect to undergo the same procedure again given their outcome).

Results: Patients averaged 68 years of age (range 45-87). 28.3% had at least one comorbidity. Procedures included interbody and instrumentation at 479 levels (average 4.5/patient; range 1-9) from T11-S1. Average preoperative Cobb angle was 24 degrees (range 10-68). At 12 months, 86.4% of patients said they were "somewhat" or "very" satisfied with their outcomes; and 83.1% said they "likely" or "definitely" would elect to undergo the same procedure again. Satisfaction rates were not statistically affected by age (p=0.0669), the pre-existence of comorbidities (p=0.7302), the severity of the curve (p=0.0967), the number of levels treated (p=0.2064) or type of instrumentation used (none/lateral/percutaneous posterior/open posterior; p=0.8782).

Conclusion: One might presume that patient satisfaction post-surgery would be influenced by such factors as general health, severity of deformity, or extent of surgical intervention. Our results do not show this, but instead show a higher satisfaction rate than reports of traditional surgical outcomes, even among the oldest, sickest patient population, perhaps due to the less invasive benefit of quicker recovery in addition to overall surgical corrections using the XLIF approach.

31. Is the Less Invasive Far Lateral Approach a Safe Way to Reconstruct the Anterior Spinal Column in Advanced Adult Deformity Surgery? A Minimum Two Year Follow-Up Study

Behrooz A. Akbarnia, MD; Gregory M. Mundis, MD; Pooria Salari, MD; Ramin Bagheri, MD
United States

Summary: 16 adult patients with an average Cobb angle of 47 degrees were treated with an anterior release and spinal fusion via a less invasive lateral interbody fusion. While there are predictable perioperative sequelae (i.e. thigh numbness, pain and/or weakness) with this approach, there was significant improvement of curve magnitude and various clinical outcome measures at two year post-op.

Introduction: Anterior reconstruction of the spine in adult deformity is a widely accepted approach to improve fusion rate and achieve coronal and sagittal deformity correction. We present our experience using the less invasive far lateral interbody fusion (LIF) to achieve these goals.

Methods: This was a retrospective review of adult deformity patients undergoing LIF. Of 58 patients, 16 met the inclusion criteria: Cobb ≥30°, initial surgery for scoliosis, and min. 2-year follow up with complete data. Exclusion criteria included add-on disease and primary diagnosis other than scoliosis. Clinical, radiographic and outcomes data were analyzed.

Results: There were 15 females and 1 male. Avg age was 56 (23-84) yrs, 7 were idiopathic and 9 were degenerative scoliosis. Avg comorbidites were 2.6 per patient. Main curve improved from 47° to 19° (p<0.01), and the curve of the LIF levels improved from 24° to 11° (p<0.01). The L4 tilt significantly corrected from 24° to 9° (p<0.01). Change in spinal balance, lordosis (L1-S1) or amount of lordosis across the LIF was not significant. 5 of 16 (37.5%) developed a total of 8 complications associated with LIF: 3 hernias, 3 post-op quadricep weakness, 1 anterior dislodgment of a PEEK cage requiring revision, and a pleural effusion requiring prolonged chest tube. All patients regained quadricep function within 6 months of surgery. 9/16 (56%) experienced anterior thigh numbness (2 permanent) and 8/16 (50%) anterior thigh pain for at least 4 weeks post-op. There were no vascular injuries and no pseudarthroses were identified among the LIF segments. Post-operative improvement at two year follow up for VAS (6.5-2.5), ODI (60-24) and SRS-22 (2.6-3.8) were all statistically significant (p value <0.01).

Conclusion: LIF approach is a safe and effective alternative to open surgery for adult scoliosis. Patients with advanced spinal deformities should be made aware of possible post-op thigh numbness, pain and/or transient weakness as sequelae of the less invasive LIF technique.

Significance: The less invasive LIF is a safe alternative to the open anterior approach for interbody release and fusion in advanced adult scoliosis.

32. Long Term, Two Year Clinical and Functional Outcomes of Minimally Invasive Surgery for Scoliosis

Neel Anand, MD; Rebecca Rosemann, MS, PA-C; Eli Baron, MD
United States

Summary: Functional outcome analysis of 22 patients undergoing MIS deformity correction for adult scoliosis with minimum 2 year follow-up. Excellent clinical and functional outcomes, low complications, and good radiographic results were shown.

Introduction: Traditional surgical approaches for Adult Scoliosis are associated with significant blood loss and morbidity.

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We review our experience with the MIS correction of scoliosis and report long term functional data.

Methods: 72 patients have undergone MIS correction of Scoliosis since 2006. 22 consecutive patients with greater than 2 year follow-up were selected for this study. All underwent MIS surgical correction using 3 techniques: Lateral Transpsoas interbody fusion, presacral interbody L5-S1 fusion where indicated (12 patients) and segmental percutaneous pedicle screw fixation. Fusion was augmented with local bone, Bone Morphogenetic Protein (rh-BMP2) and DBM Putty at each interbody space and in the Facets. Radiographs, visual analog scale (VAS), treatment intensity score (TIS), Oswestry Disability Index (ODI) and SF-36 were assessed preop and at each postop visit.

Results: Mean age was 67.7 years (range 22 to 85). Mean follow up was 32 months (range 24 to 40). Mean number of levels operated was 4 (range 2 to 8). Preop Cobb angle was 22° (range: 7° to 62°) which corrected to 7° (range: 0° to 22°). All patients maintained good global sagittal and coronal deformity correction and were noted to have solid arthrodesis on plain films. This was further confirmed on CT Scan in 15 patients. Mean preop VAS and TIS were 6.71 and 52 and at 2 years were 1.8 and 15.83 respectively. Mean preop ODI and SF-36 were 52.71 and 36 and at 2 years were 29.45 and 65.70 respectively. (Figure 1) There were no blood transfusions or ICU stays; 12 patients had transient thigh dysaesthesia for 2-6 weeks, 2 patients had transient quadriceps weakness that resolved within 6 months. One patient required removal of a proximal screw at 12 months after fusion was confirmed on CT scan and one patient had an asymptomatic proximal screw fracture with solid fusion. No patient had iliac fixation and no failures of sacral screws or sacral fractures were noted in this series.

Conclusion: A combination of 3 MIS techniques allow comparable deformity correction, with low complication rates and significantly improved functional outcomes at 2 years postop.

Significance: MIS techniques may afford older patients improved quality of life for the treatment of scoliosis.

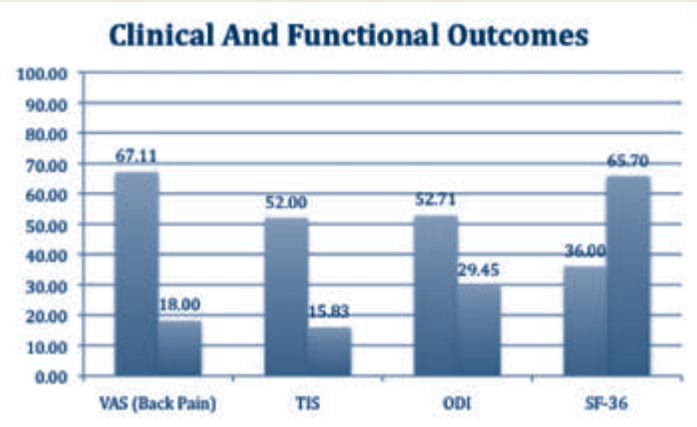

Figure 1

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

33. Evaluation of Lumbar Deformity After Decompression Surgery for Degenerative Lumbar Scoliosis

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Japan

Summary: Progression of lumbar Cobb angle (>6°) was observed in 25% of patients after decompression surgery to DLS patients, however, prediction of the progression was unable with pre-operative information. No patient needed additional spinal fixation due to progression of deformity during follow-up. Spinal fixation solely aimed for prevention of deformity progression is not always necessary if main symptom is leg pain in DLS patients.

Introduction: It is still controversial whether decompression alone is sufficient to relief leg pain in lumbar degenerative scoliosis (DLS) patients or corrective fixation is needed to prevent the progression of deformity especially in elder patients whose surgical invasion should be minimized.

In this study, we evaluated the progression of deformity and its risk factors after decompression surgery.

Methods: Twenty-eight patients (13 males, 15 females) treated with decompressive surgery with lumbar Cobb angle > 10° at final follow-up were included in this study. Main symptom was leg pain and minimum follow-up was 2 years.

Results: Lumbar Cobb angle was 16.7° (3-65°) pre-operatively and 21.0° (11-66°) at final follow-up with average 4.0° progression (-1 - 16°). We divided patients into two groups, NP group; progression of lumbar Cobb angle within 5° (21 patients, average 0° progression) and P group; the progression more than 6° (7 patients, average 8.9° progression). Lumbar Cobb angle was not significantly different in both groups pre-operatively (NP; 17.6° vs. P; 12.9°) and at final follow-up (NP; 20.5° vs. P; 21.7°). Cobb angle within the decompression level, number of decompression levels, degree of vertebral rotation at apex, degree of lateral spur (Nathan classification) and sagittal alignment showed no difference.

Five patients (4 in NP, 1 in P) needed revision surgery; decompression at or adjacent to prior level in 4 patients and interbody fusion for lateral listhesis in 1 patient.

Conclusion: Progression of lumbar Cobb angle (>6°) was observed in 25% of patients. As there was no difference between two groups in pre-operative parameters, predicting the progression of deformity was unable with pre-operative information. No patient needed spinal fixation due to the progression of deformity.

As patients with severe imbalance, back pain or deformity that should be indicated for fixation were not included in this study, we could not indicate the criteria for fixation from this study. However, spinal fixation solely aimed for prevention of deformity progression is not always necessary if main symptom is leg pain in DLS patients.

Significance: We evaluated the progression of deformity after decompression surgery in DLS patients with leg pain.

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34. Acute Proximal Junctional Failure Following Long Posterior Fusion for Spinal Deformity: Risk Factors and Radiographic Analysis Comparing Thoracolumbar to Upper Thoracic Failures

Richard Hostin, MD; Shay Bess, MD; Robert A. Hart, MD; Breton Line, BSME; Christopher P. Ames, MD; Khaled Kebaish; Douglas C. Burton, MD; Virginie C. Lafage, PhD; Michael F. O'Brien, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Kirkham B. Wood, MD; International Spine Study Group
United States

Summary: Acute proximal junctional failure (APJF) following spinal deformity surgery is a heterogenous complication. Multi-center retrospective study demonstrated that risk factors for and etiology of APJF vary in different regions of the spine. Older patients and constructs with upper instrumented vertebra (UIV) in the thoracolumbar spine most commonly fail due to vertebral fracture, however younger patients and constructs with UIV in the upper thoracic spine fail through soft tissue. Further research is needed to delineate effective preventative measures.

Introduction: Acute proximal junctional failure (APJF) is a challenging complication following spinal deformity surgery. Recent data indicates APJF is not a homogeneous entity; multiple etiologies exist for APJF. Little data exists comparing APJF in the thoracolumbar spine (TL-APJF) to APJF in the upper thoracic spine (UT-APJF). Purpose: identify demographic and radiographic characteristics of patients suffering TL-APJF vs. UT-APJF.

Methods: Multi-center, retrospective analysis of spinal deformity patients suffering APJF within 6 months of posterior instrumented fusion >4 levels. APJF defined as 15 degree postop increase in kyphosis between upper instrumented vertebra (UIV) and UIV+2, fracture of UIV or UIV+1, or need for proximal extension of fusion. TL-APJF= failures between T7-L2; UT-APJK = failures betweenT1-6. APJF etiology defined as fracture (FX), soft tissue failure (ST), or UIV fixation failure (UFF). Demographic, operative and radiographic parameters were evaluated.

Results: 63 patients, mean age 65 years (range 14-81), mean fusion levels 9.1 (range 4-17), met inclusion criteria. TL-APJF were older, had fewer fusion levels, and greater change in lumbar lordosis (LL) vs. UT-APJF ($p<0.05$; Table). Preop to postop changes in UIV/UIV+2 angle, sagittal vertical axis (SVA), pelvic incidence (PI), and pelvic tilt (PT) were similar TL-APJF vs. UT-APJF (table). FX was most common failure mode in TL-APJF, ST was most common in UT-APJF ($p<0.05$; table). FX were older than ST (69.2 vs. 58.4, respectively; $p<0.05$). Change in UIV/UIV+2, SVA, PI, PT and LL were similar between FX and ST. Time of APJF onset and body mass index (BMI) was similar TL-APJF vs. UT-APJF and FX vs. ST.

Conclusion: APJF following spinal deformity surgery is a heterogeneous complication. Discrete considerations include level of UIV and mode of failure. Older patients and constructs with UIV in the TL spine most commonly fail via vertebral fracture while younger patients and constructs with UIV in the UT spine fail through soft tissue. Further research is needed to delineate effective preventative measures.

	Total APJK	TL-APJK	UT-APJK
Patients (n)	63	43	20
Age (yrs; mean) *	65	67	58
Levels fused (mean)*	9.1	7.4	13.4
Fracture as APJF etiology (n/total;%)	29/53 (55%)	24/39 (62%)	5/14 (36%)
UIV/UIV+2 angle change	18.5	18.5	18.5
SVA change (cm)	-3.5	-3.3	-3.8
LL change (degrees)*	10.9	16.6	5.4
PI change (degrees)	1.9	2.5	0.2
PT change (degrees)	3.0	4.3	0.6
Onset APJF (weeks postop)	11.6	11.8	11.2
All screw constructs (%)	98	100	93

*= p<0.05;TL-APJK vs. UT-APJK

35. Common Mathematical Formulas Fail to Predict Postoperative Sagittal Alignment: Confirmation of a Need for More Advanced Equations

Justin S. Smith, MD, PhD; Shay Bess, MD; Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Richard Hostin, MD; International Spine Study Group
United States

Summary: Preoperative planning is essential to optimize postoperative spinal alignment. The accuracy of 5 mathematical models to predict postoperative spinal alignment following pedicle subtraction ostoeotomy was assessed. Mathematical models that did not account for compensatory changes in the spine and pelvis poorly predicted optimal postoperative alignment and may predispose to poor clinical outcome.

Introduction: Failure to achieve optimal sagittal alignment after spinal fusion correlates strongly with poor clinical outcomes. Mathematical models have been proposed to predict optimal postoperative sagittal vertical axis (SVA) following pedicle subtraction osteotomy (PSO). Most formulas fail to evaluate pelvic tilt and the compensatory interplay between the spine and pelvis in response to regional alignment changes. Purpose: comparative evaluation of mathematical formulas in predicting good/bad postoperative spino-pelvic alignment following PSO surgery.

Methods: Multicenter, radiographic evaluation of a large consecutive series of PSO procedures. The ability of 5 mathematical models to predict postoperative SVA category (poor / good, cutoff=5cm) following PSO was evaluated by comparing predicted categories to post-operative radiographic measurements.

Results: 147 patients, mean age 52 yrs (SD, 15 yrs) received 147 PSO (42 thoracic, 105 lumbar). Mean number of levels fused was 12.6 (SD, 3.8 levels). Mean pre and postoperative SVA were 108 mm (SD 95 mm) and 30 mm (SD 60 mm; $p<0.001$). 47 patients had postoperative SVA>5cm. Each mathematical formula provided unique prediction for postoperative spinal alignment (Pearson R-square < 0.15). Formulas that neglected pelvic parameters (1,2) poorly predicted final SVA and poorly correlated with post-operative SVA (Table). The formulas that included pelvic incidence (3,4) had improved SVA prediction. Formula 5 incorporated pelvic incidence, pelvic tilt and regional parameters had substantially improved SVA prediction ($p<0.05$) and correlation with optimal SVA (R=0.75).

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Conclusion: Preoperative planning is essential to optimize postoperative spinal alignment. Mathematical models that do not account for pelvic geometry and orientation poorly predict postoperative alignment and may predispose to poor clinical outcome. Formula 5 incorporated spinopelvic parameters and adjusted for the interplay between spine and pelvis based upon regional alignment changes leading to optimal prediction of post-operative SVA.

Equation	Correct prediction (%)	Correct prediction of poor SVA (%)	Correct prediction of good SVA (%)	Spearman	Mean error SVA prediction
(1) LL ≥ TK + 20	63	87	51	0.37	NA
(2) PSO angle = atan (y/z)	72	98	59	0.54	111mm
(3) LL + PI + TK ≤ 45	74	28	97	0.37	NA
(4) LL ≥ PI - 10°	78	79	78	0.55	NA
(5) SVA = -52.87 + 5.90*PI – 5.13*LL_{max} – 4.45*PT – 2.09*TK_{max} + 5.13*age	89*	70	98	0.75	30mm

LL=lumbar lordosis, TK=thoracic kyphosis, PI=pelvic incidence, LL_{max}=max lumbar lordosis, TK_{max}=max thoracic kyphosis, *P<0.05

36. Computerized Planning of Multilevel Smith-Petersen Osteotomies (SPO) and Pedicle Subtraction Osteotomies (PSO)

Nicolas Aurouer, MD; Ibrahim Obeid; Olivier Gille; Jean M. Vital
France

Summary: A new preoperative planning method for the correction of spinal sagittal imbalance, based upon a dedicated software, is presented. This method enables the assessment of the surgical correction, regardless of the type, level and number of osteotomies and regardless of the etiology of the deformity.

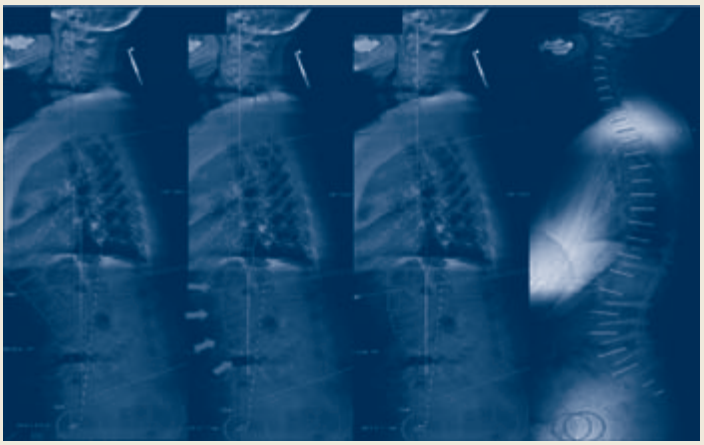
Introduction: The correction of sagittal spinal deformities is usually challenging, regardless of the etiology of the imbalance. Several methods of preoperative planning have been described for the restoration of the global balance of the trunk. These trigonometric methods are only reliable if the thoraco-lumbar spine can be modeled as a solid beam, like in the case of ankylosing spondylitis. The global spine balance is usually considered, but the local deformity is not taken into account. We present a complete preoperative method which enables the surgeon to plan SPO and PSO regardless of the cause of the deformity.

Methods: The increase of the Pelvic Tilt (PT) and the Center of both Acoustic Meati (CAM) overhang characterize the sagittal spino-pelvic imbalance. For each patient, the normal PT and the normal lumbar lordosis (LL) can be estimated from the Pelvic Incidence (PI) according to regression equations described in the literature. The purpose of the surgery is to correct the PT and the CAM. The correction can require PSO or multilevel SPO, depending on the cause of the deformity. If the thoracic spine is flexible, the restoration of the normal LL enables the correction of the imbalance. If the thoraco-lumbar spine is fused, a trigonometric construction is used for the assessment of the effect of spinal osteotomies on the PT and the CAM. Therefore, numerous parameters have to be considered for the planning: type, level and angulations of osteotomies and variations of LL or/and PT and CAM, which is very challenging to manage in daily practice without a software tool.

Results: The theoretical planning is detailed from clinical cases. The SpineView® software (osteotomy version), which enables analysis and quick visualization of different correction possibilities, is presented. All the situations can be considered to assess the effect of several types, level and/or angulations of osteotomies, depending on local conditions.

Conclusion: The preoperative planning enables the surgeon to estimate the clinical effects of the different surgical techniques in order to choose the best procedure for a given patient, regardless of the cause of the sagittal imbalance.

Significance: Case reports



Preoperative planning of multilevel SPO and postoperative result

37. Fellowship and Practice Composition Impact Surgical Decision Making in Patients with Adult Lumbar Degenerative Scoliosis: Spinal Deformity vs. Degenerative Spine Surgeons

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United States

Summary: Depending on the treating physician, patients with Adult Lumbar Scoliosis (ALS) may receive a spectrum of surgical treatments. 6 Spinal Deformity and 6 Degenerative Spine surgeons were shown 7 cases of ALS with radiculopathy. Deformity surgeons had significantly higher group consistency and planned a greater number of fusion levels than degenerative surgeons in ALS cases without significant sagittal malalignment. In patients with ALS, fellowship and practice composition have a significant influence on physicians surgical planning.

Introduction: Depending on the treating physician, patients with Adult Lumbar Scoliosis (ALS) may receive a spectrum of surgical treatments. This study aims to investigate the differences in operative planning between two groups of spine surgeons.

Methods: 12 Surgeons; 6 Spinal Deformity and 6 Degenerative Spine surgeons were shown 7 cases of ALS with radiculopathy. Radiographic inclusion included: lumbar curve between 25°-40°, T2-12 Kyphosis, 20°-50°, L1-S1 Lordosis: 30°-65°, and SVA: 0-80mm. Each case included the history, PE findings, and imaging. Surgeons completed a questionnaire including: fellowship and practice deformity experience and planned operative intervention including the number of fusion levels. Student T-Test and Pearson Correlation was used for statistical analysis. Intraclass correlation (ICC) was used to investigate the internal agreement among degenerative and deformity surgeons.

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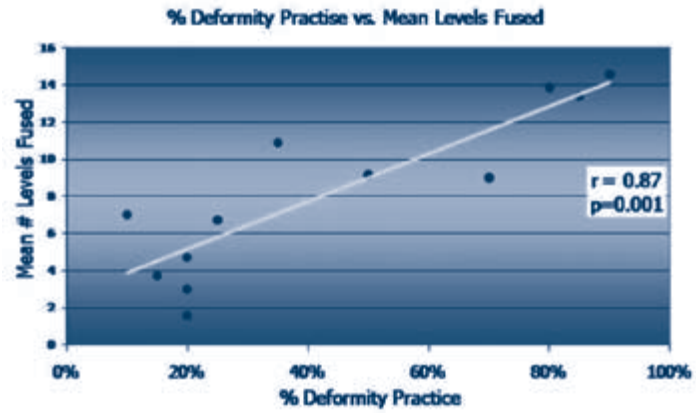
Results: Fellowship and Practice
Deformity surgeons (mean 65%, range 50-80%) were exposed to a significantly higher % of deformity cases during fellowship than degenerative surgeons (mean 33%, range 10-75%), p<0.01. Practice deformity pathology was 68% (35-90%) and 18% (10-25%) for deformity and degenerative surgeons respectively. Correlation between fellowship and practice deformity composition was r=0.62, p<0.01.

Fusion Levels
Deformity surgeons (mean 11.8, range 5.3-17.7) fused a significantly greater number of vertebral levels than degenerative surgeons (mean 4.5, range 2.8-6.2), p=0.003). Correlation between % practice spinal deformity and number of fusion levels was r=0.87, p<0.01). ICC analysis for the agreement among deformity surgeons for the number of levels fused per case was r=0.327, 95% CI: 0.07-0.76, p=0.004). ICC for Degenerative Surgeons was r=0.01 (95% CI: -0.16-0.18, p=0.842).

Conclusion: A significant association between practice composition and deformity experience during fellowship training exists. Deformity surgeons had significantly higher group consistency and planned a greater number of fusion levels than degenerative surgeons in ALS cases without significant sagittal malalignment.

Significance: In patients with ALS, fellowship and practice composition have a significant influence on physicians surgical planning.



38. Proximal Junctional Kyphosis in Primary Adult Deformity Surgery - PJK of 20 Degrees as a Critical Angle

Matthew M. Kang, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Lukas P. Zebala, MD; Joshua M. Pahys, MD; Samuel K. Cho, MD; Woojin Cho, MD, PhD; Ian G. Dorward, MD; Christine Baldus, RN MHS
United States

Summary: PJK≥20 occurred in 27.8% of adult idiopathic/degenerative scoliosis patients undergoing primary surgery between 2002-2007. PJK≥20 had the strongest association with older age and constructs from the lower thoracic spine to the pelvis. PJK≥20 generally did not lead to revision surgery for PJK, but a trend toward significance in worse SRS self image scores were seen.

Introduction: The goal of this study was to identify a proximal junctional kyphosis (PJK) angle leading to negative outcomes by comparing primary adult idiopathic/degenerative scoliosis surgical patients using 20 degrees as a critical angle as prior studies using 10 have not demonstrated negative outcomes.No study has analyzed PJK at a 20 degree threshold on predominantly pedicle screw/rod constructs while excluding patients with sagittal imbalance syndromes.

Methods: Clinical and radiographic data of 90 consecutive primary surgical patients at a single institution (2002-2007) with adult idiopathic/degenerative scoliosis and 2 yr minimum follow up (avg. 3.5 yrs) were analyzed. Assessment included various radiographic measurements, but most notably sagittal Cobb angle of the PJ angle at preop, between 1-2 months, 2 yrs, and ultimate follow up.

Results: Prevalence of PJK ≥ 20 at 3.5 years was 27.8% (N=25). Those with PJK ≥ 20 at ultimate follow up were older (mean 56 vs. 46yrs.), had lower number of levels fused (median 8 vs. 11) and were proximally fused to the lower thoracic spine more often than upper thoracic spine (all P <.001). PJK ≥ 20 was associated with significantly higher BMI and fusion to the sacrum with iliac screws (P<0.016, P<0.029 respectively). Except 1 patient revised for traumatic increase of PJK from 1 to 40, there were no statistical differences in SRS outcomes scales in patients with ≥ 20 degrees of PJK vs. <20. Mean changes in SRS outcomes (PJK ≥ 20 vs. PJK <20), for self image were 0.91 vs. 1.29 (p=0.083), for pain were 0.87 vs. 0.9 (p=0.9), and function were 0.33 vs. 0.42 (p=0.6).

Conclusion: PJK ≥ 20 degrees, in primary adult idiopathic/degenerative scoliosis with mainly pedicle screw/rod constructs, in general, does not lead to revision surgery for PJK, but is significantly associated with a mean age of 56yrs or more, shorter constructs starting in the lower thoracic spine, obesity, and fusion to the sacrum. SRS outcome score changes were lower for PJK ≥20 in all domains, but not significantly different from those with PJK <20, however, there was a strong trend towards less improvement in self image scores (p=0.083).

39. Characterization of Osteopenia/Osteoporosis in Adult Scoliosis: Does Bone Density Affect Surgical Outcome?

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Summary: Only 10% of adult scoliosis patients were osteoporotic and comparable age and sex matched bone density exists among adult scoliosis patients. There were no correlation between curve magnitude, complication rates and surgical fusion rate. Scoliosis does not predispose to osteoporosis of vice versa and patients can safely be treated surgically with acceptable results.

Introduction: To assess the prevalence of low bone mineral density (BMD) among females with adult scoliosis (AS) and relate that to surgical treatment outcome. We are not aware of a major comprehensive review of BMD in surgically treated adult scoliosis patients.

Methods: A retrospective chart and X-ray review of 176 females treated surgically

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for adult idiopathic (AIS 150pts) or degenerative scoliosis (DS 26pts). BMD of the lumbar spine, L1-L4 and femoral neck were determined by dual-energy X-ray absorptiometry(DEXA). patients were categorized as follows: concordance (osteoporosis, osteopenia, or normal BMD on both sites), minor discordance (osteoporoticin 1 site and osteopenic in the other site), and majordiscordance (osteoporosis in 1 site and normal the other site). BMI, pre operative cobb angle, fusion ratio and complication were recorded. Statistical analysis included student'sttest, chi-square test, regression coefficient test and simple linear regression. P value was set at $p<0.05$.

Results: The mean age was 51±12 years (26-82 yrs). Average follow-up was 3.4yrs (2-7 yrs). The mean T-score of the hip was -1.23±1.18 and of the spine was-0.52±1.63. Major discordance in BMD 7 (4%) pts, minor discordance 68 (39%) pts and concordance was 101 (57%) pts. There was moderate correlation between T-score of hip and spine ($R= 0.55$ $p<0.01$). T-score of the hip and of the spine showed 10.8% and 10.2% of the patients were osteoporotic. The mean Z-score of the hip and of the spine showed comparable age and sex matched values. Regression analysis showed no correlation between BMD and cobb angle ($R=0.05$ $p=0.464$). The fusion rate was 93% (164/176) and surgical complication rate was 13.6% (24/176). No significant correlation was observed between BMD and fusion ($p=0.47$) complication ($p=0.80$).

Conclusion: Comparable bone density exists among adult scoliosis patients with no correlation between BMD and curve magnitude, fusion and complication rates. The difference in BMD of the hip and of spine can not be fully explained in the review. These results will guide in surgical planning, patient select on the treatment options.

40. Impact of Upper Fusion Level on Outcome in the Setting of Adult Spinal Deformity: Effectiveness of the Clinical Impact Classification in Guiding Treatment

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United States

Summary: Using an established classification of adult spinal deformity, this multi-center study evaluated the impact of upper instrumented vertebra (UIV) on changes in clinical outcomes. This review of 1071 patients demonstrated that patients with UIV at T1-3 had the worst outcomes; T4-6 had the best outcomes when marked malalignment was present; ending fusion at T12-L1 lead to favorable SRS mental score for well aligned patients; T9-11 never outperformed any other UIV group. These findings lay a foundation for treatment algorithms development

Introduction: Adult spinal deformity (ASD) is complex due to the range of deformity patterns and clinical presentation. The ASD Classification (Schwab & al) permits a relevant description of patients based upon health related quality of life measures but outcomes based upon fusion level (upper instrumented vertebra: UIV) by Classification has not been reported. The purposed was to determine if the ASD Classification is effective in guiding selection of the UIV.

Methods: This is a retrospective review of a multicenter ASD prospective database. The study included 1071 patients, 166 male and 903 female, (mean age 59.6yo, SD=12) with minimum 1-y follow-up. Inclusion criteria were long fusion with lower instrumented level of L5 or S1 and UIV of L1 or above. Patients were classified according to: ASD Classification, UIV and outcomes measures. An analysis of variance was applied to detect differences between groups based upon outcomes changes for the following UIV groups: T1-3, T4-6, T9-11, T12-L1.

Results: Distribution by UIV was: T1-3 n=206, T4-6 n=242, T9-11 n=466, T12-L1 n=157. No significant difference was noted in terms of global balance or lumbar lordosis modifiers across UIV groups. By SF-12, SRS pain and SRS activity scores, the T1-3 UIV demonstrated the least improvement. By SRS mental score T12-L1 UIV had greater improvement than T1-3 and T9-11 groups. For patients with marked sagittal malalignment, T4-6 UIV showed greater improvement than other UIV groups. The T9-11 UIV group never outperformed all other UIV groups for any of the Classification categories

Conclusion: In this large multi-center prospective study, the application of the ASD Classification demonstrates significant differences in HRQOL outcomes by proximal fusion level for long fusions. These findings lay an important foundation for the development of treatment algorithms for surgical planning. The T1-3 UIV group fared worst in this study. The T4-6 UIV offers best outcomes when marked sagittal malalignment is present. The T9-11 UIV was never the best in terms of outcome for any of the Classification groups. Ending fusion in the thoracolumbar junction leads to favorable SRS mental component scores for patients without significant malalignment.

41. AP Spinal Fusion in Adult Deformity Surgery: Length of Staging and Perioperative Complications

Michael D. Tseng, MD; Anthony F. De Giacomo, M.S.; Amanda Tencza, MD; Sigurd H. Berven, MD; Shane Burch, MD; Christopher P. Ames, MD; Dean Chou, MD; Praveen V. Mummaneni, MD; Bobby Tay, MD; Sheri Rocha, BS; Vedat Deviren, MD; Rondall K. Lane, MD; Steven Takemoto, PHD; Serena S. Hu, MD
United States

Summary: Retrospective study of perioperative complications in patients undergoing staged combined anteroposterior spinal fusion for adult spinal deformity.

Introduction: Combined AP spinal fusion for adult deformity may be staged because of patient co-morbidities, complexity and duration of procedures. We evaluated whether the period of delay affects perioperative complications.

Methods: We conducted a retrospective review of administrative claims at a single academic medical center. Adults who underwent same-day or staged AP spinal fusion for deformity were identified querying lumbar fusion DRGs. Inclusion criteria included >5 posterior levels and spinal deformity dx. Patients admitted with infection, tumor or acute fracture were excluded. Perioperative data was obtained from electronic chart review.

Results: From 2005-2009, we identified 201 patients who met inclusion criteria (40% undergoing revision surgery). Patients were analyzed based on time between PSF and ASF and grouped to reflect varied practice patterns of multiple surgeons:Group 1: same

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day(n=37), Group 2: 1-3 days(n=41), Group 3: 4-7 days(n=71), Group 4: 1-6 wks(n=21), Group 5: >6 wks(n=31). Mean follow-up was 15.2 mo. Dx, age, gender, and ASA status were not statistically different between groups. Mean # post levels (7.6-9.8) and # ant levels (2.2-3.5) differed among groups. Overall rate of perioperative medical complications (56%) was similar among the groups, with only 3 major med complications (2 cardiac, 1 PE). There was no significant difference in deep wound infection rates among groups. Group 1 had the lowest rate of major surgical complications, as defined by need for re-operation (13%). Multivariate regression (controlling for # levels, age, gender, revision, and ASA) showed the odds of major surgical complications rose with increasing time between stages:Group 2 (OR=3.01,p=0.106), Group 3 (OR 4.03,p=0.022), Group 4 (OR 3.39,p=0.095), and Group 5 (OR=7.92,p=0.002). Group 5 was associated with higher odds of pseudoarthosis compared to Group 1 (OR= 10.4,p=0.046).

Conclusion: Adult spinal deformity reconstruction is challenging and carries a significant rate of complications. Combined fusion can be staged without an increased rate of perioperative medical complications. Same day surgery is associated with the lowest rate of major surgical complications. In particular, staging beyond 6 wks is associated with the greatest rate of non-union.

42. Alignment Failures Following Thoracic Pedicle Subtraction Osteotomies

Virginie C. Lafage, PhD; Shay Bess, MD; Frank J. Schwab, MD; Eric Klineberg, MD; Richard Hostin, MD; Douglas C. Burton, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group
United States

Summary: Thoracic pedicle subtraction osteotomy (TPSO) corrects rigid thoracic deformities. TPSO planning often focuses upon regional correction at the osteotomy site. Failure to consider global spino-pelvic alignment (SPA) may result in sub-optimal SPA. Poor final SPA occurred in 22% patients despite similar operative procedures and regional deformity correction as patients with ideal postop SPA. Preop PT and SVA predicted failed postop SPA. Additional or alternative correction procedures should be considered when planning TPSO for patients with significant spino-pelvic malalignment.

Introduction: Thoracic pedicle subtraction osteotomy (TPSO) is utilized to correct rigid thoracic deformities. TPSO planning often focuses upon regional correction at the osteotomy site. Failure to consider global spino-pelvic alignment (SPA) may result in sub-optimal correction and poor spinal balance. Purpose: evaluate risk factors for failure to achieve ideal SPA following TPSO.

Methods: Multicenter, retrospective radiographic analysis of adult spinal deformity (ASD) patients receiving TPSO. Analysis included correction at the osteotomy site, thoracic kyphosis (TK), lumbar lordosis (LL), sagittal vertical axis (SVA), pelvic tilt (PT), and pelvic incidence (PI). Radiographic measures were defined as focal (osteotomy site) or global (TK, LL, SVA, PT, PI). Final SVA and PT were assessed to determine if ideal SPA (SVA<4cm, PI <25°) was achieved. Differences between ideal (IDEAL) and failed (FAIL) SPA groups were evaluated.

Results: 41 consecutive ASD patients (mean age 42yrs) received TPSO. Average focal correction was 14° in the sagittal plane and 9.9° in the coronal plane. TPSO significantly decreased TK, max Cobb angle, SVA and PT (p<0.05). Ideal SPA was achieved in 32 pts (78%) and failed in 9 patients (22%). IDEAL and FAIL had similar number of spine levels fused (IDEAL=7.4; FAIL=7.3), similar percentage of patients fused to the sacrum (IDEAL = 87.5%, FAIL=66.7%, p=0.1), had similar focal correction, and had similar SVA and PT correction (Table). FAIL had larger preop SVA, PT and PI and a smaller LL than IDEAL (Table; p<0.05).

Conclusion: TPSO corrects rigid focal thoracic deformities. Poor final SPA occurred in 22% patients despite similar operative procedures and regional correction as IDEAL. Preop PT and SVA predicted failed postop SPA. Additional or alternative correction procedures should be considered when planning TPSO for patients with large global imbalance otherwise patients are at risk for suboptimal correction and poor outcomes.

Table

	Pre-op				Post-op				Change			
	ALL	IDEAL	FAIL	p	ALL	IDEAL	FAIL	p	ALL	IDEAL	FAIL	p
Thoracic Kyphosis	62	60	67	NS	37	36	37	NS	-25	-24	-30	NS
Lumbar Lordosis	-63	-66	-50	*	-60	-63	-49	*	3	3	1	NS
Pelvic Tilt	15	11	31	*	11	6	26	*	-5	-5	-5	NS
Pelvic Incidence	51	49	59	*	51	48	59	*	0	0	0	NS
SVA (mm)	24	6	89	*	-2	-15	46	*	-26	-22	-43	NS

*= p<0.05 IDEAL vs. FAIL

43. Results of Surgical Treatment for Scheuermann's Kyphosis Using Combined Front-Back Approach & Pedicle-Screw Constructs: A Base for Benchmark Comparisons through Analysis of 111 Cases

Heiko Koller, MD; Oliver Meier; Luis Ferraris, MD; Axel Hempfing; Marianne Umstätter; Rene Schmidt; Juliane Zenner, MD
Germany

Summary: Analysis of surgical results with anterior-open release and posterior fusion using pedicle-screw constructs in the treatment of 111 Scheuermann's kyphosis (SK).The combined approach offered good results in a large series.Findings of our study emphasize the impact of curve flexibility on curve correction in SK and curve flexibility as the decisive parameter to compare cohorts treated with combined vs. posterior-only approach. Concerning the pathogenesis of PJK, we identified the spino-pelvic morphology as a potential key-parameter for further research.

Introduction: A paucity of data on treatment for Scheuermann's kyphosis (SK) exists regarding the ideal strategy.The impact of combined strategy (ant.release & post.fusion;AR/PSF) on correction rate&surgical outcome is yet to be defined.

Methods: Review of 111 consecutive SK operated w/ AR/PSF.Assessment

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of demographics, complications & radiographs incl. flexibility & correction measures,prox.junctional kyphosis angle (JKA+1) & spino-pelvic parameters focusing on impact of curve flexibility on correction & outcomes (ODI,SRS-24).

Results: Age 23±11y, follow-up 25 mo. Number of levels treated 8±1.5. Correction per level was 4±2°.Screw-density rate was 87±13%. Cobb angle (CA) at fusion length was 68±12° preop, 41±16° postop. Flexibility on traction films was 35±14% & correction rate 47±22%. 22 pat sustained minor complications. 21 pat had additional surgery.Statistics showed a mean difference betw/ CA at fusion length on traction-films vs postop films of 9±11°.Postop & follow-up CA were highly correlative w/ preop traction-films (r=.7). Correction sign. depended on preop flexibility on traction-films (r=.6). Statistics revealed additional scoliosis reduced flexibility (p=.01) & correction (p=.03).Higher screw-density increased correction (p<.001,r=.4). In 46 pat prox. JKA+1 could be assessed in detail averaging 8°±9.21 of 46 pat (46%) had a PJK (JKA+1 ≥10°,≥10° than preop) of 16°±6. Pat w/ increased JKA+1 were at higher risk for revision (p=.049) while pat w/ revision or subsequent surgery had decreased outcomes (SRS-24:p<.01;ODI:p<.01).Concerning spino-pelvic balance, interrelations betw/ pelvic & spinal parameters maintained. Median PI was 46±11°.The preop JKA+1 sign. correlated w/ PI (r=.4),number of levels fused (r=.4) and postop loss of correction (r=-.3).

Conclusion: Our study highlights that flexibility is the decisive measure when comparing outcomes w/ different treatment strategies. Findings might indicate that changes at the junctional level are a) impacted by individual spino-pelvic morphology and b) exacted by the individually predetermined thoracolumbar curvature & sagittal balance. Good results could be achieved w/ AR/PSF. Data are open for benchmark comparisons w/ posterior-only strategies yielding for a refinement of surgical indications in SK.

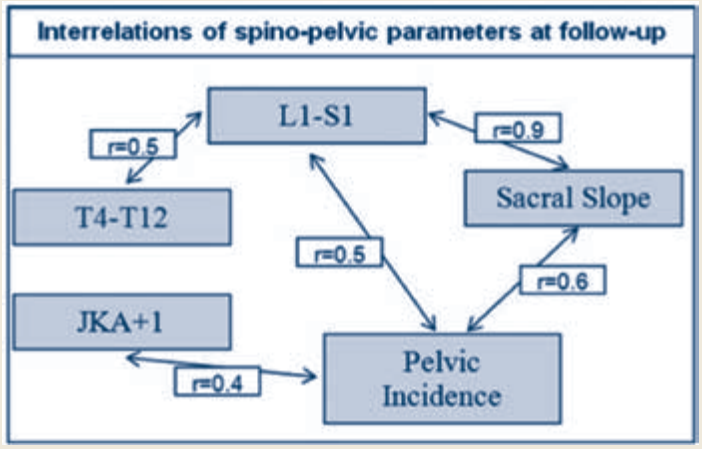

Fig.1

44. Radiographic Comparison of Lateral Fusion (LLIF) vs. ALIF vs. TLIF vs. Posterior Fusion: Analysis of Segmental Sagittal Contour Change

Jonathan N. Sembrano, MD; Amit K. Sharma, MD; Ryan D. Horazdovsky, MD; Bieta Azmoudeh, BS; Edward Rainier G. Santos, MD; David W. Polly, MD
United States

Summary: 167 patients underwent fusion of 245 lumbar levels via TPLIF, ALIF, TLIF or PSF. Segmental lordosis change was measured. All interbody fusion procedures provided significantly greater lordosis at the operative levels compared to posterior fusion.

Introduction: Potential advantages of minimally-invasive transpsoas lumbar interbody fusion (TPLIF) include reduced morbidity and blood loss, decreased post-op pain, and faster recovery. Improvement in sagittal parameters is considered an important goal in lumbar fusion. There are no studies comparing restoration of sagittal parameters utilizing the TPLIF approach versus standard approaches.

Methods: This is a comparative x-ray analysis of 4 lumbar fusion approaches. In a 2-year period, 245 levels in 167 patients were fused: TPLIF (43 patients; 63 levels); ALIF (41 patients; 67 levels); TLIF (56 patients; 74 levels); and PSF (30 patients; 41 levels). The following parameters were measured on pre- and post-op standing radiographs: segmental lordosis; overall lumbar lordosis (L1-S1); anterior and posterior disk heights. Comparison of measurement changes between groups were performed using student's t-test.

Results: All interbody procedures produced significantly greater lordosis change compared to posterior fusion alone (ALIF p=0.007; TLIF p=0.019; TPLIF p=0.03). The 3 interbody approaches were not significantly different (ALIF vs. TLIF p=0.15; ALIF vs. TPLIF p=0.28; TLIF vs. TPLIF p=0.80). Only ALIF showed significant improvement in overall lumbar lordosis (p=0.0017). Significant differences were noted in terms of anterior disk height restoration, in the following order: ALIF > TPLIF > TLIF > PISF.

Conclusion: TPLIF provides similar segmental sagittal contour change compared to ALIF and TLIF, and significantly greater compared to posterior fusion alone. Overall lumbar lordosis remains unchanged after TPLIF.

Significance: This is the first study that directly compares the sagittal radiographic parameter changes provided by a TPLIF approach compared to traditional approaches.

45. Risk-Benefit Assessment of Surgery for Adult Scoliosis: An Analysis Based on Patient Age

Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Steven D. Glassman, MD; Sigurd Berven, MD; Christopher Hamill, MD; William C. Horton, MD; Stephen L. Ondra, MD; Frank Schwab, MD; Charles A. Sansur, MD; Ketih H. Bridwell, MD
United States

Introduction: Complications increase with age for adults undergoing scoliosis surgery We assessed whether elderly patients undergoing scoliosis surgery have improvement in outcome measures that is at least comparable to younger patients, despite increased risk of complications

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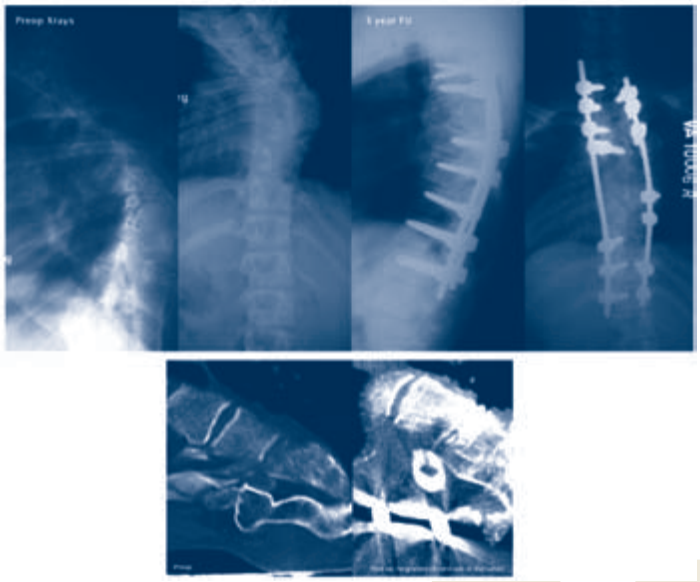
Methods: This is a retrospective review of a prospective multicentered spinal deformity database (level iii) Patients complete the oswestry Disability index (oDi), sF-12 and srs-22 inclusion criteria included: age 25-85, scoliosis (Cobb angle ≥30 degrees), plan for scoliosis surgery and 2-year follow-up

Results: Over a 5-year period, 206 of 453 patients (45%) completed 2-year follow-up, distributed among age groups as follows: 25-44 (n=47), 45-64 (n=121), and 65-85 (n=38) Perioperative complication rates were greater among older patients, with minor complication rates of 11%, 27% and 42% (P=0 004) and major complication rates of 6%, 15% and 29% (P=0 02) among patients aged 25-44, 45-64 and 65-85 years, respectively At baseline older patients had greater disability (oDi, P=0 001) and worse health status (sF12-PCs, P<0 001) Mean srs-22 did not differ significantly at baseline Within each age group, at 2-year follow-up there were significant improvements in oDi (P≤0 004) and srs-22 (P≤0 001) sF-12PCs did not improve significantly for patients 25-44 years old but did among those 45-64 (P<0 001) and 65-85 years old (P=0 001) improvement in oDi was significantly greater among older patients (mean change, 25-44: -7; 45-64: -13; 65-85: -19, P=0 003), and there were trends for greater improvement in sF-12PCs (P=0 08) and srs-22 (P=0 047) among older patients.

Conclusion: elderly patients with scoliosis electing for surgical treatment have significantly greater disability and worse health status compared with younger patients Despite increased complications, elderly patients undergoing scoliosis surgery had improvements in disability and health status that are at least comparable to younger patients.



Posterior vertebral column resection osteotomy in a congenital kyphoscoliotic deformity. Note the compression of the cord in the preoperative CT myelogram. Column resection and shortening allows the cord to move into the concavity of the to curve thus decompressing it (post op myelogram).

46. Management of Thoracic Insufficiency Syndrome (TIS) in Patients with Jeune Syndrome Using Expandable Prosthetic Titanium Rib

Robert M. Campbell, MD; Ajeya P. Joshi, MD; James W. Simmons, DO; Vishwas Patil, MD; Kent Reinker, MD; Will Koeck, MD; Hari Athreya; James Schmitz, BSC
United States

Summary: Jeune syndrome patients with TIS have improved thoracic volumes and respiratory performance and demonstrate long-term survival after treatment with Expandable Prosthetic Rib. Complications including cerclage wire cut-out and infection were manageable.

Introduction: Jeune Syndrome is an autosomal recessive skeletal disorder with a long, narrow bell-shaped thorax and short horizontal ribs. Many patients die from respiratory failure during infancy and early childhood due to TIS.

Methods: A total of 15 patients (9 M, 6 F), of average age 23 months (range, 9 - 61) at the time of the initial surgery, comprised the study group for retrospective review. The average follow-up was 87 months (range, 24 - 186 months). The thoracic cage was expanded by performing multiple rib osteotomies, both anteriorly and posteriorly, and capturing and stabilizing the rib segments with a 70mm device and cerclage wires. Serial expansions were carried out every 6 months. Pulmonary function (Assisted Ventilation Rating (AVR) and Respiratory Rate (RR)), lung volumes on CT, and complications were analyzed. Results were analyzed using parametric and non-parametric paired-samples tests.

Results: Each patient underwent the staged bilateral initial implant surgeries with a 70 mm implant, and additional surgeries including an average of 8 (range 4 - 13) expansions and 2 (range 0 - 4) device replacements. Four patients required addition of a hybrid device on the left for correction of spinal deformity. The average Assisted Ventilation Rating scale improved from 2.3 to 1.4 at the time of last f/u (p=0.031). Mean respiratory rate was 34/min preop and 26/min at final post-op (p=0.036). Five patients had lung volume studies. Average lung volumes following surgery and at final follow up were 461.99 cc and 564.58 cc respectively (p=0.063). Asymptomatic migration of the superior or inferior rib cradles and 'rib cut through' of titanium slings occurred in 14 patients. Other complications noted were superficial infection in 3 patients, deep infection in 4 patients, and skin breakdown in 8 patients.

Conclusion: Thoracic cage expansion using Expandable Prosthetic Rib improves respiratory status in patients with Jeune syndrome. Although complications are encountered during the long course of treatment involving multiple surgeries, they are treatable.

Significance: Patients with TIS associated with Jeune Syndrome, previously thought to have poor prognosis and survival, benefit from treatment with Expandable Prosthetic Rib as shown by improved respiratory performance.

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47. 3D Analysis of Congenital Scoliosis and Hemivertebrae

Jean-Sébastien Steffen; Ludovic Humbert, PhD; Raphael Vialle, MD, PhD; Jean M. Vital; Jean Dubousset; Wafa Skalli, PhD
France

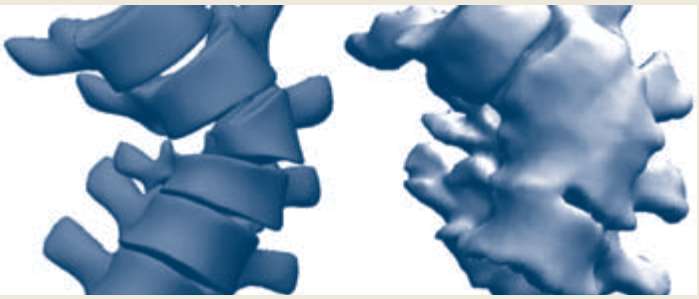
Summary: A new method to help 3D assessment of congenital scoliosis was developed using 3D reconstruction from biplanar radiographs. Precision was evaluated retrospectively including 5 patients. Automatic measurements provide global analysis of scoliotic curve and segmental quantification of the congenital deformity which may help orthopaedics follow-up and plan surgery.

Introduction: Frontal and lateral radiographs remains gold standard for congenital scoliosis follow-up. Computed Tomography (CT) scan helps to assess local morphology but only provides qualitative analysis in prone position. The current study aims at proposing a method for congenital scoliosis assessment using 3D reconstruction from biplanar radiographs and automatic parameters calculation.

Methods: A validated method for idiopathic deformation 3D reconstruction is used to model the spine from T1 to L5, excluding possible hemivertebrae. Morphology of hemivertebrae is handled during a supplementary process: A specific 3D model is created from the anatomical features which constitute the hemivertebra (body, pedicles, lamina, and processes) and adjusted using control points. This reconstruction leads to a global assessment of the spine curves but also a local characterization of each hemivertebra. Precision was evaluated on 5 patients qualitatively comparing 3D model with CT scans.

Results: Reconstructions of congenital scoliosis were possible on curves affecting the thoracic, the thoracolumbar or the lumbar spine. 3D reconstruction provided good fitness with the 3D visualization from CT scan (figure). On our patients, Cobb angles ranged from 24° to 78°. Local hemivertebral deviation ranged from 7 mm to 19 mm and wedging angle ranged from 16° to 36°.

Conclusion: 3D reconstruction of congenital scoliotic spines including hemivertebrae delivers a 3D representation of the spine in standing position and proposes a set of parameters to evaluate global and local deformities. Future work should aim at improving the validation of the method and confirming its potential interest in clinical routine practice.



Fitness of the 3D model from biplanar radiographs (left) with the visualization from Computer Tomography (right).

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

48. Is Vertebral Column Resection the Only Effective Treatment Option for Correction in Adolescent Patients with Complex Congenital Thoracic Kyphoscoliosis: The Safety and Efficacy of Posterior All Pedicle Screw Instrumentation Combined with Multiple Chevron and Concave Rib Osteotomies

Z Deniz Olgun, MD; H Gokhan Demirkiran, MD; Mehmet Ayvaz, MD; Ahmet Alanay, MD; Muharrem Yazici, MD
Turkey

Summary: Congenital kyphoscoliosis is a complex disorder that often requires surgery. PVCR, the preferred form of treatment, is technically demanding and physiologically draining. An alternative method, multiple chevron and concave rib osteotomies with all pedicle screw instrumentation is evaluated for safety and efficacy.

Introduction: Congenital kyphoscoliosis has rapid progression, causes severe cosmetic deformity, neurologic and pulmonary complications and often requires surgical treatment. With recent improvements in radiology, monitorization, implants and surgical technique, PVCR has become routine procedure in advanced spine centers and the preferred treatment in congenital kyphoscoliosis. However, it remains a technically challenging procedure, and cannot be performed everywhere. It is known that all pedicle screw instrumentation combined with procedures to increase flexibility achieves safe and effective correction in neglected idiopathic scoliosis. In this study, all pedicle screw instrumentation combined with multiple chevron and concave rib osteotomies was assessed for safety and efficacy.

Methods: 31 patients treated with this technique for thoracic kyphoscoliosis in a 2-year period were included. Inclusion criteria for the study were adolescent age (10-18), thoracic kyphoscoliosis, mixed-type deformity involving >3 levels, and treatment with posterior-only all-pedicle screw instrumentation and multilevel chevron/concave rib osteotomy. 17 patients met these inclusion criteria (average age 14.1[11-17], 7F, 10M). Efficacy was assessed using radiologic parameters, safety with intra- and postoperative progress.

Results: The average level chevron osteotomies performed was 4.5 (2-7). Average preop scoliosis was 68.5(31-110), became 26.0 (12-52) degrees (62%). Average global kyphosis was (T2-12) 75.8, became 49.4. The average local kyphosis was 71.4, became 38.2. Average intraop bleeding was 1120cc, surgical time 294 min and ICU stay overnight. There were no neurologic complications, two minor wound complications, one postop meningitis.

Conclusion: Multiple level chevron and concave rib osteotomies in combination with all-pedicle screw instrumentation result in acceptable correction for congenital deformities in adolescents suitable for treatment with PVCR with less intraop bleeding, shorter surgical times, fewer transfusions and complications. This technique appears to be a safe and effective alternative.

Significance: Multiple Chevron osteotomies presents a favorable treatment option for congenital rigid kyphoscoliotic deformities, achieving good correction with few complications.

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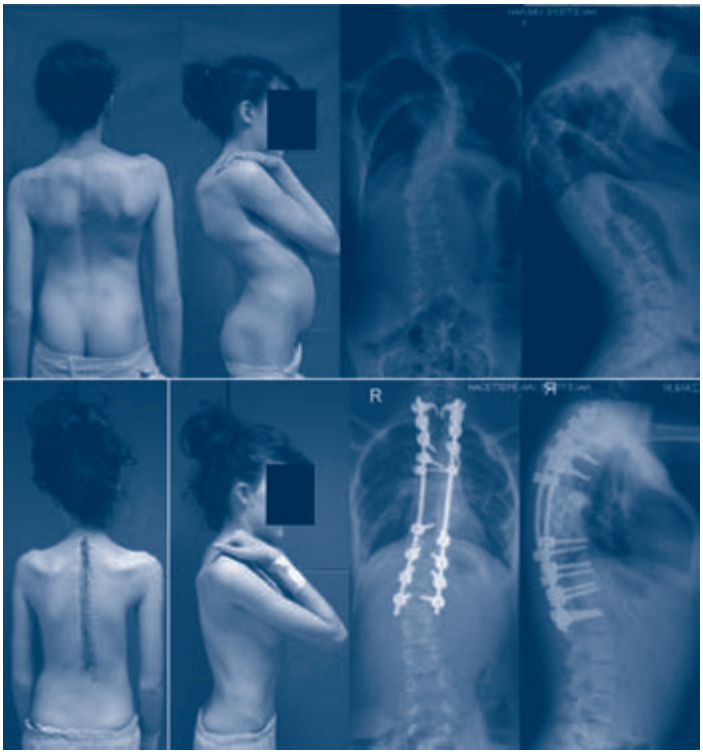

49. Bilateral 'Percutaneous' Rib-to-Pelvis VEPTR Technique for the Management of Early Onset Scoliosis: An Alternative to 'Growing Rods'?

John T. Smith, MD
United States

Summary: This is a retrospective review of 37 patients with EOS treated with the Bilateral Rib-to-Pelvis VEPTR technique. This technique is a viable alternative to Growing rods with comparable adverse events.

Introduction: Early Onset Scoliosis (EOS) describes progressive spinal deformity of varying etiologies in the growing child. The management of EOS is a challenging problem with many treatment options and strategies, but no conclusive evidence for the optimal treatment method.

Methods: This is an IRB approved retrospective review of 37 consecutive patients treated for EOS at our institution using the Bilateral Percutaneous VEPTR Technique without concomittent thoracoplasty.

Results: Patients were divided into two functional groups: 18 were ambulatory (Group A) and 19 were non-ambulatory (Group B).

For Group A, the diagnosis was: EOS:14; Neurofibromatosis Type I:2; Neuromuscular Kyphosis:1; Kyphoscoliosis:1. The average age was 6.0 years. The average pre-op coronal cobb angle was 63 degrees and was 44 degrees at last follow-up.The average saggital cobb angle was 61.1 degrees and corrected to 54 degrees at last follow-up. The average length of follow-up was 83.9 months. There were 18 adverse events in 121 procedures (14%). 7 of 18 patients developed significant crouched gait requiring conversion rib-to-spine fixation (39%).

There were 19 non-ambulatory patients in Group B. The diagnosis was Spina Bifida:6;Myopathy:6;Cerebral Palsy:4; and syndromic scoliosis:1. The average length of follow-up was 63.8 months. The average pre-op coronal cobb was 64 degrees and improved to 38 degrees at latest follow up. The saggital cobb improved from 70 degrees pre-op to 47 degrees. There were 15 adverse events in 100 procedures (15%).

Conclusion: The Salt Lake City Bilateral Percutaneous Rib to Pelvis VEPTR technique represents the only FDA approved approach to the management of EOS using growing instrumentation. This procedure is simple, minimally invasive, and does not compromise alternative treatment pathways if there is failure of the technique. We no longer use this technique in ambulatory children due the the significant incidence of crouched gait postoperatively. Complication are comparable to growing rod procedures.

Significance: This technique represents one method in the ongoing evolution of new ways to manage EOS in the growing child.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

50. Neurocentral Synchondrosis Screws to Create and Correct Experimental Deformity

Hong Zhang, MD; Daniel J. Sucato, MD, MS
United States

Summary: In an immature pig model, pedicle screw epiphysiodesis of the neurocentral synchondrosis (NCS) produced an average scoliosis of 39 degree to the ipsilateral side and the deformity was limited by delayed screw inhibition of the NCS on the contralateral side with 46% correction. This study demonstrated that pedicle NCS screw placement inhibited the overgrowth of the NCS to prevent further curve progression obtaining some correction of the deformity. This strategy may have some role in the treatment of growing patients with spinal deformity.

Introduction: Pedicle screw neurocentral synchondrosis (NCS) epiphysiodesis can create scoliosis to the ipsilateral side in an immature pig model. This study sought to determine whether screw inhibition of the NCS on the contralateral side could limit or correct this scoliosis.

Methods: 11 one-month-old pigs were randomly assigned to 3 groups: Sham (n=3) no pedicle screw fixation; Scoliosis-untreated (n=4): right double pedicle screws crossing the NCS from T7 to T14; Scoliosis-treated (n=4): the same as scoliosis-untreated except that a second set of double pedicle screws were placed in the left pedicles at 6 weeks. All animals were euthanized at 17 weeks and plain radiographs, axial CT images and histological analyses were performed.

Results: All animals had surgery without neurologic problems. Scoliosis was seen in: sham: 0 of 3 animals; scoliosis-untreated: 4 of 4 animals, average of 38.8 ± 10.4°; and scoliosis-treated: 4 of 4 animals, average

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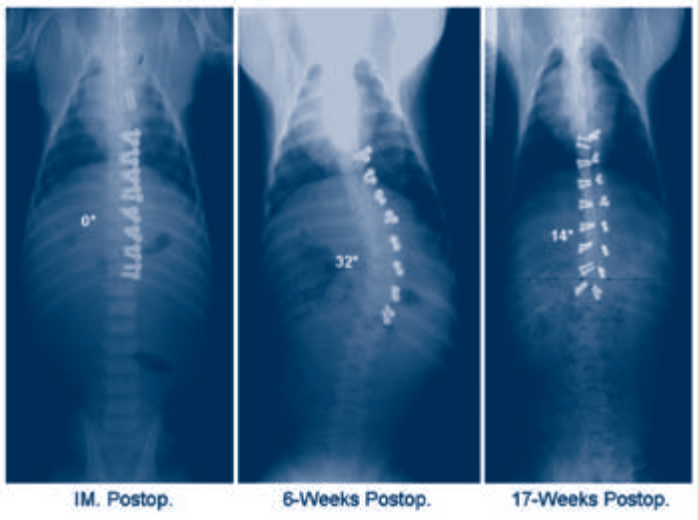
of 20.8 ± 4.7°. Apical vertebral rotation occurred toward the screw side and was greater in the untreated (24.5 ± 2.6°) than in the treated (15.2 ± 3.6°) and the sham group (0°) (p=0.0001). The NCS screws produced 12% shortening of the pedicle and 43% narrowing of the spinal hemi-canal on the screw-insertion side to create scoliosis in every animal. In the scoliosis-treated group a 38% reduction of the apical vertebral rotation and a 46% correction of the scoliosis was seen (Figure).

Conclusion: Contralateral staged pedicle NCS screw placement inhibited the overgrowth of the NCS to prevent further curve progression obtaining some correction of the deformity. The NCS screw epiphysiodesis can create and reverse the scoliosis in an immature pig model.

Significance: Pedicle screw epiphysiodesis of the faster-growing NCS has the potential to arrest or reverse progressive spine deformity. This growth modulation strategy would be especially useful in young scoliosis patients where formal arthrodesis of the spine results in a short trunk and limits lung development and ultimately has a detrimental effect on pulmonary function.



51. Surgical Management of Early Onset Scoliosis and Kyphosis by Proximal Fixation with a Novel Four Rib Construct

AlaaEldin A. Ahmad, MD; Richard H. Gross, MD
Palestinian Territory, Occupied

Summary: 23 cases of early onset scoliosis , 15 of which were associated with kyphosis; performed with a 4 rib construct for proximal thoracic fixation were reviewed . Preliminary results were very encouraging.

Introduction: Current methods (growing rods and VEPTR) for managment of early onset scoliosis associated with kyphosis have not been satisfactory. We introduce a new method of proximal rib fixation that has proven reliable for control of kyphotic deformity.

Methods: Records and radiographs of 23 patients with rib pelvic(21) or rib spinal (2) dual rod placement were studied .Diagnosis of early onset deformity included 8 scoliosis (2 syndromic ,2 neuromuscular scoliosis,4 congenital), 11 kyphoscoliosis (4 congenital, 4 syndromic,3 neuromuscular) 4 kyphosis (2 syndromic, 1 neuromuscular ,1 congenital). Surgical technique consisted of bilateral 4.5 mm rods; distal fixation with" S" rods or iliac screws(except 2 with spinal pedicle screw fixation distally), and bilateral proximal fixation with 2 downgoing superior laminar hooks and 2 upgoing inferior laminar hooks on 4 adjacent ribs. 13 were in brace or cast for 6 months post op. Mean follow up was 9.8 months (1-30 months).

Results: Mean age at surgery was 6.8 years (from 2.5-13.5). 10 had prior spinal surgical management. Mean preop major scoliosis was 74.4, mean pre op kyphosis for 7 patients with thoracic kyphotic deformity was 98 degrees , for 8 thoracolumbar was 70.2 . .Mean post op scoliosis 51.2 degrees , mean post op thoracic kyphosis 64.3, thoracolumbar kyphosis 29.1 . Implant dislodgment was found in 2 case(iliac screws) , one delayed infection required removal of instrumentation, one patient required exchange of 4.5 to 5.5 rods for recurrent kyphosis . None of the cases had proximal dislodgment of any kind.

Conclusion: The 4 rib construct has been a safe and reliable method of proximal fixation for early onset scoliosis, and may be a superior method in the presence of kyphosis.

Significance: Treatment of early onset deformity associated with kyphosis has been difficult with current methods. The method described has been more reliable than currently used methods for proximal fixation in this patient population.

52. Simultaneous Vertebral Column Resection and Growing Rods for Severe Early Onset Spinal Deformity

Ashley Goldthwait, BS; John B. Emans, MD; Peter O. Newton, MD
United States

Summary: Vertebral column resection (VCR) with simultaneous growing rod (GR) insertion permits correction of severe local deformity while allowing further spine growth in selected severe early onset spinal deformity (EOSD).

Introduction: Severe EOSD may consist of both an acute angular localized deformity and a more extensive global deformity. Traditional treatments include osteotomy and fusion with an undesirable loss of spine growth, or fusion-less treatment with incomplete correction of the localized angular deformity. Control of local and global deformity with GR alone may be difficult owing to the severity and rigidity of the local deformity. Simultaneous VCR and GR insertion may offer a potential solution.

Methods: Four patients with severe EOSD treated simultaneously with VCR and GR were identified in a multicenter retrospective review of pediatric VCR patients. IRB approval was obtained at all centers. Clinical data and radiographs were reviewed.

Results: Four patients were successfully treated with VCR and GR. Diagnoses included paralytic scoliosis (1), congenital kyphoscoliosis (1), and congenital spinal dysgenesis/dislocation (2). Mean age at surgery was 3 yr (range 1-4 yr) and average follow-up was 1.8 yr (range 1-2.9 yr). GR techniques included dual posterior distraction-based GR (2) and Shilla sliding rods (2). Three VCRs were done through a posterior-only approach and one as a combined anterior/posterior approach. In each a local fusion and instrumentation

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bridging the VCR was used and in 3 of 4 the local instrumentation was incorporated into the GR construct. Of 3 patients with intact pre-op neurologic exam, 1 had transient post-op paraplegia and all were normal at follow-up. One patient with trace-only motor strength pre-op experienced a permanent loss in motor strength. Mean Cobb angle of scoliosis improved from 66° pre-op to 26° post-op and was 32° at last follow-up. Mean maximum kyphosis corrected from 79° pre-op to 35° post-op and was 49° at last follow-up. Thoracic height (T1-T12) increased a mean of 1.9 cm post-op. Mean growth in thoracic height with lengthening after the initial procedure was 0.67 cm/year.

Conclusion: Management of severe EOSD with rigid local deformity as well as global deformity remains challenging. VCR combined with GR offers an option permitting control of both deformities while allowing for continued spinal growth. Longer follow-up is needed to assess the usefulness of this technique throughout the entirety of growth.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

53. Factors Influencing the Decision for Surgical Intervention in Early Onset Scoliosis

Pooria Salari, MD; Jeff Pawelek, BS; Gregory M. Mundis, MD; Paul D. Sponseller, MD; Oheneba Boachie-Adjei, MD; Richard M. Schwend, MD; Patrick Bosch, MD; Laurel C. Blakemore, MD; Behrooz A. Akbarnia, MD
United States

Summary: When surveyed, scoliosis surgeons felt age and weight were the most significant factors in decided whether to perform vs. avoid surgery in early onset scoliosis (EOS). Diagnosis, pulmonary function, cardiac status and bone mineral density alone do not appear to be major contraindications for surgery in EOS.

Introduction: Children with early onset scoliosis (EOS) range from otherwise healthy idiopathic type to complex spinal anomalies with serious medical issues. No definitive recommendations exist regarding contraindications to the surgical treatment of EOS. We aimed to identify surgeons' limits when considering surgical intervention in this complex group of patients.

Methods: A survey was designed to assess the demographic, diagnostic and clinical thresholds surgeons use when considering surgery in EOS. Seven multiple choice questions were selected based on a variety of clinical factors and were posed to surgeons who specialize in the treatment of EOS (Table 1).

Results: 31 surgeons responded to the survey. 27 (87%) surgeons considered age as a factor when considering surgical treatment and 22 (71%) would operate on patients between 6 months and 2 years of age. Osteogenesis imperfecta was the most common (14%) diagnostic contraindication for surgery; however, 22 of 28 (79%) respondents stated the patient's diagnosis was not a factor. While nearly half (53%) of surgeons stated weight was not a contraindication for surgery, the 25th weight-for-age percentile was most commonly (33%) reported as the minimum weight range considered for surgical treatment. If cleared by a pulmonologist, pulmonary function was not a factor for 23 of 31 (74%) surgeons. Similarly, if cleared by cardiology, 24 of 30 (80%) respondents would operate despite the presence of a cardiac disorder. Bone mineral density (BMD) was not a consideration for 22 of 31 (71%) surgeons; however, 22% of surgeons would avoid surgery if the Z-score < -2.5. When asked to rank the top 4 factors that influence their decision whether or not to perform surgery, 28 of 31 (90%) surgeons indicated patient age was most critical variable.

Conclusion: The survey results indicate diagnosis, pulmonary function, cardiac status and BMD alone are not major influencers in the decision to perform surgery in EOS while age and weight are more critical factors. However, the decision to perform or avoid surgery is often complicated by the combination of these factors, and an obvious need to arrest the natural history of the spinal deformity may outweigh potential risks.

Survey Questions
What is the minimum age you will perform surgery?
Is there a specific diagnosis (with EOS) that you will not perform surgery?
What is the minimum weight for age percentile you will perform surgery?
What is the minimum pulmonary function you will perform surgery?
Which cardiac issues do you consider as a contra-indication for surgical treatment?
What is the minimum Bone Mineral Density Z-Score you will perform surgery?
Rank the 4 most important factors in your decision making.

Table 1. List of questions posed to surgeons regarding contraindications for the surgical treatment of early onset scoliosis.

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54. Single Growing Rods: Outcome of 23 Cases with Minimum Two Year Follow-Up After Definitive Fusion

Najma Farooq, FRCS(Tr & Orth); Subhamoy Chatterjee, FRCSEd(Tr&Orth); Stewart Tucker, FRCS; Hilali H. Noordeen, FRCS
United Kingdom

Summary: This consecutive series of 23 patients treated with single submuscular growing rods attained a 58% correction in deformity and 4.4cm gain in T1-S1 height when followed up at least 2 years beyond definitive fusion.

Introduction: Growing rods remain an evolving technique in the treatment of early onset scoliosis. Following a period of serial distractions, definitive fusion defines the completion of this treatment regime. In contrast to the increasing numbers of studies examining the outcomes of growing rods, studies reviewing the results after final fusion are limited.

Methods: A retrospective study reviewing clinical and radiological outcomes in 23 patients who had undergone definitive spinal fusion after a serial distraction program between 2006 and 2008 at a single centre. Radiological parameters including assessment of sagittal and coronal deformity correction, coronal and sagittal balance, T1-S1 heights at: preoperative, pre-final fusion, post- final fusion and at the latest follow up. Complications during the treatment period were also examined.

Results: The average period of distraction before final fusion was 4.6 years with an average of 5.6 distractions. Average Coronal Cobb angle preoperatively was 67

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degrees, post growth rod insertion was 39 and at the latest follow up after final fusion was 38, amounting to 58 % correction. The average total gain in T1 S1 length was 4.4cm. Six rod fractures were noted in this series with one superficial wound infection. There were no neurological complications and there was no complications related to final fusion surgery.

Conclusion: The single growing rod technique achieves acceptable clinical and radiological results following completion of treatment at 2 years post definitive fusion.

Significance: Serial distraction with the single rod technique remains an effective method of correcting deformity and maintaining growth. Good outcomes without significant adverse effects were noted with followup beyond definitive fusion for this group of patients with early onset scoliosis.

55. CT Lung Volume Studies are Still Necessary to Document Volume Changes in Early-Onset Scoliosis (EOS)

Anna McClung, RN; Charles E. Johnston, MD; Salah Fallatah, MD, FRCS(C)
United States

Summary: Plain xray measures of thoracic dimensions have moderate correlation to CT volume determinations, but predicted lung volumes from surrogate measures on 2 dimensional xrays are too discrepant from actual CT volume to allow CT scans to be replaced for lung volume determination in EOS patients.

Introduction: Due to radiation-related health concerns, CT scanning is being more critically scrutinized in pediatric patients. Attempting to identify surrogate measures of thoracic/lung volume parameters from plain xrays, we have correlated such measures to CT volumes in our EOS population.

Methods: Xray measures of deformity and thoracic dimensions (MT Cobb, T1-12 coronal length, T6 coronal width, T6-sternal sagittal width, pelvic width), and 2 products of Th measures were correlated to 84 CT volume studies (range 181-2020 cc) obtained in 69 patients with EOS (age 0+6-9+3). Scan dx's included 41 congenital, 12 syndromic, 17 IIS, 8 idiopathic-like, 2 NF, 4 skel. dysplasia. Pearson correlation coefficients were determined for 7 variables with 3 CT volumes (convex, concave, and total lung).

Results: MT Cobb(mean 54°,range 13-108) and T6 sag width had no correlation with any CT volume. T1-12 length (r=.69), T6 width (r=.65), pelvic width (r=.58), chest vol (T1-12 x T6wid x T6 sagwid) (r=.67) all correlated with total CT volume at p<.0001, with same significance for CT vol convex and concave. Multiple regression of thoracic measures resulted in a prediction equation CT total= -885 + 4.6 (T6 width) + 4.65 (T1-12 length) + 6.1 (pelvic width), r^2=0.56, with T1-12 length the most significant contributor. Equations for convex and concave predicted volumes had similar r^2 = .53 and .51 respectively. However predicted total CT volume was only within 163cc (21%) of actual volume in 50% of cases, and within 394cc (86%) in 95% of cases. Concave and convex predicted values were similarly discrepant with actual volumes.

Conclusion: Plain 2-dimensional xray measurements of thoracic parameters statistically correlate moderately with actual CT volumes. However predicted volumes from these plain xray measures are insufficiently accurate to be useful for documentation of indication for or result of treatment. Surrogate measures do not replace actual CT volume determinations in our EOS population.

Significance: Direct CT volume measurement remains the most accurate method to evaluate lung volume in EOS patients.

56. Increased Rates of Anchor Failure can be Predicted by an Early Onset Scoliosis Severity Score

Sumeet Garg, MD; Anna McClung, RN; Charles E. Johnston, MD
United States

Summary: Spine and rib anchor implant failure is common in early onset scoliosis. A prognostic scoring system incorporating systemic severity of EOS was predictive in identifying patients at risk for more frequent episodes of implant failure.

Introduction: Surgical treatment with fusion-less spine and rib-based implants for patients with early onset scoliosis (EOS) is almost universally beset by implant complications. A comprehensive assessment score of overall severity may identify those at risk for complications.

Methods: An EOS severity score including nutritional status, medical health, radiographic deformity/flexibility and functional status was developed, with a maximum score of 14. Records and radiographs of all patients treated surgically at a single institution were reviewed. Complications were divided into implant (spine or rib-based), neurologic, surgical site infection, and skin erosion. 36 EOS patients have been treated surgically since 2003 with an average age of 4.7 years (range 1.3-9.3). Diagnoses included syndromic (20), muscular dystrophy (6), congenital (5), idiopathic (3), and thoracogenic (1). 4 patients recently operated have not been lengthened and are excluded from complications analysis.

Results: Severity scores ranged from 2-11 (mean 6). 23 had spine-based growing implants (mean severity 5.4) while 13 had rib-based (mean severity 8.1, p<.001). Implant complications were common, averaging 0.55 episodes of rib anchor failure and 0.25 episodes of spine anchor failure per surgical procedure, in spite of 11 patients having no failures. Overall anchor failures/procedure was 0.65. Patients with > 0.4 failures/procedure had higher severity score (7.9 vs 5.5, p<.008) than those with <0.4. Complications not correlated to severity score included 5 infections requiring I&D, 3 implant erosions through skin, 4 intraoperative neuromonitoring changes and 2late motor deficits (1 brachial plexus injury after VEPTR, 1 paraparesis from thoracic pedicle screw migration).

Conclusion: Many EOS patients have severe co-morbidities that directly affects success of surgical intervention. A higher (more severe) score correlates with an increased frequency of anchor complications. Patients with more severe disease are more likely to be treated with rib-based devices. The incidence of neurologic injury, infection, and skin erosion was too small to be related to the severity score.

Significance: The EOS severity score appears to identify patients at higher risk for anchor complications.

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57. Pediatric Posterior-Only Vertebral Column Resection Successfully Treats Congenital Spinal Dysgenesis and Dislocation

Ashley Goldthwait, BS; John B. Emans, MD; Lawrence G. Lenke, MD
United States

Summary: Early decompression and circumferential fusion is advocated for congenital spinal dysgenesis and spinal dislocation (CSDD). Early vertebral column resection (VCR) through a posterior-only approach may be the preferred treatment.

Introduction: Congenital spinal dysgenesis and dislocation are among the most severe congenital spinal deformities with variable vertebral body, laminar, rib and other anomalies. Static or progressive neurologic compromise is common, and most deformities worsen rapidly with growth. Early decompression and circumferential fusion is usually suggested to preserve neurologic function and restore spinal alignment. Posterior-only VCR may be the most satisfactory way to achieve these goals.

Methods: A multicenter retrospective review of pediatric VCR patients yielded 6 individuals with CSDD treated with posterior-only VCR. IRB approval was obtained at all institutions. Clinical and radiographic data were assessed.

Results: Six patients with CSDD were successfully treated with posterior-only VCR. Location of CSDD varied by patient: T3/4 (n=2), T5/6, T9, T11/12, and T12/L1. Mean age at surgery was 7 yr (range 2-16 yr) and average follow-up was 2.8 yr (range 1.7-4 yr). The 3 oldest patients had undergone previous anterior/posterior spinal fusion. A mean of 3 vertebral segments (range 1.5-5 segments) were involved in the VCR. Mean estimated blood loss as a % of blood volume was 45% (range 0.07-1.14%). Two patients also received growing rod constructs at the time of VCR. Of the 2 patients with intact neurologic exams pre-op, 1 patient had transient post-op paraplegia which resolved within 9 months. Of the 4 patients with abnormal pre-op neurologic exams, 2 patients improved to normal, 1 was unchanged, and 1 with trace-only pre-op motor strength lost motor strength post-op. Three patients later required an implant-related procedure. Mean maximum kyphosis improved from 95° pre-op to 38° post-op and was 42° at last follow-up. Mean growth in thoracic height (measured T1-T12) after the initial procedure was 0.36 cm/year.

Conclusion: Early VCR through a posterior-only approach for CSDD appears to give satisfactory restoration of spinal column alignment while permitting neural decompression. Treatment remains challenging, with risk of neurologic change and concern for long-term loss of spinal height associated with early operation.

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58. Posterior Hemivertebra/Bar Resection and Segmental Instrumentation in the Treatment of Congenital Scoliosis at the Cervicothroracic Junction

Lynn J. Letko, MD; Jurgen Harms, MD
Germany

Summary: Posterior hemivertebra/ bar resection at the cervicothoracic junction is a technically demanding surgical procedure which allows a high degree of deformity correction with a manageable rate of complications.

Introduction: Cervicothoracic junction (CTJ) congenital scoliosis has been surgical dilema. We report a series of patients treated with posterior cervicothoracic hemivertebra/bar resection.

Methods: 7(4F, 3M) patients with congenital scoliosis at the CTJ (C6 - T3), who underwent correction 2001 - 2007 with posterior hemivertebra/bar resection and segmental instrumentation were retrospectively reviewed. A pre-op CT angiogram/angiogram was performed in all cases instrumented into the cervical spine. The surgery was done as a single stage procedure in tong/halo placement. Posterior elements were exposed leaving the periosteum intact except where fusion is planned. The cervical & upper thoracic nerve roots comprising the brachial plexus must be maintained All patients had > 2 y follow- up (2 - 9 yrs).

Results: Mean age at surgery was 10yrs (3- 15 yrs).
Pre-operative mean curve magnitude was 37° (20° - 60°). Post-operative mean was 1.4° (0° -10°) (maintained at last follow -up) Mean % correction was 97% (78 -100%). 1 hemivertebra was at C7, 2 at T1, 1 at T2, 2 at T3. The bar was located C7-T3. All resected hemivertebrae were below the entrance of the vertebral arteries. 3 cases were instrumented into the lower cervical spine. A halo body jacket was used 3 mos. post-op in 2/3 patients instrumented into lower cervical spine.

6 complications occurred in 4 patients: 2 patients required revisions 2° to screw loosening in the lower thoracic region, 2 patients had a brachial plexus root irritation post-op. This subsequently resolved.
1 patient developed a post -op pneumonia and pleural effusion,
1 patient developed a Horner Syndrome. No spinal cord deficits occurred.

Conclusion: Posterior hemivertebra/ bar resection at the CTJ is a technical challenge.

It can be accomplished safely with proper surgical planning and execution. The procedure results in high degrees of correction with a manageable complication rate.

Significance: There is a paucity of literature regarding the treatment techniques and results of cervicothoracic hemivertebra which present challeges to the spine surgeon.

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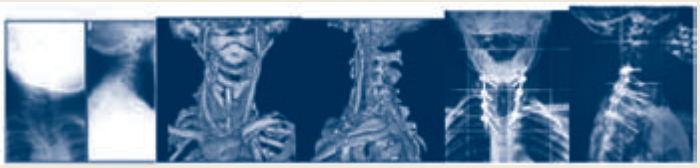

Case Example C7a hemivertebra Pre-op x-rays and Angio CT Follow-up x-rays

59. Posterior Instrumentation Results of Congenital Scoliosis

Tolga Ege; Serkan Bilgic, MD; Omer Ersen; Yuksel Yurttas; Erbil Oguz; Ali Sehirlioglu
Turkey

Summary: Presently, treatment of congenital scoliosis maintains its complexity and debate.We have evaluated 42 patients (13 male,29 female) who were operated for congenital scoliosis between 1996 and 2008. Posterior spinal instrumentation was applied to all patients. Nowadays using of modern spinal instrumentations in congenital scoliosis , makes the succes rates higher and decreases the complications ratio

Introduction: Presently, treatment of congenital scoliosis maintains its complexity and debate. Curve structures in congenital scoliosis are generally rigid, so conservative treatment methods are usually unsuccessful

Methods: We have evaluated 42 patients (13 male,29 female) who were operated for congenital scoliosis between 1996 and 2008. Posterior spinal instrumentation was applied to all patients. We have used translation maneuver for correction of curves. During the surgery, continuous neuromonitorization was performed

Results: When we compare the patients with or without costal anomalies on the concave side of the curve, the correction rate of the main curve was %23.3 in the group with costal anomalies and % 40.6 in the group without costal anomalies. This difference between two groups was found statisticaly expressive

Conclusion: This success rates and decreased complication ratios correlate with evaluating the patient for intraspinal and extraspinal anomalies preoperatively.

Significance: Although many complication rates have been reported for the patients who were operated with 1st. generation spinal implants in the literature, nowadays success rates are higher with the use of 3rd generation spinal implants

60. Can Pedicle Screws Eliminate the Need for Hemivertebrae Excision?

Vishal Sarwahi, MD; Adam L. Wollowick, MD; Etan P. Sugarman, MSIV; Melanie Gambassi, NP; Terry Amaral, MD
United States

Summary: Hemivertebra excision is not required in the surgical treatment of congenital scoliosis. Our technique allows for similar curve correction and comparable length of fusion, eliminates the need for bracing and decreases risk of neurologic injury.

Introduction: Hemivertebra excision is typically required to obtain maximal correction in congenital scoliosis. This is technically challenging. Complications can include spinal cord and nerve root injury and CSF leak. Our technique involves pedicle screw fixation without the need for hemivertebra excision.

Methods: Pedicle screws are placed using a free-hand, anatomic technique. The same approach is carried out for the hemivertebra. A smaller pedicle finder is utilized for the hemivertebra. A Ponte osteotomy is carried out at the level above and below the hemivertebra as well as at other levels as necessary. Fixation levels are determined based on the number of hemivertebra, curve size, and kyphosis. In a single level hemivetebra, a short fusion can be performed.

Results: Nine patients with single or multiple hemivertebrae producing scoliosis and/or kyphoscoliosis underwent surgery. A retrospective chart, x-ray, CT, and MRI scan review of these patients was carried out. There were 5 females and 4 males with a mean age of 11.8 years, mean Cobb angle of 50°, and mean kyphosis of 46°. All patients had thoracic hemivetebra. In addition, one patient had a lumbar hemivertebra. Three patients had multiple hemivetebra. The average levels fused were 9, with an average EBL of 456, and an average operative time of 6hrs 36min. One patient had CSF leak. The average length of stay was 7 days. T he mean VAS pain score was 3, the average day out of bed was 2.5. None of these patients were braced. The average postoperative Cobb angle was 13.5 and the average postoperative kyphosis was 34. The average followup was 2.0 years.

Conclusion: Hemivertebra excision is considered the gold standard to achieve maximal correction with shorter fusion. With pedicle screws, this can be achieved through a posterior-only approach. However, this is technically challenging with potential neurologic compromise. Our technique eliminates the need for hemivertebra excision, increasing safety, while keeping the fusion short. The 80% or greater correction seen with this technique is comparable to that reported in the literature.

Significance: Correction of congenital scoliosis can be achieved without the need for hemivertebra excision, thereby decreasing the associated neurological risks.

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61. Safety and Accuracy of Pedicle Screw Placement in Young Children with Scoliosis

Feng Zhu; Yong Qiu, MD; Bin Wang, MD; Yang Yu; Zezhang Zhu, MD; Bangping Qian; Xu Sun, MD, PhD
China

Summary: An analysis of 242 pedicle screws inserted in young children with scoliosis showed good safety and accuracy. There were 18 screws in malposition but only two were supposed to be related to neurologic complications.

Introduction: Neurovascular complication remains one of the great concerns when placing pedicle screws especially when applied to unmatured spine. We reported the results of a retrospective study on the safety and accuracy of pedicle screw insertion in the patients younger than 10 years old with spinal deformities.

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Methods: A total of 37 consecutive cases subjected to posterior pedicle-based instrumentation for scoliosis were analyzed in terms of the accuracy of pedicle insertion. The patients included 19 girls and 18 boys, with a mean age of 5.4 years at surgery (range 2-10 years old). Etiologic diagnosis were congenital scoliosis in 28, early onset idiopathic scoliosis in 6, neuromuscular scoliosis in 2, and scoliosis associated with achondroplasia in 1. The average preoperative coronal Cobb's angle was 58° (ranged 40°-120°). On the postoperative CT scans, the penetration of medial, lateral pedicle cortex and anterior vertebral cortex by screws were analyzed.

Results: A total of 242 pedicle screws were inserted with 6.5 screws per patient. There were 18 screw malpositions (7.4%) with the definition of 2 mm penetration out the cortex. The malpositions were lateral in 5, medial in 8 and anterior in 5. Screw related neurologic complication occurred in two patients, one transient paraparesis and one dural tear. Two screws were pulled out and repositioned during surgery. There were no other screw-related visceral complications. The mean postoperative Cobb's angle was 28° (ranged 6°-65°). The incidence of screw malposition in malformed vertebra and in concave side was higher than that in normal vertebra and in the convex side.

Conclusion: Screw mal-positioning in posterior pedicle instrumentation was not rare but neurological complication related to the mal-positioning was low.

Significance: Pedicles screws used in unmatured spine won't increase the risk of neurologic complication.

62. Progression in Patients with Combined Congenital Scoliosis and Rib Anomalies

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Japan

Summary: This study was designed to evaluate scoliosis progression in patients with congenital scoliosis (CS) and rib anomalies (RA). 64 patients matched the inclusion criteria: younger than 10 years of age, minimum F/U 2 years, no treatment procedures, plain X-ray films at the first visit and final F/U. Risk factors were determined to be: severe curve at younger age, unilateral involvement of RA, mixed type of CS with unilateral unsegemented bar and contralateral hemivertebrae, and wider range of RA.

Introduction: The goals of this study were to evaluate progression in patients with combined congenital scoliosis (CS) and rib cage anomalies (RA), and to determine risk factors for progression.

Methods: Based on a survey of patients with combined CS and RA that was conducted via questionnaires (response rate 50.5%), 64 patients matched the inclusion criteria: younger than 10 years of age at the first visit, minimum F/U 2 years, no treatment procedures, plain X-ray films at their first visit and final F/U. Plain X-ray images were evaluated in terms of range & type of RA, severity & type of CS, thoracic height, and associated anomalies.

Results: Of the 64 patients, there were 25 males and 39 females with an average age of 2.4 years at the first visit and 10.8 years at the final F/U. Average F/U time was 8.3 years. 43 of the 64 patients had unilateral RA. RA included rib fusion in 45, mixed rib fusion and defect in 11, rib proximity w/o any rib fusion in 5, and rib defect in 3. Vertebral anomalies included failure of formation in 5, failure of segmentation in 17 and mixed type in 40. The magnitude of scoliosis was 41.6° at the first visit and 60.9° at the final F/U. Scoliosis progression per year was 2.7°/y in 64 patients, 2.0°/y in bilateral involvement and 3.1°/y in unilateral, although 5 patients did not show any progression. One third of the rib cage was involved in 28 patients, two thirds in 25, and almost all in 11. Progression rate in patients with almost all involvement (3.1°/y) was statistically higher than those with one third involvement (2.2°/y). Cases with unilateral unsegmented bar with contralateral hemivertebrae demonstrated much higher progression rates (4.1/y) than any other types of vertebral anomalies. 5 patients were treated with some respiratory support (home oxygen therapy in 2, BIPAP in 2 and assisted ventilation in 1).

Conclusion: Risk factors in patients with combined CS and RA were determined to be: severe curve at younger age, unilateral involvement of RA, mixed type of CS with unilateral unsegemented bar and contralateral hemivertebrae, and wider range of RA.

Significance: By evaluating progression in patients with combined CS and RA, we could determine risk factors for progression in primary thoracic insufficiency syndrome.

63. Effect of Anterior Vertebral Instrumentation and Fusion on Spinal Canal Dimension in Children Ages One and Two Years

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Egypt

Summary: Anterior vertebral body screws with fusion can encroach and damage the NCC especially at the site of screw insertion. Retrospective clinical and radiological analysis of 7 consecutive pediatric cases aged 1 and 2 years treated with anterior vertebral instrumentation by downsized rod screw systems.Anterior vertebral body screws with fusion can encroach on the NCC when inserted in the very young age, this seems to cause decrease in the ipsilateral canal dimension between 10 to 20%.

Introduction: There is an unresolved controversy in the published studies regarding the effect of screws crossing the Neuro Central Cartilage on spinal canal dimension in very young children as well as in experimental animals. Anterior vertebral body screws with fusion can encroach and damage the NCC especially at the site of screw insertion , this finding have never been studied.

Methods: Retrospective clinical and radiological analysis of 7 consecutive pediatric cases aged 1 and 2 years treated with anterior vertebral instrumentation and fusion by downsized rod screw systems. The mean age at time of surgery was 2 y 4 m (1y 9m to 2y 10 m). The average follow up period was 3 y and 3 m (2 y 6m to 4 y 5 m). A total of 16 screws inserted anteriorely were evaluated by a follow up CT scan. Spinal canals were divided using known anatomical landmarks into right and left hemicanals. The relation of the anterior screws to the NCC and the spinal canal

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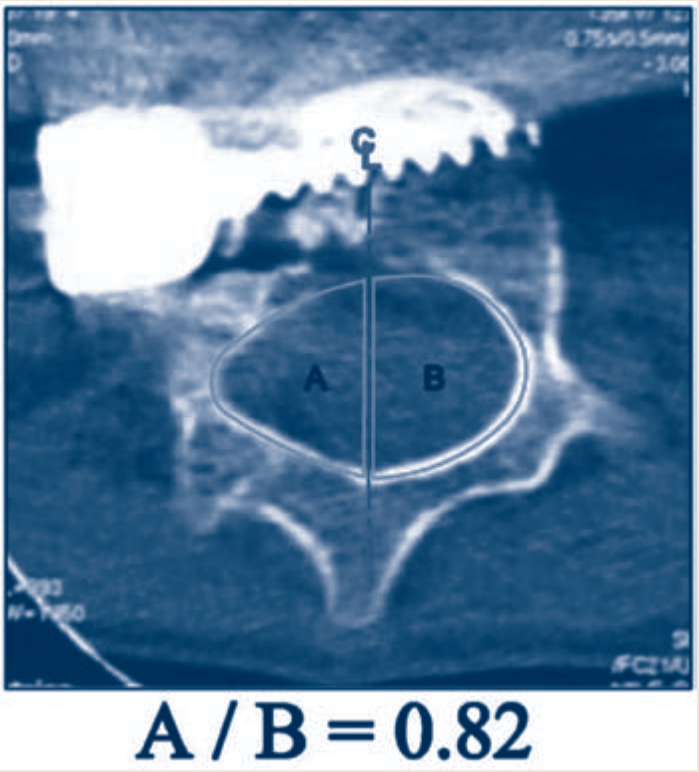
dimension were studied. All clinical or radiological complications ware recorded.

Results: Only 11 screws were suitable for measurements. There was a difference of 10 to 20% between the surface areas of the 2 hemicanals in 6 levels where the screw heads were passing through or encroaching on the NCC; the canal was smaller ipsilateral to the affected NCC. The hemicanals were almost symmetrical in 5 levels where the screw heads were away from the NCC except in one in which it was touching the NCC. For the 16 screws evaluated there were no recorded complications except for 1 screw breaching the adjacent end plate.

Conclusion: Anterior vertebral body screws with fusion can encroach on the NCC when inserted in the very young age, this seems to cause decrease in the ipsilateral canal dimension between 10 to 20%, otherwise anterior instrumentation is safe even when used in very young children age 1 and 2.

Significance: Canal asymetry had no clinical effect in childhood, long term follow up of these children is needed to determine its clinical significance.



Axial CT showing an asymetric hemicanals with reduced dimension of the one ipsilateral to screw insertion.

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64. Crossing the Cervico-Thoracic Junction in Multilevel Posterior Cervical Fusions Reduces the Rate of Symptomatic Adjacent Segment Breakdown

Joshua D. Auerbach, MD; Jennifer K. Sehn, BS; Woojin Cho, MD, PhD; Andrew H. Milby, BS; Charles H. Crawford, MD; Brian A. O'Shaughnessy, MD; Michael S. Chang, MD; K. Daniel Riew, MD
United States

Summary: The purpose of this study is to compare clinical outcomes and rates of symptomatic adjacent segment disease(ASD) in posterior cervical fusions(PCF) constructs with end-instrumented vertebrae in the cervical spine to in the proximal thoracic spine. Long PCF that cross the C-T junction have superior clinical outcomes and reduced rates of adjacent breakdown, at the expense of longer fusions and higher EBL with no increase in the rate of complications. Crossing the C-T junction affords protection of the adjacent levels.

Introduction: While many surgeons advocate crossing the cervico-thoracic junction in order to avoid junctional breakdown in multilevel posterior cervical fusions(PCF), we know of no direct evidence to support this practice. The purpose of this study is to compare clinical outcomes and rates of symptomatic adjacent segment disease(ASD) in PCF constructs with end-instrumented vertebrae in the cervical spine(EIV-C) to PCF constructs that end in the proximal thoracic spine(EIV-T).

Methods: Retrospective review of 1,714 consecutive cervical spinal fusion cases by a single surgeon between 2000-06. Two groups were identified: 36 cervical end-instrumented vertebra(EIV-C) patients(age56±10yrs) underwent a minimum 3-level PCF were compared with 53 thoracic EIV patients(age57±9yrs) who underwent a minimum 3-level PCF(avg follow-up:35Mos;range:18-82). Symptomatic ASD was defined as revision surgery or nerve root injection (or recommended surgery or injection) at the adjacent levels.

Results: There were no baseline group differences in age, gender, or number of primary surgeries. The rate of symptomatic ASD requiring intervention was significantly higher at the cranial adjacent level in the EIV-C group(28%) compared with the EIV-T group(9%,p=0.04) at 2 years. Similarly, EIV-C patients had a significantly higher rate of caudal-level symptomatic ASD requiring intervention compared with EIV-T patients (39% vs 15%,p=0.01). The development of caudal-level ASD was highest at C7(41%), followed by C6(40%), C5(25%), T1(18%), T3(18%), T2(17%), and T4(0%). The overall complication rate and surgical revision rates, however, were similar between the groups. Neck Disability Index outcomes at 2 years postop were significantly better in the EIV-T group (24.5 vs 34.0,p=0.05).

Conclusion: Long PCF that cross the C-T junction have superior clinical outcomes and reduced rates of cranial and caudal breakdown, at the expense of longer fusions and higher EBL, with no increase in the rate of complications. Crossing the C-T junction affords protection of the adjacent levels without adding significant operative time or morbidity.

Significance: Long PCF that cross the C-T junction have superior clinical outcomes and reduced rates of cranial and caudal breakdown, at the expense of longer fusions and higher EBL.

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Table: Demographics and Clinical Outcomes in Posterior Cervical Fusion with Cervical vs. Thoracic EIV

	EIV-Cervical (n=36)	EIV-Thoracic (n=53)	p-value
Age	55.8±10.3	56.6±9.0	NS
%males	20/36 (56%)	26/53 (49%)	NS
%Myelopathy	3/36 (8%)	6/53 (11%)	NS
%Radiculopathy	19/36 (53%)	33/53 (62%)	NS
%Myeloradiculopathy	11/36 (31%)	6/53 (11%)	*0.03
%Primary Surgery	10/36 (28%)	8/53 (15%)	NS
Total Levels Fused	3.9±0.9	7.0±2.7	*<0.001
EBL (mL)	206±54	343±242	*<0.001
Op Time (min)	180±65	196±70	NS
Overall Revision rate	9/36 (25%)	9/53 (17%)	NS
Overall Breakdown above	10/36 (28%)	5/53 (9%)	*0.04
Overall Breakdown below	14/36 (39%)	8/53 (15%)	*0.01
Post-operative NDI score (minimum 18 months)	34.0±21.2	24.5±12.2	*0.05

*Denotes statistically significant differences between EIV-C and EIV-T Groups

65. The Role of the Interspinous and Supraspinous Ligaments in Preventing Proximal Junctional Kyphosis

Patrick J. Cahill, MD; Amer F. Samdani, MD; Wenhai Wang, PhD; Jahangir Asghar, MD; George R. Baran, PhD
United States

Summary: We have utilized a finite element model to demonstrate the importance of the interspinous and supraspinous ligaments (ISL/SSL) in preventing pathologic intradisc pressure and excessive range of motion at the level above a scoliosis construct. When the ISL/SSL are absent, range of motion is increased by 29% and intradisc pressure by 32%.

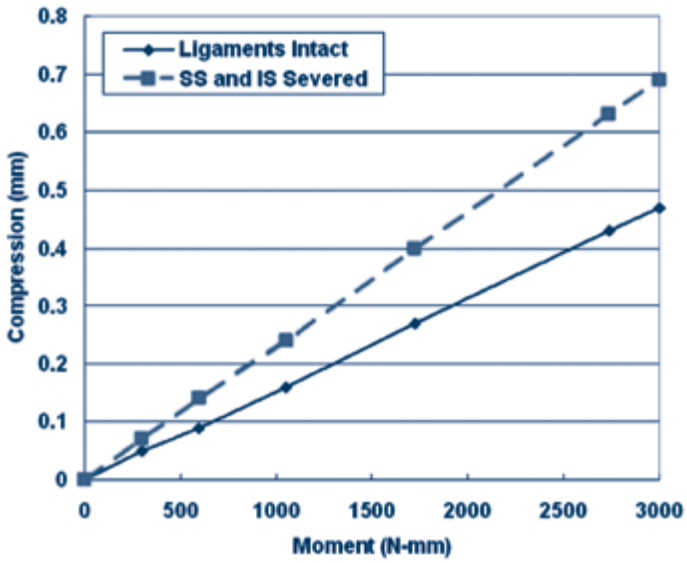
Introduction: Proximal junctional kyphosis (PJK), a vexing complication of spinal deformity surgery, is defined as a focal kyphosis at the level immediately superior to a long instrumented fusion. It leads to deformity, disability, and extension of the instrumentation into the cervical spine. The factors that lead to PJK have not been clearly defined. It has been suggested that the interspinous and supraspinous ligaments play an important role in stabilizing the motion segment in flexion by acting as a tether against hyperflexion. In this study, we have attempted to quantify the effect of sectioning the interspinous and supraspinous ligaments in the upper thoracic spine by employing a finite element model of the spine with a long thoracic fusion from T2 to T12. We have quantified the differences in range of motion and intradiscal pressure with and without the presence of the interspinous and supraspinous ligaments.

Methods: The spine solid model was first altered to accurately simulate the non-homogeneous structure of the vertebral bodies. A generic instrumented spinal fusion construct and ligaments were incorporated into the model according to published stiffness values. The model was run through a series of flexion tests while measuring the effect of the interspinous and supraspinous ligaments on the range of motion and stress levels in the adjacent structures. A 3000N-mm moment was applied to the motion segment. Variations in sagittal range of motion and anterior disc compression were recorded.

Results: The flexion arc of T1 is 29.35% greater with the interspinous and supraspinous ligaments sectioned, while while pressure within the disc is nearly 32% greater. The stress along the anterior of the disc is much higher with the posterior ligaments severed (Figure 1).

Conclusion: It is important to preserve the interspinous and supraspinous ligaments in order to prevent proximal junctional kyphosis above a long instrumented construct ending at the base of the cervical spine.

Significance: When the ISL/SSL complex is compromised, the surgeon should consider extending the construct cephalad.



66. Biomechanical Analysis of Osteotomy Type (OWO, CWO) and Rod Diameter for Treatment of Cervicothoracic Kyphosis

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United States

Summary: Pure moment biomechanical testing showed that CWO (closing wedge osteotomy) is more mechanically stable than OWO (opening wedge osteotomy) and increasing rod diameter from 3.5 to 4.5mm results in a non-trivial increase in rigidity.

Introduction: Sagittal imbalance of the cervicothoracic spine causes severe pain and loss of horizontal gaze. Traditionally, C7 OWO has been performed for patients with ankylosing spondylitis, but for those without, CWO may be considered for more controlled closure. This study characterizes the structural stability of the two osteotomy types and the independent effect of rod diameter.

Methods: 14 human spines (M/F=8/6; 60±10y.o.; C3-T6) underwent sagittal alignment and posterior bilateral screw-rod fixation (C4-C6 4.0x16mm lateral mass screws; T1-T3 4.0x34mm pedicle screws) with both 3.5 and 4.5mm Ti posterior fixation rods (Ulrich Medical). Half the specimens received OWO and half received CWO. Non-destructive flexion/extension (FE), lateral bending (LB), and axial rotation (AR) tests were conducted to 4.5 Nm. 3D motion tracking monitored primary range-of-motion (ROM) across the fixation (C4-T3) and osteotomy (C6-T1).

Results: Independent of osteotomy type, constructs instrumented with 4.5mm rods exhibited a significant increase in rigidity compared to the 3.5mm rods in all bending modes ($p<0.01$). Relative to 3.5mm rods, 4.5mm constructs showed 31±12% greater rigidity in FE, 37±39% in LB, and 31±11% in AR. At the osteotomy, there was a 43±23% increase in FE rigidity,

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45±36% in LB, and 41±17% in AR. Independent of rod diameter, CWO was significantly stiffer than OWO in FE bending only ($p<0.05$). Relative to OWO, CWO demonstrated 42% greater rigidity in FE for the construct and 56% for the osteotomy.

Conclusion: OWOs and CWOs demonstrated similar sensitivity to changes in rod diameter, meaning that the surgeon can expect a similar increase in construct rigidity in switching from 3.5 to 4.5mm rod independent of osteotomy type. The increased stiffness observed in specimens receiving CWOs has an anatomical basis. OWOs disrupt the ALL and leave a significant anterior gap while CWOs create a wedge through the vertebral body and leave the ALL and the discs above and below the osteotomy intact. The closure in CWOs leaves no anterior gap providing greater axial loading stability. This greater bone on bone contact in CWOs is likely a significant reason for the anterior stiffness and may provide greater fusion rates in the non ankylosing spondylitis patient population.

67. Treatment Techniques for Operative Correction of Proximal Junctional Kyphosis of the Upper Thoracic and Cervical-Thoracic Spine

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United States

Summary: Proximal junctional kyphosis (PJK) is a multi-dimensional problem hypothesized to be caused by patients in negative thoracolumbar sagittal balance due to flat back deformity or surgical overcorrection of lumbar lordosis. The combination of an aging spine, facet violation, paraspinal muscle dissection, and/or loss of posterior tension band have contributed to this problem.

Introduction: The iatrogenic kyphosis at the junction of fused and mobile segments in the upper thoracic and cervical-thoracic spine can lead to complaints of pain, neurologic deficit, ambulatory difficulty, or poor maintenance of chin-brow angle. We will discuss corrective techniques of this deformity that allow for overall global alignment.

Methods: After IRB confirmed approval, all patients who received treatment for PJK from 2003-2009 were retrospectively reviewed. Inclusion criteria were patients who underwent surgical correction for PJK of the cervical-thoracic and upper thoracic spine, and had > 1 year follow-up. Clinical and radiographic data included preoperative lumbar lordosis, preoperative thoracic kyphosis, pre- and postoperative global sagittal balance and sagittal proximal junctional Cobb angles. All corrective procedures were performed in two stages, each patient receiving halo traction performed for three days between cases. 6 patients received multi-level Smith-Petersen osteotomies (SPOs) with 2 patients receiving thoracic spine untethering with rib osteotomies, and 1 patient received a vertebral column resection (VCR).

Results: 7 patients (5 females, 2 males) were included with mean age of 55 years (range 18 to 80 years). Preoperative (mean 45 degrees) versus postoperative (14 degrees) proximal junctional Cobb angle differences were statistically significant, p=0.02. The mean degree of correction was 31 degrees. All patients had maintained or improved sagittal balance and improved proximal junctional cobb angles following surgical correction of PJK, although preoperative versus postoperative global sagittal balance was not statistically different. A minimum 1 year follow up confirmed improved neurologic complaints.

Conclusion: For a select cohort of patients who develop PJK of the upper thoracic and cervical-thoracic spine, multiple operative corrective techniques are available. SPOs with rib osteotomies, VCR, ligamentous relaxation by cervical traction, and intra-operative manual reduction offer a statistically significant solution.

Significance: To our knowledge, this is the first study to address the surgical treatment for patients with symptomatic upper thoracic and cervical-thoracic PJK including clinical and radiographic outcomes.

68. Correlation Between Cervical Spine Sagittal Alignment and Clinical Outcomes after ACDF

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United States

Summary: There was improvement in NDI, arm and neck pain scores two years after ACDF. No correlations between cervical sagittal alignment and HRQOLs were seen. Cervical lordosis of at least 6 degrees was fairly predictive of achievement of the MCID for NDI suggesting that maintenance or restoration of overall cervical lordosis is important in achieving a successful result after ACDF.

Introduction: Studies have shown that maintenance of lordosis and decreased subsidence with anterior cervical plates improves outcomes after anterior cervical discectomy and fusion (ACDF). However, the relationship between maintenance or restoration of lordosis after ACDF and health-related quality of life measures (HRQOLs) have not been evaluated. The objective of this study is to determine associations between cervical sagittal alignment after ACDF and improvement in Neck Disability (NDI) scores.

Methods: Preop and two-year postop cervical lordosis (C2-C7) and segmental lordosis were measured from neutral upright lateral cervical spine radiographs using the Cobb method in patients who had ACDF. HRQOL scores including the NDI, SF-36 PCS, arm and neck pain scores were also collected pre-op and at two-years post-op. Paired t-tests were used to compare pre-op and two-year post-op radiographic measures and HRQOLs. Spearman correlations were used to determine associations between sagittal alignment and HRQOLs. Receiver operating characteristic curves were constructed to identify sagittal parameters that could predict achievement of a minimum clinically important difference (MCID) in outcome measures.

Results: 101 patients (26 male, 75 female; mean age:52 ± 9.6 yrs) were included. There was improvement in all HRQOLs from pre-op to two years post-op, which reached statistical significance for NDI, arm and neck pain. There was no statistically significant difference in pre-op and two-year post-op sagittal alignment. Although no associations were noted between the radiographic measures and the clinical outcome scores, ROC curve analysis showed that a post-op cervical lordosis of at least 6 degrees predicted achievement of MCID for NDI (8 point change in NDI) with an area under the curve of 0.708.

Conclusion: There was a statistically significant improvement in NDI, arm and neck pain two years after ACDF. No statistically significant

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correlations between cervical sagittal alignment and HRQOLs were seen. An overall cervical lordosis of at least 6 degrees was fairly predictive of achievement of the MCID for NDI suggesting that maintenance or restoration of overall cervical lordosis is important in achieving a successful result after ACDF.

69. Comparison of Prognostic Value of MRI Classifications of Signal Intensity Change for Cervical Spondylotic Myelopathy

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India

Summary: The clinical significance of signal intensity change in cervical spondylotic myelopathy remains controversial and there are no previous studies comparing the prognostic significance of different classification systems that are available. This retrospective study performed on 35 patients with CSM undergoing surgical decompression with a mean follow up of 51.3 months showed that both T1 & T2 changes are important and patients with low T1 weighted intensity changes had the worst neurological recovery.

Introduction: Several classifications exist for signal intensity (SI) change on magnetic resonance imaging (MRI) in cervical spondylotic myelopathy (CSM). However, there are no previous studies comparing their prognostic significance. We aimed to determine the MRI classification of SI changes in patients with CSM that is useful for prognostication of surgical outcome.

Methods: We retrospectively studied 35 of the 77 CSM patients (mean age 57.8 years, range 30-69) who underwent cervical laminectomy and met the inclusion criteria. Follow-up MRIs were taken at a mean of 51.3 months postsurgery. The pattern of spinal cord SI was classified in three different ways based on: 1.High SI on T2-weighted images (T2WI) (Grade 0-absent, Grade 1-obscure, Grade 2-intense); 2. The extent of SI on T2WI into focal (confined to one disc level) and multisegmental (more than one disc level); 3. T1- weighted (T1WI) and T2-weighted (T2WI) images SI changes into Group A (N/N), no SI abnormality on T1WI or T2WI; Group B (N/Hi), no SI abnormality on T1WI and high SI on T2WI; Group C (Lo/Hi), low SI abnormality on T1WI and high SI abnormality on T2WI. Preoperative clinical findings and MRI abnormalities were correlated with outcomes (Nurick grades, recovery rate) following surgery.

Results: Resolution of SI in T2WI was seen in most patients; however, four patients developed low SI in T1WI in the follow-up MRI. There was no significant difference in the recovery rates of patients with different grades in T2WI or with focal or multisegmental SI changes ($p=0.47$ and 0.28 respectively) although patients with low SI changes in T1WI were associated with a poor surgical outcome ($p<0.001$). The linear regression model also confirmed low SI changes on T1WI to be a predictor of surgical outcome.

Conclusion: A classification system of MRI signal changes which accommodates both T1WI and T2WI is more predictive of surgical outcome than those with T2WI SI changes alone. Postoperative MRI is useful to identify late onset of low SI in T1WI in patients with poor neurological recovery.

70. Surgical Treatment of Cervical Degenerative Disc Disease with Myleradiculopathy: Two-Level Anterior Discectomy vs. One-Level Anterior Corpectomy

Ahmet Alanay, MD; Kursat Ganiyusufoglu; Selhan Karadereler; Mehmet Aydogan; Cagatay Ozturk, MD; Azmi Hamzaoglu, MD
Turkey

Summary: Surgical management of 2-level cervical degenerative disc disease with myeloradiculopathy by ACDF or ACCF showed no significant differences in terms of clinical symptom improvement and fusion rates.

Introduction: The aim of this retrospective study is to compare two fusion techniques with reference to radiological and clinical outcomes in patients.

Methods: Seventy-four patients who underwent ACDF (two contigous levels) or ACCF (single level including 2 disc spaces) for treatment of myeloradiculopathy due to disc herniation and uncovertebral joint ostophytes were included. The perioperative parameters (hospitalization, blood loss, operation times, complications), clinical parameters (visual Analog Scale [VAS] scores of neck and arm pain), and radiologic parameters (cervical lordosis, fusion rate) were compared between two groups. Intergroup comparisons were made by using the t test.

Results: There were 47 patients (21 male 26 female) with a mean age of 53,7 (range; 42 to 66) years in the ACDF group while there were 27 (11 male, 16 female) patients with a mean age of 55.3 (range; 45 to 68) years in the ACCF group. Mesh cages filled with allograft and semi-dynamic plates were used for all patients in both groups. Two groups were similar according to age, sex, operated levels and smoking habits. Mean follow-up period was 48.4 for AACF and 51.2 for ACDF (range; 24 to 84) months. There was no difference between both groups in terms of hospitalization period. Blood loss and operation time was lower in ACDF group but statistically insignificant. Complications in ACDF group were dura laceration in one patient and hoarseness in 3 patients. Complications in the ACCF group were dura laceration in one patient and incomplete transient C5 palsy. Postoperative neck and arm VAS scores were similar in both groups (2.8 versus 2.5). Solid fusion was observed in all patients at 6 months follow-up x-rays. Cervical lordosis improved meanly from 18.3 degrees to 24.4 degrees in ACDF group and meanly from 17.4 degrees to 21.6 degrees ($p<0.05$)

Conclusion: Surgical management of 2-level cervical degenerative disc disease with myeloradiculopathy by ACDF or ACCF showed no significant differences in terms of clinical symptom improvement and fusion rates. Although statistically insignificant, blood loss and operation times were lower in ACDF group. In addition, ACCF provided less improvement in cervical lordosis.

Significance: -

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71. Prognostic Factors in the Surgical Management of Cervical Spondylotic Myelopathy

Christopher G. Furey, MD; Henry Bohlman, MD
United States

Summary: It is generally agreed that cervical spondylotic myelopathy is most effectively treated with surgery. It is less clear what factors are associated with post-operative neurologic improvement.

Introduction: The purpose of this study was to evaluate multiple clinical and radiographic features and their relationship with surgical outcome in the treatment of cervical spondylotic myelopathy.

Methods: We evaluated one hundred twenty consecutive patients (77 males and 43 females) with multilevel cervical spondylotic myelopathy who underwent surgery over a 7 year period (1999-2005). Nurick scores were obtained pre- and post-operatively. Neurologic improvement was defined as a drop in Nurick score. Variables were evaluated with chi-square, student's t-test, ANOVA, and Logistic Regression Analysis.

Results: The Nurick score improved from a pre-operative mean of 3.6 to a post-operative mean of 2.8. 91 patients (76%) improved at least one Nurick Grade, 19 patients (16%) were unchanged, and 10 patients (8%) worsened at least one grade. Factors found to be significantly different in those patients with neurologic improvement included : age < 65 years at the time of surgery, Nurick Grade 3 or better pre-operatively, duration of symptoms less than 12 months, absence of pathologic reflexes (Hoffman's or clonus), no history of diabetes, absence of cardiac disease having required surgical intervention, and no history of smoking. Radiographic features that were significantly different in those patients with neurologic improvement included absence of T2 weighted signal change within the spinal cord on pre-operative MRI. Factors not significantly different in those with or with out neurologic improvement included the type of surgical management or the occurrence of a peri-operative complication or the need for additional surgery.

Conclusion: While surgery should be offered to most, if not all, patients with cervical spondylotic myelopathy, those with more advanced clinical features at the time of presentation (Nurick Grade 4 or worse) and those with symptoms for greater than a year are less likely to improve neurologically.

Significance: The severity and duration of myelopathy can be predictive of neurologic improvement following surgical treatment for cervical spondylotic myelopathy.

72. Hybrid Surgical Technique Combining Fusion and Disc Arthroplasty for the Treatment of Multilevel Cervical Degenerative Disc Disease

Mehmet Aydogan; Cagatay Ozturk, MD; Mehmet Tezer; Selhan Karadereler; Ahmet Alanay, MD; Azmi Hamzaoglu, MD
Turkey

Summary: The aim of this study is to report clinical and radiological results of hybrid technique in patients with multilevel symptomatic cervical degenerative disc disease. Hybrid surgical strategy for multilevel degeneration is safe and effective in patients with varying degrees of degeneration in each symptomatic level.

Introduction: Hybrid solutions such as fusion + disc arthroplasty may be an option for patients with more advanced multilevel degeneration of cervical spine. The aim of this study is to report clinical and radiological results of hybrid technique in patients with multilevel symptomatic cervical degenerative disc disease.

Methods: Clinical and radiographic outcome of 10 patients having symptomatic multilevel cervical degenerative disc disease treated by using hybrid technique and with minimum 2 years follow-up were analyzed retrospectively. Clinical analysis included pain, function and complications. Radiological parameters analyzed included sagittal alignment, presence of heterotopic ossification, adjacent segment disease, fusion rate and mobility of the arthroplasty level.

Results: The average age of patients was 37 (range; 26 to 45) years and male/female ratio was 4/6. The mean follow-up was 15.3 (range; 12 to 24) months. 2 patients had single level corpectomies, while 5 patients had single level and 3 had two level discectomies. Nine of the patients had single level arthroplasty while 1 had 2 levels. Total number of implanted prosthesis was 11 and of cages were 13. Mean operation time was 266 minutes, the average blood loss was 236 ml and the average hospitalization period was 6.4 days. Clinical follow-up outcome questionnaires demonstrated significant improvement. Five patients having preoperative incomplete neurological deficit in the form of radicular motor weakness improved completely. Radiological examination showed that preoperative segmental and global lordosis values of 2.5 and 16.2 degrees have improved to 7.8 and 25.5 degrees immediately after surgery and maintained until last follow-up with 3% loss. None of the patients had heterotopic ossification and degeneration adjacent to the arthroplasty level.

Conclusion: Hybrid surgical strategy for multilevel degeneration is safe and effective in patients with varying degrees of degeneration in each symptomatic level.

Significance: -

73. Reliability of the SDSG Classification of Lumbosacral Spondylolisthesis

Jean-Marc Mac-Thiong, MD, PhD; Luc Duong; Stefan Parent, MD, PhD; Michael T. Hresko, MD; John R. Dimar, MD; Mark Weidenbaum, MD; Hubert Labelle, MD
Canada

Summary: This study evaluates the reliability of the Spinal Deformity Study Group (SDSG) classification of lumbosacral spondylolisthesis based on slip grade, pelvic incidence, sacro-pelvic and spinal balance. Substantial intra- and inter-observer reliability was found, and all six types of spondylolisthesis described in the classification were observed. The reliability of the SDSG classification compares favorably with the reliability of other spinal classification systems.

Introduction: The SDSG has proposed a new classification of lumbosacral spondylolisthesis based on slip grade, pelvic incidence (PI), sacro-pelvic and spinal balance (Figure). Three types of low-grade spondylolisthesis are described: low PI (Type 1), normal PI (Type 2), and high PI (Type 3). High-grade spondylolisthesis are defined as Type 4 (balanced sacro-pelvis), Type 5 (retroverted sacro-pelvis with balanced spine), and Type 6 (retroverted sacro-pelvis with unbalanced

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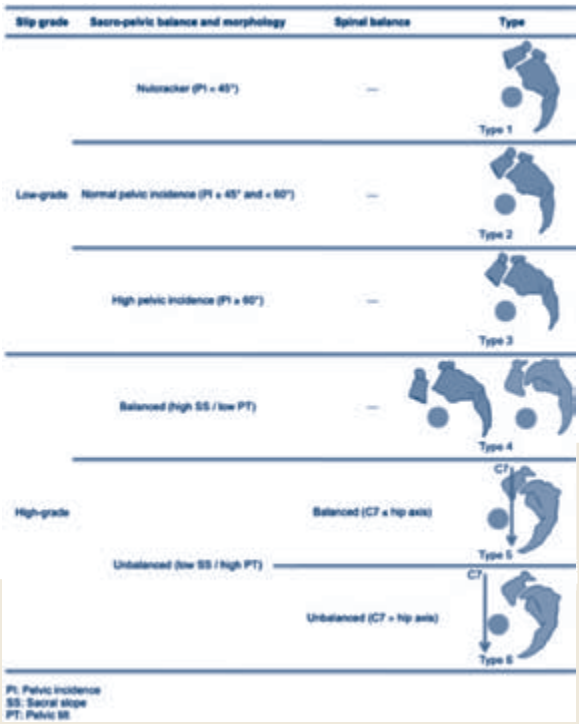
spine). This study evaluates the reliability of the SDSG classification of lumbosacral spondylolisthesis.

Methods: Full length standing lateral radiographs of the spine of 40 subjects with lumbosacral spondylolisthesis were reviewed twice by seven observers. Custom software was used by the observers to identify 7 anatomical landmarks on each radiograph, in order to determine the SDSG type for all subjects. Percentage of agreement and kappa coefficients were used to determine the intra- and inter-observer reliability.

Results: All six types of spondylolisthesis described in the classification were identified. Overall intra- and inter-observer agreements were 80% (kappa: 0.74) and 71% (kappa: 0.65), respectively. Intra- and inter-observer agreements associated with determination of slip grade were 92% (kappa: 0.83) and 88% (kappa: 0.78), respectively. As for sacro-pelvic and spinal balance, intra- and inter-observer agreements were 86% (kappa: 0.76) and 75% (kappa: 0.63) for low-grade slips, while they were 88% (kappa: 0.80) and 83% (kappa: 0.75) for high-grade slips.

Conclusion: Substantial intra- and inter-observer reliability was found for the SDSG classification, and all six types of spondylolisthesis were identified. Refinement of the computer-assisted technique is expected to further increase the reliability of the classification and facilitate its clinical use.

Significance: There is a need for a reliable classification of spondylolisthesis since past classifications are inadequate for guiding treatment, resulting in significant variations in treatment plans. The SDSG classification is reliable and is designed to facilitate clinical evaluation of spondylolisthesis and therefore hopefully allow more comprehensive investigation of future progression and treatment of this pathology.



74. Operative Treatment of Isthmic Spondylolisthesis in Children up to the Age of 12 Years: A Long-Term, Retrospective Comparative Study with Matched Cohorts

Tuomas Jalanko; Ilkka Helenius, MD, PhD; Ville Remes, MD, PhD; Pekka Tervahartiala; Timo A. Yrjonen; Mikko S. Poussa; Dietrich K. Schlenzka, MD
Finland

Summary: A retrospective, long-term follow-up study examined operative treatment for isthmic spondylolisthesis in children (≤12 yrs). Outcomes were comparable with adolescents. In children there seems to be less low back pain in adulthood. Bony remodeling decreases vertebral slip in children.

Introduction: Few data exist on the surgical treatment of isthmic spondylolisthesis in children (≤12 yrs). A retrospective follow-up study compared preoperative characteristics and long-term outcomes of operative treatment for isthmic spondylolisthesis between children (≤12 yrs) and adolescents (>12 yrs).

Methods: 287 consecutive patients (6 -19 yrs; reductions excluded) were operated on between 1977-91. 31 (11%) were ≤ 12 yrs at the time of surgery. The follow-up time averaged 17 yrs (10.7 - 26.3 yrs). Two cohorts, Children (11.1 [8.1-12.4] yrs; n=27; 12 high-grades) and Adolescents (15.8 [12.9-19.3] yrs; n=27), were formed and matched for gender, severity of slip, operative method and age at final follow-up. Operative methods: 4 pts direct repair, 28 pts posterior or posterolateral, 12 pts anterior and 10 pts circumferential fusion.

Results: Preoperatively there were more females in children (7:1) and tended to be more high-grades when compared to adolescents (39% vs. 24 %). The preoperative slip averaged 47.6% (9 - 107) in Children and 44.0% (9 - 82) in Adolescents. The slip improved postoperatively on average 7.8 % points in Children but remained unchanged in Adolescents. Non-union was noted in 1/3. SRS-24 and SF-36 scores were similar. The mean ODI was 3.3% (0-11) in Children and 7.5% (0-32) in Adolescents (p=0.021). The VAS (low back pain) averaged 10.3 (0-48) and 19.7 (0 - 84), respectively (p=0.104). Non-union did not affect the outcome.

Conclusion: Children (≤12 yrs) with isthmic spondylolisthesis can be operated on with good long-term clinical outcome that is comparable with adolescents. In children there seems to be less low back pain in adulthood. Bony remodeling decreases vertebral slip in children.

Significance: Spinal growth and bony remodellation seem to diminish the vertebral slip after in situ fusion.

75. Radiological and Clinical Outcome of Non-Surgical Management for Pediatric High Grade Spondylolisthesis: Comparison with Surgical Management

Étienne Bourassa-Moreau, Bsc; Jean-Marc Mac-Thiong, MD, PhD; Hubert Labelle, MD
Canada

Summary: 5 cases of pediatric high grade spondylolisthesis selected not to undergo surgery are presented and compared with a group of 29 non surgically managed patients. Non surgical patients had better quality of life and

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improved physical examination. The outcome of these patients was similar to surgically managed patients.

Introduction: Some authors consider pediatric high-grade spondylolisthesis as an absolute indication for surgery, regardless of symptoms while others sometimes recommend observation in asymptomatic patients. Very few is known about the indications and outcome of non surgically managed high grade spondylolisthesis. We wanted to describe and compare the outcome of patients with pediatric high grade spondylolisthesis who were managed nonsurgically and surgically.

Methods: A prospective database comprising all the spondylolisthesis cases from a single paediatric institution was reviewed in order to identify all cases of high grade spondylolisthesis. Non surgically treated patients were identified and compared to surgically treated patients. Data from clinical assessment (neurological impairment, straight-leg raising manoeuvre, flexion and extension range of motion, Lasegue sign), radiological analysis (grade, pelvic incidence, sacral slope, pelvic tilt, lumbar lordosis, thoracic kyphosis, lumbosacral angle and location of C7 plumbline), Short form (SF)-12 and Scoliosis Research Society (SRS)-22 questionnaires were collected at baseline and at last follow-up for each patient.

Results: Of 333 spondylolisthesis, 34 were identified as high grade and 5 of them were non surgically treated. Average duration of follow-up in the non surgical patients was of 30.0 months (range 10-57months). The clinical evaluation and quality of life questionnaires showed less impairment in the non surgical group when compared to the surgical group at the preoperative assessment. Moreover at last follow-up, the clinical examination and the quality of life questionnaires were similar between the two groups. No differences were noted concerning the radiological analysis.

Conclusion: Surgical intervention in symptomatic high grade spondylolisthesis offers similar outcome to non surgical approach in relatively asymptomatic high grade spondylolisthesis. There was no complication or progression observed in non surgical patients during follow-up. No radiological findings seemed to contribute to the indication of non surgical treatment.

Significance: It is safe to manage non operatively high grade spondylolisthesis in pediatric patients with relatively normal quality of life and clinical assessment.

76. Complications in the Surgical Treatment of Spondylolisthesis

Michael T. Hresko, MD; Mark Weidenbaum, MD; Courtney W. Brown, MD; Hubert Labelle, MD
United States

Summary: In this prospective, multi- center study of surgery for L5-S1 spondylolisthesis in 84 patients with mean age15.1 yrs, the incidence of intra-operative complication was 9.5% with additional procedure within 3 months in 8.3%. Pre operative neurological abnormality was identified as a risk factor for a complication within the first year of surgery. BMI, age, surgical approach, reduction of spondylolisthesis, and type of spondylolisthesis were not statistically significant factors.

Introduction: Published studies on the complications of surgical treatment of spondylolisthesis often have a long time span with evolving surgical techniques. The goal of this prospective multiple center study was to identify the rate of complications and risk factors in the contemporary surgical treatment of spondylolisthesis.

Methods: A prospective, multi-center study of surgery for L5-S1 developemental spondylolisthesis in 84 patients, mean age 15.1 yrs (SD 2.8) consisted of 29% males and 71% females who had surgery between 2002 and 2008. Clinical assessment, operative report, and radiographs were analyzed for the frequency and type of complications during the first year after surgery. Results were assessed for the significance of pre operative factors (demographics, type of spondylolisthesis, grade), surgical strategy (reduction vs in situ fusion), and approach (anterior vs anterior- posterior) on the incidence of complications.

Results: Intra-operative complications occurred in 8 of 84 patients (9.5%): 2 CSF leaks, 1 excessive bleeding and 5 nerve injury (6%). At 3 months post op, 18 (21%) of patients had a complication with 1 deep and 1 superficial infection, 1 DVT, 3 persistent pain, 1 wire breakage with 7 patients (8.3%) having an additional surgery. At 1 year post op, 70% had no complication while 25 of 84 (30%) had some complication related to surgery with implant failure in 5, 1 pedicle fracture, 4 with pain. Complications rate did not vary with BMI, age, reduction, approach, or type of spondylolisthesis. Pre-operative neurological abnormality, which were present in 31%, was a significant factor with 48% complication within one year from surgery.

Conclusion: Spondylolisthesis patients with neurological abnormality prior to surgery were at increased risk for complications within the first year of surgery. The incidence of complications did not vary with approach or reduction of spondylolisthesis.

Significance: Contemporary surgical treatment of spondylolisthesis reduced the incidence of operative complications compared to historical rates. Identification of risk factors may lead to further improvement of treatment.

77. Biomechanical Analysis of Risk Progression in Spondylolisthesis

Carl-Eric Aubin, PhD, P.Eng; Amandine Sevrain, MA,Sc.; Hubert Labelle, MD
Canada

Summary: This biomechanical study confirmed that the risk progression in spondylolisthesis is affected by an anterior movement and an increase of compression and shear stresses at the lumbosacral junction in accordance with spino-pelvic parameters in the sagittal plane, especially the pelvic incidence.

Introduction: The severity and progression of spondylolisthesis are usually documented using spino-pelvic parameters measured on radiographs, but their biomechanics is still not well known. The aim was to biomechanically evaluate the stress at the lumbosacral junction and the conditions at risk of progression.

Methods: A finite element model of the spine, pelvis and rib cage was constructed based on measurements from biplanar radiographs. At the lumbosacral junction, the model includes the spondylolysis with

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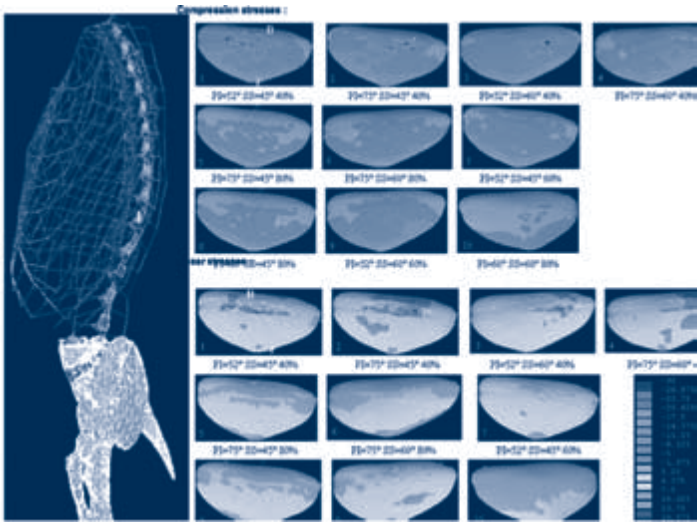
adjustable gap, sacral dome, intervertebral disc, growth plate, and relevant inter and para-vertebral connective tissues. Using a design of experiments, ten different cases of spondylolisthesis were simulated to study the effect of varying spino-pelvic parameters and grade. The stresses at the lumbosacral junction were analyzed under various pelvic incidences, sacral slopes and slip percentages. Their influence on progression risk was analyzed using a one-way analysis of variance.

Results: Compression and shear stresses were mainly concentrated on the growth plate of S1, on the intervertebral disc of L5-S1, and in fornt of the sacral dome for low grade spondylolisthésis (Fig 1; #1-4). In high grade spondylolisthésis (#4-10), more important compression and shear stresses were seen in the anterior part of the growth plate and disc as compared to the lateral and posterior areas. Stress magnitudes over this area increased with slip percentage, sacral slope and pelvic incidence. In high grade spondylolisthesis with a balanced pelvis (#6), the shear and compression stresses were higher than in high grade spondylolisthesis with a retroverted pelvis (#5). Strong correlations were found between pelvic incidence and the resulting compression and shear stresses in the growth plate and intervertebral disc at the L5-S1 junction.

Conclusion: Progression of the slippage is mostly affected by a movement and an increase of stresses at the lumbosacral junction in accordance with spino-pelvic parameters.

Significance: Pelvic incidence is a predictive parameter to determine progression of spondylolisthesis.



Finite element model and resulting compression and shear stresses (MPa) in the growth plate of S1 for the 10 different simulated cases (PI = pelvic incidence; SS = sacral slope; % = slip percentage; top of each image = back of the growth plate; bottom of each image = front of the growth plate)

78. Adult Isthmic Spondylolisthesis: Posterior Lumbar Interbody Fusion (PLIF) vs. Posterolateral Fusion (PLF)

Francesco Lolli; Giovanni Barbanti Brodano; Mario Di Silvestre, MD; Tiziana Greggi, Head; Alfredo Cioni
Italy

Summary: 114 patients affected by adult low grade isthmic spondylolisthesis, treated with pedicle screws fixation in combination with posterior lumbar interbody fusion (PLIF Group: 47 cases) or posterolateral fusion (PLF Group: 67 cases) were reviewed. Our results didn't show a clear advantage of posterior lumbar interbody fusion (PLIF) over posterolateral fusion (PLF) in terms of clinical and radiological outcome. However, a trend toward a higher incidence of pseudoarthrosis in PLF Group was found.

Introduction: Purpose of our study was to evaluate if adult patients affected by low grade isthmic spondylolisthesis have significant clinical and radiological improvement following posterior lumbar interbody fusion (PLIF) than those who received posterolateral fusion (PLF), in combination with pedicle screws fixation.

Methods: 114 patients affected by adult low grade isthmic spondylolisthesis, treated with pedicle screws fixation in combination with posterior lumbar interbody fusion (PLIF Group: 47 cases) or posterolateral fusion (PLF Group: 67 cases) were reviewed. Inpatient and outpatient charts were used to collecte demographic, pre-operative, peri-operative and post-operative data. Clinical outcome was assessed by means of the questionnaires ODI, RMDQ an VAS. Radiographic evaluation included preoperative CT, MRI and x-rays. The results were analyzed using the Student's "t" test.

Results: The two groups were well matched according to age, gender, spondylolisthesis grade and level, extension of fusion. At an average follow-up of 62.1 months (range, 51 to 78), 71 patients, 28 of PLIF Group and 43 of PLF Group, were completely reviwed. Mean ODI, RMDQ and VAS scores didn't show statistically significative differences. Fusion rate was superimposable between the two groups (97% in PLIF Group, 95% in PLF Group). Major complications, requiring revision surgery, occurred in 5 of 71 patients reviewed (7%): 1 in PLIF Group (3.6%), 4 in PLF Group (9.3%). Pseudoarthrosis occurred in 1 case in PLIF Group (3.6%), in 2 cases in PLF Group (4.6%).

Conclusion: In our series, there does not appear to be a clear advantage of posterior lumbar interbody fusion (PLIF) over posterolateral fusion (PLF) in terms of clinical and radiological outcome for treatment of adult low grade isthmic spondylolisthesis. However, a trend toward a higher incidence of pseudoarthrosis in PLF Group was found, highlighting the increased mechanical stability provided by posterior lumbar interbody fusion, especially in case of important gap between vertebral bodies, as when we perform a laminectomy or a listhesis reduction, wich increases the disc space.

Significance: Level 3

79. Mini-Invasive Instrumented Transforaminal Interbody Fusion for Low Grade Degenerative Instability of Lumbar Spine

Petr Vanek; Karel Saur
Czech Republic

Summary: Study was conducted to compare efficacy of three surgical techniques of instrumented transforaminal interbody fusion - 1.performed from standard median aproach, 2.from two paramedian incisions and 3.instrumented by tubular retractor and percutaneous screws. No significant difference measured by VAS and ODI was

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found in two years follow up, but better pain profile during the first week after surgery and less blood losses were found in group 2. a 3. compare to group 1.

Introduction: The objective of our study was to compare the efficacy of three techniques of instrumented transforaminal lumbar interbody fusion (TLIF) in the treatment of low grade degenerative instability of lumbar spine.

Methods: Prospective study with mean follow up 26 months. Eighty-five patients were enrolled into study. Twenty-seven patients (group 1) were treated by standard median approach with subperiosteal separation of muscles and 38 by two paramedian Wiltse transmuscular incisions (group 2). Interbody fusion was done by unilateral insertion of cage after total or partial resection of facet joint.Twenty patients (group 3) were instrumented by percutaneous screw system a way for interbody fusion was done through tubular retractor. Decompression of spinal canal was done by one side partial hemilaminectomy. Operation time, blood losses, number of complications, accuracy of pedicle insertion were evaluated. Post operative pain profiles were measured each day during the first week after surgery by Visual analoque scale (VAS). VAS and Oswetry disability index (ODI) were filled during outpatient controls 6weeks, 3 and 6months, one and two years after sugrery. Overall patients satisfation and fusion were assesed 2 years after surgery.

Results: No significant diference in operation time among groups was found ($p>0.05$). In group 2 and 3 blood losses were less significantly compared to group 1 ($p<0.05$). First week post operative pain profile meassured by VAS was significantly different for groups 2 and 3 compared to group 1.($p<0.05$) Patients from group 2 and 3 were less painful and no significant difference between these groups were found.No significant difference in values of VAS and ODI were found during the rest of followw up. Overal satisfaction was without any significant difference among the groups after two years of follow up.($p>0.05$)

Conclusion: Long term clinical and radiological results after instrumented TLIFs in degenerative lumbar spine instability are not related to extend of surgical approach. Less invasive technique can offer more convenient pain profile during the first days after surgery.

80. A Comparison of MIS Fusion to Open Fusion for Degenerative Lumbar Disorders: A Systematic Review

Doron Rabin, MD; Sooyong Chua; Shawn Liu, BSc (Hons); Oma Persaud, MSc; Y. Raja Rampersaud, MD, FRCSC
Canada

Summary: A systematic review of the literature was used to identify reports comparing MIS posterior arthrodesis with open procedures for degenerative lumbar disease. Data was of insufficient quality to perform a detailed meta analysis. A simple qualitative and quantitative analysis supports that posterior MIS arthrodesis for lumbar disorders may have better acute surgical outcome and equivalent clinical efficacy compared to open procedures. However, there is insufficient evidence to support any claims of clinical superiority.

Introduction: Most reports of minimally invasive spine (MIS) lumbar arthrodesis are non-comparative descriptions of heterogeneous patient populations. This study aims to compare efficacy of MIS posterior fusion surgery for lumbar spondylosis (LS) in comparison to open surgical technique.

Methods: Medline, EMBASE, PubMed, Web of Science, and Cochrane databases were queried. MeSh terms were derivatives of the following: "Spine"; "Lumbar vertebra"; "Spinal fusion"; "Arthrodesis"; and "Minimally invasive surgical procedure". Inclusion and exclusion criteria were applied to the articles. Inclusion criteria were comparative cohort (lumbar degenerative pathology) studies or better with more than 10 patients, with at least 1 of the following: clinical outcome measures; perioperative data; radiographic outcomes; and complications. Studies describing decompression without arthrodesis or anterior techniques were excluded. 2 spine surgeons independently reviewed the articles. Disagreement was resolved by a third surgeon. A non-paired student t-test was used to compare means between MIS and open groups.

Results: 1144 articles were identified. 8 of 54 articles reviewed in detail meet the inclusion criteria. 2 of 5 studies with clinical outcomes reported significantly better outcomes in MIS patients compared to controls at early (1 day - 6 weeks) and later (12 month) follow-up. 3 articles reported no significance between group differences in clinical outcome ranging from 6 months to 2 years follow-up. Overall, MIS patients had fewer postoperative complications than controls (7.6% vs. 16.6%; $p<0.001$). MIS procedures had significantly less blood loss (192 cc vs. 455 cc; $p<0.001$), shorter OR time (167 min vs. 184 min; $p<0.001$) and shorter length of stay (3.4 vs. 5.2 days; $p<0.001$). Radiographic fusion rates appear to be equivalent (Table 1).

Conclusion: MIS posterior arthrodesis for LS confers superior acute surgical and utilization outcomes in the early postoperative period and appears to be at least clinically equivalent to open procedures at 1-2 years. Additional comparative data is required to better delineate the benefits of one technique over another.

81. Marked Improvement in Patients Treated with Vertebroplasty after Painful Osteoporotic Compression Fractures

Hyun W. Bae, MD; Linda EA Kanim, MA; Nupur Gupta, MPH; Michael Kropf, MD; Timothy Davis, MD; Rick B. Delamarter, MD
United States

Summary: Vertebroplasty (PVP) is a common procedure used to treat painful osteoporotic vertebral compression fractures. A post-hoc analysis of data on patient reported pain and disability outcomes at one site in a multicenter, prospective RCT. This study showed a significant improvement in pain and disability post-treatment and after additional fractures.

Introduction: Several recent studies report limited reduction in pain and disability after treatment with either PVP or a sham procedure. Outcomes following PVP are reported herein.

Methods: Patients underwent PVP with either 'Cortoss' or 'PMMA' cements from Feb 2004 to Dec 2008. The 'serial self-reported outcome measures,' were compared to baseline values using ANOVA to determine improvement, defined as decreased pain and increased function. The time-to-treat interval was the patient reported fracture date subtracted from the initial treatment date. A further analysis was made of improvement after additional fractures.

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Results: 50 fractures at thoracic and lumbar levels were treated in 44 patients. The average VAS was 6.73±2.04 pre-operatively. After treatment, VAS was 3.82±2.68 at 72 hours, 3.46±2.74 at 1 week, 2.86±3.00 at 3 months, 2.37±2.94 at 6 months, 2.47±2.78 at 12 months, and 3.05±3.24 at 24 to 36 months (all post-op<0.01). The average ODI score was 32.08±8.53 pre-operatively. After treatment, ODI was 22.17±9.71 at 1 week, 17.04±10.65 at 3 months, 15.22±10.92 at 6 months, 15.73±10.65 at 12 months, and 16.48±10.94 at 24 to 36 months (all post-op<0.01). VAS pain improved by 54.7% and ODI disability by 48.6%. Subsequent fractures occurred in 15 patients over 36 months. Additional fractures occurred from 51.5 ± 17.7 days to 174.1 ± 254.2 days after the initial vertebroplasty procedure. Average improvements ranged from 24.5% to 52.9% for VAS and 18.3% to 30.4% for ODI disability after additional fractures.

Conclusion: Contrary to reports of pain improvement of 1.5-2.4% (1) vs. 43% (2), this study showed a 48% to 54% significant improvement in disability and pain as early as 72 hours among patients who had vertebral compression fractures treated with PVP. The significant continued improvement in pain and disability following additional fractures is also indicative of the positive effects of treatment with PVP. 1.Buchbinder, R et al.. Randomized Trial of Vertebroplasty for Painful Osteoporotic Vertebral Fractures. NEJM 2009. 2. Kallmes, D et al. A Randomized Trial of Vertebroplasty for Osteoporotic Spinal Fractures. NEJM 2009

82. Restoration of Thoracic Kyphosis in the Treatment of Adolescent Idiopathic Scoliosis Using a Sagittal Adjusting Screw

Kamran Z. Hassan, FRCS; John A. Ferguson, FRACS
New Zealand

Summary: Level 3 evidence
There has been concern expressed in the literature recently relating to the use of fixed angle screws and their perceived inability to ensure balance in the saggital plane. Some authors are adamant that stiffer rods are mandatory if one wishes to restore kyphosis. We wished to challenge this

Introduction: There has been concern expressed recently regarding the tendency of pedicle screw constructs to further reduce already abnormally low thoracic Kyphosis in the treatment of Adolescent Idiopathic Scoliotic (AIS).

Methods: 42 patients were diagnosed with AIS and operated on a by a single surgeon in a tertiary referral teaching hospital with a minimum 6 month follow up. Uniaxial screws were used in all cases. Measurements were made preoperatively and at six weeks post-op. Measurements were made in accordance with the coronal and sagittal parameters set out in the Spinal Deformity Study Group Radiographic Measurement Manual. Cobb angle, Coronal balance Lumbar lordosis, thoraco-lumbar sagittal alignment, mid/lower Thoracic kyphosis, Upper thoracic Kyphosis, Sagittal Balance

Results: Mean Cobb angles pre op were 51 degrees improving post operatively to 19. The range of total (T2-T12)Thoracic Kyphosis pre operatively was 17-74 and post operatively 4-88 degrees respectively. Normal Kyphosis was restored in 29, over-corrected in 7 (excessive Kyphosis) and under-corrected in 6 patients respectively.

Conclusion: Uniaxial screws are able to correct thoracic hypokyphosis and may be superior to both fixed angle screws and multiaxial screws in treatment of the multiplanar deformity that constitutes AIS.

Significance: It appears that a sagittal adjusting screw and a 5.5 mm Ti rod when used in conjunction with this surgical strategy may allow better restoration of thoracic sagittal profile than fixed screws and better rotational control than multiaxial screws.

83. Adding Fusion to the Thoracic Curve in Lenke 5 Curves - Risks and Benefits

Robert Lark, MD; Burt Yaszay, MD; Tracey Bastrom, MA; Peter O. Newton, MD; Harms Study Group
United States

Summary: Patients with Lenke type 5 curves fused only in the thoracolumbar/lumbar region were matched with a group of similar patients fused across the thoracic curve as well. A comparison of radiographic and clinical outcomes demonstrated the group with the longer thoracic and lumbar fusion to have slightly improved coronal correction, however, at the expense of reduced flexibility and thoracic kyphosis.

Introduction: The Lenke classification suggests a limited thoracolumbar fusion for type 5 curves; this is not however routinely accepted. We wished to determine the costs and benefits with regards to the outcomes of non-selective vs. selective fusions in a matched set of Lenke 5 curves.

Methods: Prospectively collected cases from a multi-center database were analyzed. Lenke 5 AIS patients were divided into two groups (109 selective: only TL/L curve fused and 41 non-selective: both TL/L and Th curves fused). Patients were then matched based on pre-op radiographic and clinical measures. Two year post-op radiographic and clinical outcomes were compared utilizing ANOVA with bonferonni correction ($p < 0.008$).

Results: Thirty-five matched pairs (70 pts) of Lenke 5 curves were available. There was no difference pre-operatively between the groups in age, thoracic (33° vs 36°) or lumbar (49° vs 48°) curve magnitude, curve flexibility (60% vs 54%), thoracic kyphosis, clinical trunk flexibility or SRS scores. Post-op, patients in the non-selective group exhibited greater coronal curve correction for both curves (Table I). However, the longer fusions had significantly less thoracic kyphosis and truncal side bending/rotational flexibility. There was no difference in clinical balance or SRS-22 scores.

Conclusion: Surgeons attempt to achieve balanced correction with the fewest motion segments fused. Our data suggests that primary thoracolumbar scoliosis fusion into the thoracic spine may add modest improvement in coronal correction, but at the cost of decreased thoracic kyphosis and clinical flexibility (at 2 years). Ultimately, long term effects of these longer fusions will be needed to determine if selective thoracolumbar fusions should be approached with the same vigilance as selective thoracic fusions.

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84. Rod Strength: Is it an Important Factor in Coronal and Sagittal Realignment after Surgery for Adolescent Idiopathic Scoliosis?

Suken A. Shah, MD; Peter O. Newton, MD; Baron S. Lonner, MD; Harry L. Shufflebarger, MD; Tracey Bastrom, MA; Michelle C. Marks, PT, MA; Harms Study Group
United States

Summary: Yield strength of rods used in the surgical correction of AIS is an important factor. Higher strength rods are more effective in coronal and sagittal plane restoration of spinal deformities. Stainless steel performs better than titanium with segmental pedicle screw constructs, even in the challenging scenario of kyphosis restoration with posterior surgical techniques in the hypokyhotic patient.

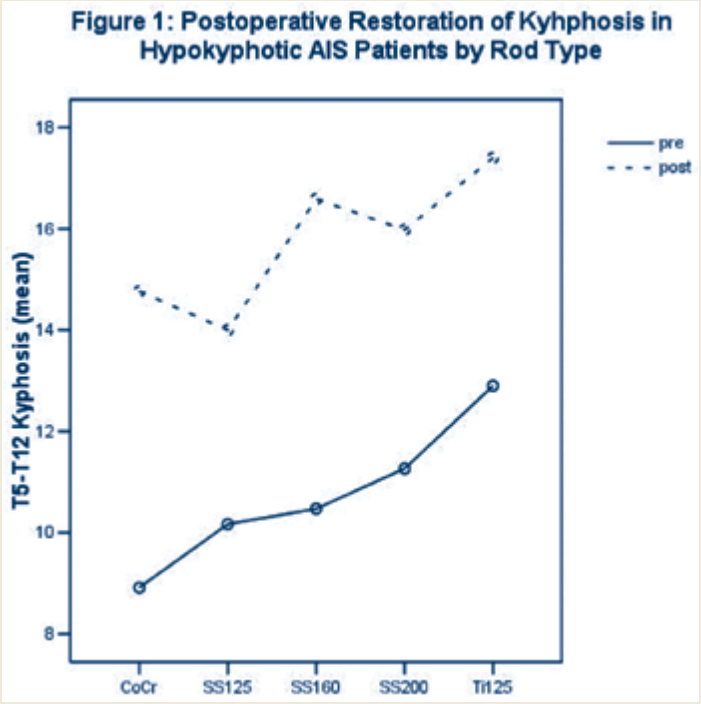
Introduction: With modern instrumentation, significant coronal correction of a structural spinal deformity is possible. A side effect of powerful segmental correction of AIS with pedicle screws is induction of hypokyphosis in the thoracic spine. To mitigate the "hypokyphosing" effect of pedicle screws, surgeons may choose to use rods with higher yield strength in order to pull the spine dorsally into kyphosis with a contoured rod. The hypothesis of this study was that higher strength rods would provide better coronal and sagittal plane restoration in AIS patients.

Methods: From a prospective, consecutive series, patients with preoperative thoracic kyphosis (T5-T12) less than 20° who underwent PSF for AIS with segmental pedicle screw instrumentation (N = 142) were included in the analysis. Radiographic data preoperatively and postoperatively were compared between groups based on the type of rods used (5.5 mm): titanium (Ti), cobalt chromium (CoCr), standard stainless steel (SS), high strength (HSS), and ultra high strength (UHSS).

Results: When corrected for flexibility, coronal curve correction was similar among the SS groups (74%) and significantly better than CoCr (64%)($p<0.05$) and Ti (68%)($p<0.001$). In the sagittal plane, all rod types were able to improve kyphosis ($p<0.01$), especially the UHSS rods (11° to 16°) and CoCr rods (9° to 15°), but the difference among rod types was not significant. There were no complications of the higher strength rods, such as screw pullout or instrumentation failure. In one and two-year follow up, there was no significant loss of correction in any of the groups.

Conclusion: Yield strength of rods used in the surgical correction of AIS is an important biomechanical consideration. While rod contouring and derotation may also be important, the choice of rod strength appears to affect the outcome of postoperative correction. Higher strength rods are more effective in coronal and sagittal plane restoration of deformities. Stainless steel and cobalt chromium perform better than titanium with segmental pedicle screw constructs, even in the challenging scenario of kyphosis restoration with posterior surgical techniques in the hypokyhotic patient.

Figure 1: Postoperative Restoration of Kyhphosis in Hypokyphotic AIS Patients by Rod Type



85. Vertebral Coplanar Alignment for Correction of Thoracic Scoliosis: Techniques and Clinical Results

Yong Qiu, MD; Feng Zhu; Bin Wang, MD; Yang Yu; Zezhang Zhu, MD; Bangping Qian; Xu Sun, MD, PhD
China

Summary: The de-novo posterior instrumentation of "Vertebral coplanar alignment (VCA)" has been applied in 36 patients with idiopathic thoracic scoliosis. Totally 27 patients with minimum one-year follow-up showed excellent and modulatable three-dimensional correction.

Introduction: The VCA technique was developed by Vallespir with the intention to correct three-dimensional deformity of scoliosis. The present study aimed to evaluate the clinical outcomes of the VCA techniques in posterior correction for thoracic scoliosis prospectively.

Methods: Between June 2008 to December 2008, 36 patients with idiopathic thoracic scoliosis underwent posterior pedicle -based instrumentationwith assistance of VCA system, of which, 27 patients have a minimum 12 months follow-up. The average age was 15.9 years (ranged 11~23 years). The classification was all Lenke type 1, being legible for selective thoracic fusion. The extended coplanar tube was set up to each pedicle on convex side in line with pedicle screw axis. Then two rigid bars were inserted through the uppermost part of the slotted tube sequentially. As the bar was gently driven down toward the bottom end, the pedicle screws axis started to converge in the straight line and correct translation and rotation. Spacers were placed into the slots of the tubes to achieve the ideal physiologic thoracic kyphosis.

Results: The scoliosis was corrected from 49° (ranged 40°~70°) to 14° (ranged 6°-25°) representing the correction rate of 70.7%. The average duration of surgery was 297 min and mean EBL was 1500 ml.

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The thoracic kyphosis was restored from average 18° to 25°. Intra-operative fracture of outer wall of pedicle occurred in two patients. There was no death, infection nor neurological complication. No coronal or sagittal plane decompensation occurred during averaged 15 months follow-up.

Conclusion: The VCA is a new technique for the correction of thoracic scoliosis, its advantage lies in modulatable three-dimensional realignment with a single and standardized maneuver.

Significance: The VCA system provides another option for the three-dimensional deformity of thoracic scoliosis.

86. Correction of Moderate (<70-degree) Lenke 1A and 2A Curve Patterns: Comparison of Hook, Hybrid and All-Pedicle Screw Systems at Two-Year Follow-Up

Scott J. Luhmann, MD; Lawrence G. Lenke, MD; Mark A. Erickson, MD; Keith H. Bridwell, MD; B. Stephens Richards, MD
United States

Summary: 110 AIS patients underwent primary PSF with various constructs (53 pedicle screw, 48 hybrid, 9 hook). Preoperative and OR data were similar between groups. All-pedicle screw systems had better absolute and % coronal Cobb correction, LIV tilt, scoliometer and SAQ measures than hooks and hybrid constructs. The improved coronal correction in the PS group is likely due to the higher number of spine fixation points than in the hook or hybrid group constructs.

Introduction: The purpose of this study is to compare the outcomes of various constructs for the correction of moderate AIS (<70-degree) curves.

Methods: A prospective, multi-center database on AIS identified patients with <70-degree main thoracic curves surgically treated with a posterior spinal fusion. Inclusion criteria were: Lenke 1A and 2A curve patterns, neurologically normal, primary surgery only, and >13 years of age at surgery or Risser 3 or greater, with a minimum f/u of 2 years postoperative. Patients were excluded if surgeries included any releases, which may increase curve flexibility.

Results: A total of 110 patients satisfied the criteria for inclusion: pedicle screws/PS (n=53), hybrid (n=48) and hook (n=9). Preoperative patient data and curve characteristics and operative data were similar between the 3 groups. Postoperative thoracic coronal Cobb demonstrated PS had better proximal thoracic (PT) and main thoracic (MT) correction (absolute and %) and correction index (CI) than hybrid or hooks. Interestingly there were no differences in CI/fixation point between the 3 groups, indicating PS constructs achieved better correction due to the greater number of spine fixation points. LIV tilt and rotational correction was better in the PS group than hooks and hybrid. At 2-year f/u, PS had better absolute FEV1 values, trunk shift and total SAQ than hybrids. T5-T12 sagittal alignment was unchanged at 2-year f/u for PS vs. increased kyphosis in hybrids. PS had greater increase in negative sagittal balance than hybrids. There were no differences in FVC, coronal decompensation, AVT, T1 tilt, TL/L measures, clavicle angle, coronal angulation below LIV, coronal position of LIV to CSVL, UIV tilt, T2-T5, T12-S1, complications or SRS scores between the 3 groups.

Conclusion: All-pedicle screw systems had better coronal correction, LIV tilt, scoliometer and SAQ measures than hooks and hybrid constructs. The improved coronal correction in the PS group is likely due to the higher number of spine fixation points than in the hook or hybrid groups.

Significance: PS constructs demonstrate better overall correction of moderate Lenke 1A and 2A curve patterns than hybrid or hook constructs.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

87. Radiographic Assessment of Shoulder Position in 619 AIS Patients: Can T1 Tilt be Used as an Intraoperative Proxy to Determine Postoperative Shoulder Balance?

Scott J. Luhmann, MD; B. Stephens Richards, MD; Charles E. Johnston, MD; Daniel J. Sucato, MD, MS; Lori A. Karol, MD
United States

Summary: This study focused radiographic shoulder measures of 619 AIS patients who underwent spinal deformity surgery. T1 tilt, radiographic shoulder height and clavicle angle were analyzed preoperatively and postoperatively. The relationship of T1 tilt to radiographic shoulder height does not remain constant preoperatively to postoperatively, hence T1 tilt cannot be used as an intraoperative proxy for shoulder balance.

Introduction: The purpose of this study is to assess radiographic shoulder measures from the preoperative to the postoperative time period, specifically to determine if T1 tilt could be used as an intraoperative proxy for shoulder balance determination.

Methods: A prospective, multi-center database of AIS was queried to identify all patients who had undergone spinal deformity surgery with greater than 2 year followup postoperatively. Radiographic analysis (preoperative and 2-year postoperative) focused on measures of shoulder balance: T1 tilt, clavicle angle, and radiographic shoulder height.

Results: A total of 619 patients were included in this analysis. Mean age at surgery was 14.8 years (9 to 22) with 83% female. Mean preoperative curve size was 58.0o. Mean T1 tilt preoperatively was -0.10o (-31o to +24o) and postoperatively 2.42o (-26o to +27o). Mean clavicle angle preoperatively was -1.39o (-12o to +10o) and postoperatively 0.79o (-6o to +8o). Mean radiographic shoulder height preoperatively was -7.04 mm (-111 mm to +44 mm) and postoperatively 1.63 mm (-63 mm to +37 mm). All 3 radiographic parameters demonstrated reasonable correlation preoperatively (0.511 to 0.840) and postoperatively (0.534 to 0.829) to each other. The inter-variable correlations from the preoperative to postoperative time period were not significantly different. To assess the viability of T1 tilt as an intraoperative proxy for shoulder balance standardized ratios between the variables were created. Analysis of these ratios demonstrated little or no relationship preoperatively to

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postoperatively, hence the relationship of T1 tilt to radiographic shoulder height does not remain constant.

Conclusion: Analysis of the relationship of T1 tilt to radiographic shoulder height from preoperative to postoperative did not demonstrate consistency. Based on this data T1 tilt cannot be used as an intraoperative proxy to assist the surgeon in assessing postoperative shoulder balance.

Significance: T1 tilt cannot be used as an intraoperative proxy for postoperative shoulder balance.

88. The Use of Low Dose Tranexamic Acid Reduces Blood Loss and Blood Transfusions in Adolescent Idiopathic Scoliosis Surgery

Lukas P. Zebala, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Colin E. Nabb, BS; Scott J. Luhmann, MD; Samuel K. Cho, MD; Joshua M. Pahys, MD; Matthew M. Kang, MD; Woojin Cho, MD, PhD; Brenda Sides, MA
United States

Summary: This is the largest comparison of the use of low dose tranexamic acid to no antifibrinolytic controls in adolescent idiopathic scoliosis surgery from a single institution. Compared to controls, low dose tranexamic acid significantly reduced the amount of perioperative blood loss and blood transfusion requirements. Low dose tranexamic acid appears to be safe and efficacious in adolescent idiopathic scoliosis surgery.

Introduction: Previous studies have reported on the efficacy and outcomes of tranexamic acid (TA) during adult spine surgery. This study reports outcomes of low dose tranexamic acid versus controls in adolescent idiopathic scoliosis (AIS) surgery.

Methods: 48 consecutive AIS patients with posterior spinal fusion (PSF) by the same surgeons at 1 hospital from 1/07-9/09 had low dose TA during surgery. Low dose TA consisted of a 10 mg/kg bolus followed by 1 mg/kg/hr maintenance dose. 44 consecutive AIS patients with primary PSF from 2000-02 served as controls as antifibrinolytics were not used in pediatric scoliosis surgery at this time. 34 control and 0 TA patients had iliac crest bone graft for fusion. Demographic, operative and perioperative data was analyzed.

Results: The low dose TA and control groups were similar at preop age (14.5 vs 14.8 yrs), gender, body mass index (20.7 vs 20.9) and major curve Cobb (61° vs 61°). The length of surgery (LOS) was shorter (4.7 hr) in the low dose TA patients compared to controls (5.2 hr,p=0.01)(Table 1). The number of posterior fusion levels was similar (9 vs 10,p=0.2) between groups. Patients with low dose TA had lower average intraoperative estimated blood loss (EBL) (415 vs 689 ml,p<0.001), intraoperative blood transfusions (0.4 vs 0.8 units,p<0.001) and amount of cell saver given back (22 vs 195 ml,p<0.001) than control patients. Postoperative drain output was significantly less for low dose TA (925 ml) than control (1508 ml,p<0.001) patients. Total EBL was less for the low dose TA (1321 ml) than control (1854 ml,p<0.001) group and the low dose TA patients required less total blood transfusions than controls (0.4 vs 1.4 units,p<0.001). There were no postoperative cases of seizure, CVA or PE in any group. 1 low dose TA patient developed a jugular vein DVT 6 weeks after surgery and was treated with anticoagulation.

Conclusion: This single institution comparison of low dose TA to no antifibrinolytic controls in AIS surgery revealed that low dose TA significantly reduced intraoperative EBL, blood transfusion and cell saver requirements. Additionally, postoperative EBL and total blood transfusion requirement were lower in the low dose TA patients. There were no catastrophic complications attributable to tranexamic acid.

89. Selective Thoracic Fusion in Lenke 1C Curves: Prevalence and Criteria

Charles H. Crawford, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; B. Stephens Richards, MD; John B. Emans, MD; Michael G. Vitale, MD, MPH; Mark A. Erickson, MD; James O. Sanders, MD; Keith H. Bridwell, MD
United States

Summary: Factors other than those included in the Lenke et al classification system are being used to select fusion levels (selective thoracic vs fusion of both curves) for type 1C curves. Larger TL/L curves and MT:TL/L ratios, more TL/L clinical deformity and a greater patient desire for appearance change favored performance of a nonselective fusion.

Introduction: Classification systems for Adolescent Idiopathic Scoliosis (AIS) have been developed to help surgeons identify curve types and select appropriate fusion levels. Selective thoracic fusion has been advocated for the so-called “false double major” curve (Lenke 1C, King II). Despite this recommendation, many surgeons continue to perform non-selective fusions for this curve type. It is unknown to what extent these classification systems and other factors influence the surgeon’s selection of fusion levels.

Methods: A prospective multicenter database included 264 patients with surgically treated 1C curves. Patients were divided into two groups: the selective thoracic fusion group (ST) included patients with the lowest instrumented vertebra (LIV) at or cephalad to L1, while the non-selective group (NS) included patients with the LIV at or caudal to L3. Preoperative radiographic, clinical (scoliometer) and SAQ/SRS questionnaire data were analyzed and compared between the groups.

Results: (See table). Only 138/264 (49%) underwent an ST fusion. Gender ratio (90% vs 86% female), avg age (14.7 vs 14.8yrs), and preop main thoracic (MT) Cobb angles (56.0°±9.9 vs 55.3°±11.4) were not significantly different between groups (ST vs NS). However, the avg thoracolumbar/lumbar (TL/L) preop Cobb angle was significantly smaller in the ST group (42.1°±8.6 vs 47.0°±9.0; p<0.001) while the MT:TL/L Cobb ratio (1.35±0.20 vs 1.18±0.15; p<0.001), AVT ratio (1.82±0.59 vs 1.31±0.53; p<0.001) and AVR ratio (1.16 vs 0.98; p<0.001) were significantly greater in the ST group. Sagittal parameters (including T10-L2 kyphosis) were not significantly different between the groups. Preop TL/L scoliometer measures were significantly less in the ST group (8.1°±3.7 vs 10.3°±5.4; p=0.001). On the Scoliosis Appearance Questionnaire, patients in the ST group had less desire for an appearance change (p<0.05).

Conclusion: Despite a recommendation to fuse only the structural thoracic curve in a 1C curve type, only 49% in this multicenter series were treated with an ST fusion. Patients who underwent an ST fusion had a smaller TL/L Cobb angle and TL/L scoliometer measures, with

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larger AVT and AVR ratios, and significantly less desire to change their appearance versus those undergoing an NS fusion.

90. Cross-Ethnicity Comparisons of the Scoliosis Research Society Outcomes Instrument in Adolescent Idiopathic Scoliosis

Lee J. Morse, MD; Noriaki Kawakami, MD; Lawrence G. Lenke, MD; Daniel J. Sucato, MD, MS; James O. Sanders, MD; Mohammad Diab, MD
United States

Summary: We evaluate differences in the pre-operative Scoliosis Research Society Outcomes Instrument (SRS-30) between US Caucasian, Black, Hispanic, and Asian, as well as Japanese ethnicities in adolescent idiopathic scoliosis.

Introduction: The SRS-30 was developed using a US cohort of patients with adolescent idiopathic scoliosis. There are no comparative studies of SRS-30 outcomes between multiple US ethnicities, and between US and non-US cohorts.

Methods: Pre-operative SRS-30 outcomes data were collected from 2371 patients with adolescent idiopathic scoliosis from 5 different ethnic groups: US Caucasian (1534), Black (306), Hispanic (104), and Asian (218), as well as a Japanese cohort from Nogoya, Japan (209). Outcomes from the 5 domains of the SRS-30 were analyzed and compared between groups. Pair-wise comparisons in the SRS-30 domains were adjusted for multiple comparisons using Bonferroni correction.

Results: Statistically significant differences ($p < 0.05$) are reported. Japanese and US Asians had higher Pain scores (Japanese 4.47, US Asian 4.47, Hispanic 4.10, Black 4.19, Caucasian 4.05) but lower Appearance scores than other groups (Japanese 2.79, US Asian 2.98, Hispanic 3.13, Caucasian 3.30, Black 3.45). Japanese had the highest Activity scores, while US Asians had the lowest (Japanese 4.30, Caucasian 4.16, Black 4.04, Hispanic 3.98, US Asian 3.83). Japanese had the highest Mental scores, while Hispanics had the lowest (Japanese 4.17, Black 4.01, Caucasian 3.94, US Asian 3.87, Hispanic 3.77). Japanese and Blacks had the highest Total scores (Japanese 3.90, Black 3.90, US Asian 3.76, Hispanic 3.75, Caucasian 3.84).

Conclusion: Among several significant differences, Japanese patients had the highest Pain, Activity, Mental and Total scores but the lowest Appearance scores. US Asians resembled Japanese patients in having high Pain scores and low Appearance scores, but differed in having lower Activity scores.

Significance: Ethnic and geographic variations in the SRS-30 must be taken into account when counseling patients about operative treatment for adolescent idiopathic scoliosis, and when interpreting outcome studies.

91. Does More Complete Thoracic Apical Vertebral Derotation Really Help with the Rib Prominence?

Peter O. Newton, MD; Krishna C. Ravi; Tracey Bastrom, MA; Burt Yaszay, MD
United States

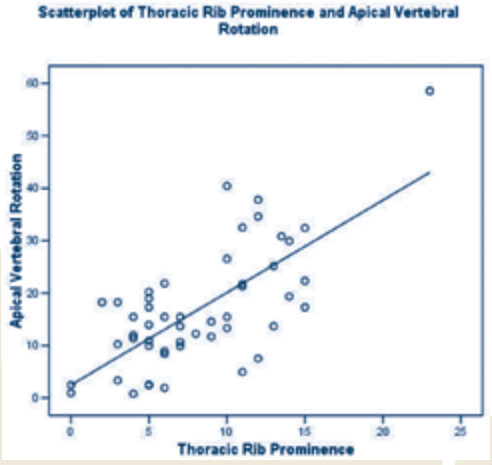
Summary: 50 patients with thoracic AIS were analyzed following pedicle screw correction. There was a good correlation between the magnitude of the remaining apical vertebral rotation and the postop residual rib hump measured by scoliometer ($r = .70$, $p<0.001$). Patients with smaller degrees of vertebral rotation had similarly smaller postop rib prominences.

Introduction: The purpose of this study was to evaluate the relationship between residual apical vertebral rotation in standing post-op patients with AIS, (after attempted direct vertebral derotation-DVR) and truncal rotation measured on forward bend via scoliometer. Does a more complete DVR result in less rib deformity?

Methods: 50 AIS patients with primary thoracic curves (Lenke type 1-3) whose data was collected as part of a longitudinal, prospective study at a single institution were included. All patients had undergone posterior instrumentation with segmental pedicle screws so that apical vertebral rotation could be calculated utilizing a previously published trigonometric model (Upasani et al.). This calculation is based on the upright radiographic appearance of bilateral pedicle screws (of known length and assuming equal convergence) at the apical vertebra. All measurements were performed digitally using SpineView 2.4 software (Surgiview SA, Paris, France). None of the patients had a thoracoplasty. Thoracic rib prominence (angle of trunk rotation) data from the corresponding post-operative visits were correlated with the calculated vertebral rotation measurements using Pearson's correlation analysis.

Results: The apical vertebral and trunk rotation assessments were made from 6 weeks - 2 years post operatively. The average pre-op thoracic Cobb of 55 ± 14° was improved to 15 ± 7° (average correction 72 ± 14%). Pre-operative thoracic rib prominence averaged 16 ± 4°, with an improvement to 8 ± 5° post operatively. The average apical vertebral rotation on the post op radiograph was 16 ± 13°. A significant correlation was found between the calculated residual apical vertebral rotation and the thoracic rib prominence ($r = 0.70$, $p<0.001$).

Conclusion: There is a strong correlation between the residual apical vertebral rotation after pedicle screw instrumentation with DVR as measured on standing PA radiographs and the residual thoracic cage rib prominence as measured by scoliometer. This confirms the benefit and justifies attempts of more complete transverse plane vertebral correction with regards to the rib hump of thoracic scoliosis.



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92. Direct Vertebral Body Derotation: How Much Correction of the Rib Hump Can Be Expected?

Steven W. Hwang, MD; Amer F. Samdani, MD; Baron S. Lonner, MD; Peter O. Newton, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Randal R. Betz, MD; Patrick J. Cahill, MD
United States

Summary: Direct vertebral body derotation (DVBD) is commonly used for rib hump correction. We sought to determine the correction of rib hump achieved and what preoperative factors may have predictive value. We analyzed 148 AIS patients from a prospective, longitudinal database who had undergone a PSF with pedicle screws and a DVBD performed. Surgeons can expect a 50% decrease in rib hump with DVBD, with no preoperative variables predictive of this correction.

Introduction: DVBD is a powerful tool in the surgical correction of rotational spine deformity and has decreased the use of thoracoplasty for rib hump correction. In this study we sought to determine the extent of rib hump correction which can be expected with DVBD and factors which may correlate with improved correction.

Methods: A prospective, longitudinal database was queried to identify AIS patients who underwent a PSF with 2 yr f/u and Lenke 1-3 curves. All patients had undergone DVBD maneuvers (en-bloc, segmental or both) during their surgery. Patients having undergone concurrent thoracoplasty were excluded from the study. The absolute change and percent change from preoperative inclinometer readings were correlated with preoperative clinical and radiographic data using a Pearson correlation.

Results: 148 patients were identified who fulfilled the inclusion criteria. The mean age was 14.8 ± 2.0 years with a mean primary thoracic curve of 55.3 ± 9.3°. The primary thoracic curve reduced to 28.1 ± 12.0° on bending radiographs translating to a flexibility of 49%. The mean preoperative inclinometer reading was 14.9 ± 4.5° which reduced to 7.5 ± 4.0° post-op for a 50% improvement. We attempted to correlate 23 of the most commonly used pre-op radiographic measures. Interestingly, none correlated with rib hump correction including: preoperative rib hump (p=0.16), thoracic curve flexibility (p=0.71), and thoracic curve magnitude (p=0.78). An additional 80 patients had apical vertebral rotation measured using the apical vertebral body-rib ratio. Neither the initial ratio (p=0.52), nor the change in ratio during bending radiographs (p=0.45) correlated with inclinometer results.

Conclusion: Utilizing DVBD, the surgeon can expect a 50% reduction in the rib hump as assessed by inclinometer. This is irrespective of the pre-op inclinometer reading, thoracic curve flexibility, and degree of apical rotation on standing and bending x-rays.

Significance: Surgeons can expect 50% reduction of rib hump when performing direct vertebral body derotation in patients with AIS.

93. Direct Vertebral Body Derotation, Thoracoplasty or Both: Which is Better with Respect to Inclinometer and SRS-22 Scores?

Steven W. Hwang, MD; Amer F. Samdani, MD; Peter O. Newton, MD; Baron S. Lonner, MD; Michelle C. Marks, PT, MA; Tracey Bastrom, MA; Patrick J. Cahill, MD; Randal R. Betz, MD
United States

Summary: We evaluated 203 patients from a prospective, longitudinal database to ascertain which surgical techniques of thoracoplasty (Th), direct vertebral body derotation (DVBD), or both (Th/DVBD) achieved the best post-op results by inclinometer and SRS scores. Patients with mild rib prominences have equivalent post-op inclinometer values for all three groups, but higher SRS self-image scores for Th/DVBD. For larger rib humps, significantly better results are achieved with thoracoplasty, but SRS scores remain comparable.

Introduction: DVBD and Th are powerful tools for correction of rib humps in patients with AIS. We evaluated Th, DVBD, and Th/DVBD with respect to post-op inclinometer readings and SRS scores to determine which provides the best correction of rib hump and patient satisfaction.

Methods: A prospective longitudinal database was queried to identify AIS patients who underwent a PSF with pedicle screws and 2 yrs follow-up. 203 patients were identified and divided into 3 groups: 1) Th alone (N=30), 2) DVBD alone (N=122), and 3) both Th/DVBD (N=51). Patients were subdivided into categories based on their pre-op inclinometer reading: 1) ≤ 9° (mild), 2) 10-15° (moderate), and 3) ≥16° (severe). Pre- and post-op inclinometer readings and SRS scores were compared using ANOVA.

Results: Overall, the groups were similar preoperatively except for the DVBD group having higher percent thoracic flexibility. The preoperative rib hump values were Th=13.2, DVBD=14.0, and Th/DVBD=12.9 (p=0.27). Taken collectively, the post-op 2-year inclinometer readings were similar for all three groups (Th=5.2, DVBD=7.0, Th/DVBD=5.6, P=0.66). However, the SRS-22 self-image scores were significantly better for patients having both Th/DVBD (Th=3.4, DVBD=3.4, Th/DVBD=3.8, P<0.01). When patients were stratified by severity of pre-op rib humps, all patients with mild prominences achieved similar corrections, although SRS self-image scores were highest in the Th/DVBD group. In patients with moderate and severe pre-op rib prominences, the addition of Th was necessary for optimal rib hump correction, but there was no difference in SRS-22 domains (Table 1).

Conclusion: Our results suggest that Th alone, DVBD alone, or both Th/DVBD provide equivalent inclinometer results in patients with mild preoperative rib humps, but higher SRS-22 self-image scores are achieved using both Th/DVBD. For more severe rib prominences (> 10°), better inclinometer readings are achieved with thoracoplasty, although SRS-22 self-image scores are comparable.

Significance: Although thoracoplasty provides optimal correction in patients with moderate to severe rib humps, SRS self image scores are equivalent when compared to direct vertebral body derotation alone.

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94. A Simple and Effective Method for Directing the Sagittal Placement of Thoracic Pedicle Screws without Intraoperative Imaging

Kenneth M. Cheung, MD; Tarek A. El-fiky, MD; Dino Samartzis, DSc, PhD, MSc; Wai Yuen Cheung, MD; Yatwa Wong; Keith D. Luk, MD
China

Summary: Our study describes a simple free-hand technique for the application of thoracic pedicle screws without the use of intraoperative navigation in patients with adolescent idiopathic scoliosis. Based on a prospective consecutive series of 66 patients representing 510 pedicle screws, our technique was found to be safe and accurate with no intra- or post-operative neurological complications.

Introduction: This study addressed a simple and novel free-hand technique of directing the sagittal inclination of thoracic pedicle screws, without the use of intraoperative monitoring, in AIS patients. The safety and accuracy of this technique was evaluated in a consecutive series of 510 pedicle screws placed by this method.

Methods: A prospective radiographic and clinical study was conducted. Thoracic pedicle screw insertion from T1-T12 was performed in 66 consecutive AIS patients who underwent PSF. Intraoperatively, a right-angle, "Langenbach" retractor was utilized to define the sagittal direction of insertion. After surgery, the positions of the screws were evaluated using lateral radiographs. Screw location was described as the position of the screw tip with reference to three vertebral body zones (A, B, & C). Additionally, the screws were categorized as acceptable when they engaged the pedicle in the lateral view, and unacceptable if they perforated the pedicle or violated the superior or inferior disc spaces. Furthermore, pedicle screw application into Zones A & B were regarded as ideal. Intra- and postoperative complications were also assessed in every patient.

Results: There were 15 males (22.7%) and 51 females (77.3%), with a mean age of 15.0 years. There was a sum of 510 pedicle screws inserted from T1-T12, with a mean of 7.7 screws inserted per patient. 501 screws (98.2%) were located in Zones A or B, and only 9 screws in zone C (1.8%), and 1 screw perforated the superior end-plate. whereas screw insertion into Zone C entailed 1.8% (n=9 screws). None of the patients had intra- or postoperative neurological sequelae.

Conclusion: We report a simple, free-hand technique of directing the sagittal inclination of pedicle screws, without the use of intraoperative radiographic monitoring. Our technique was found to be safe and accurate in AIS patients.

Significance: The authors' simple, free-hand technique of directing the sagittal inclination of pedicle screws, without the use of intraoperative radiographic monitoring, is a safe and effective method.

95. Comparison of Traction Radiographs Taken Under General Anesthesia with Conventional Flexibility Graphies in AIS Patients: Which is Better?

Azmi Hamzaoglu, MD; Ahmet Alanay, MD; Cagatay Ozturk, MD; Levent Ulusoy; Selhan Karadereler; Mehmet Tezer
Turkey

Summary: Traction X-ray taken under general anesthesia (TrUGA)is the best modality to predict the postoperative correction rate provided by pedicle screw constructs.

Introduction: The purpose of this study was to compare the correction rates with TrUGA to conventional flexibility radiographs in different curve types and curve magnitudes.

Methods: Between 1999-2008; preoperative standing AP, side-bending (SB), supine traction (Tr), fulcrum (F), TrUGA and postoperative AP graphies were obtained for 623 consecutive patients with adolescent idiopathic scoliosis who had surgical treatment. Proximal thoracic (PT), main thoracic (MT) and thoracolumbar/lumbar (TL/L) curves in all patients were measured by using all the x-ray methods and correction rates were compared between each method and for postoperative results. All patients had pedicle screw constructs for surgical treatment.

Results: The average age was 15.4 years and the male to female ratio was 76 to 547. TrUGA demonstrated greater curve correction than SB and Tr X-rays for all PT curves. Flexibility rates for MT (345 patients) were 68% with TrUGA, 61% with F, 58% with B and 52% for Tr ($p>0.05$). TrUGA demonstrated greater correction for MT more than 65° (106 patients) (50% versus 34%, 26% and 29% for F, Tr and SB respectively, $p<0.05$). For TL/L curves of <65° (447 patients); SB graphies showed higher curve correction with the flexibility rate of 76% when compared to flexibility rate with TrUGA (72%). For TL/L curves >65 degrees (176 patients), TrUGA showed greater flexibility than others with flexibility rate of 60% versus 50%, 44% and 42% for SB, Tr and F ($p<0.05$). Postoperative correction rate for PT, MT and TL/L curves <65° were 61%, 80% and 76% respectively. Postoperative correction was 63% for MT and 77% for TL/L in curves >65°. Anterior release would be necessary when less than 30% flexibility criterion was taken into account, in 73 of 106 patients with MT curves of >65 degrees, but anterior surgery in 69% of patients was eliminated when the same criterion was applied by using TrUGA.

Conclusion: TrUGA is superior to SB, F and Tr in determination of flexibility of PT and MT, especially for MT >65° in magnitude. For TL/L curves, it demonstrates similar correction rates with SB in curves <65° and but more than SB for curves >65° degrees in magnitude. TrUGA is also the best modality to predict the postoperative correction rate provided by PS constructs.

Significance: -

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96. Factors Predicting Coronal Decompensation of Lenke 1 Curves Following Selective Fusion

Michael G. Vitale, MD, MPH; Daniel J. Miller, BS; Daniel J. Sucato, MD, MS; John B. Emans, MD; Mark A. Erickson, MD; James O. Sanders, MD; Lawrence G. Lenke, MD; B. Stephens Richards, MD
United States

Summary: Relatively high rates of early frontal decompensation may be improved by careful attention to preoperative socioclinical and radiographic characteristics.

Introduction: Selective fusion of main thoracic curves (Lenke I) can lead to coronal decompensation. This study examines factors which may predict decompensation, including the relationship between the lowest instrumented vertebral level and lowest end vertebral level (LIV-LEV).

Methods: Review of a prospective multicenter database revealed 460 AIS patients who have been treated with primary selective posterior spinal fusion for Lenke Type 1 curves. Patients with coronal decompensation (defined as trunk shift > 2cm away from CSVL) 2 years following surgery were compared to those without such imbalance. The LIV-LEV relationship was compared between groups, with a negative number implying an LIV proximal to the LEV of the main thoracic curve.

Results: Rates of coronal decompensation 2 years postoperatively were as follows: Type A (19/250, 7.60%), Type B (5/73, 6.85%), Type C (16/137, 11.68%). No significant differences in age, sex, total levels fused, or LIV level were noted between those decompensated and those not decompensated for all curve types. The relationship between LIV and LEV did not correlate with decompensation for 1A (p=.2), 1B (p=.6) or 1C (p=.3) curves. 1B curves with coronal decompensation were found to have a significantly higher curve correction (74.5% vs. 58.5%, p=.02). 1C curves with coronal decompensation were found to have significantly higher BMI (24.8 vs. 21.3, p=.01) and preoperative curve size (64.8° vs. 55.4°, p=.005).

Conclusion: The relationship between LIV and LEV was not associated with rates of curve decompensation for any curve type. In 1B curves, overcorrection may lead to increased rates of decompensation. In 1C curves, larger curves and higher BMI correlated strongly with decompensation.

Significance: In 1B curves, care must be taken not to overcorrect the main thoracic curve. In 1C curves, consideration should be given to either nonselective fusion or earlier intervention before curve magnitude increases, especially in patients with higher BMI.

97. Do Contiguous Multilevel Pedicle Screws Offer Added Curve Correction over Alternate Level Screw Strategy in AIS Patients when Curve Flexibility is Taken into Account?

Kenneth M. Cheung, MD; Dino Samartzis, DSc, PhD, MSc; Keyi Yu, MD; Deepa Natarajan, MBBS; Wai Yuen Cheung, MD; Yatwa Wong; Jianxiong Shen, MD; Keith D. Luk, MD; Guixing Qiu
China

Summary: This study assessed the radiographic and cost analysis of contiguous multilevel pedicle screws to alternate level pedicle screw strategy (ALSS) in the context of the fulcrum bending correction index (FBCI) in AIS patients treated with titanium instrumentation. The study noted similar FBCIs between strategy-types, but significant cost reductions associated with ALSS.

Introduction: With the use of each pedicle screw in AIS surgery, there is an increase in instrumentation-related costs, operative time, risk of complications and health-care expenses. As such, alternate level screw strategy (ALSS) is an alternative to contiguous multilevel screw strategy (CMSS). Moreover, studies have demonstrated the importance in accounting for the flexibility of the curve based on the fulcrum bending radiograph when assessing postoperative curve correction. Therefore, being cognizant of curve flexibility, the following study addressed a radiographic and cost analysis comparing CMSS to ALSS for the treatment of thoracic AIS with titanium instrumentation.

Methods: Seventy-seven AIS patients underwent surgery (range: 6-15 levels). Thirty-five patients received CMSS, characterized as bilateral screw fixation at every level. Forty-two patients underwent ALSS, which entailed bilateral screw fixation at alternate levels. Titanium rods were utilized in all cases. Pre- and postoperative postero-anterior and fulcrum bending radiographic Cobb angles were obtained of all patients. The fulcrum flexibility and the fulcrum bending correction index (FBCI) were assessed. Cost analysis was also performed.

Results: There was a statistically significant difference between screw strategy-type to that of pre- and postoperative Cobb angles, and postoperative curve correction ($p<0.05$). No statistically significant difference was noted between screw strategy-type and fulcrum flexibility (CMSS mean, 66.9%; ALSS mean, 62.7%; $p>0.05$). The mean FBCIs of the CMSS and ALSS were 126.1% and 122.1%, respectively, and did not statistically differ (p=0.734). In comparison to the CMSS, the ALSS was associated with pedicle screw cost reductions of up to 46.2%.

Conclusion: This study is the first to illustrate that regardless of curve rigidity, ALSS utilizing less pedicle screws can achieve comparable FBCI as CMSS. We attribute this to the relatively flexible titanium rods used in this study. Thus in this context, ALSS is as effective as CMSS in terms of coronal curve correction, it has the added benefits of reducing operative time and neurological complication risk, as well as the possiblity of better kyphosis restoration compared to the lordosing effect of CMSS.

98. Sagittal Plane Changes According to the Thoracic Kyphosis Change Following Posterior Segmental Spinal Instrumented Fusion of Adolescent Idiopathic Scoliosis

Yongjung J. Kim, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Oheneba Boachie-Adjei, MD; Munish C. Gupta, MD; Jean-Luc Clement, MD; Thomas D. Cha, MD, MBA; Samuel K. Cho, MD
United States

Summary: Radiographic measurements of 397 AIS patients (average age 14.7 years) who underwent posterior only segmental spinal instrumentation and fusion (lowest instrumented vertebra: L2 or above) with a minimum 2 years postoperative follow up demonstraed that thoracic kyphosis change at ultimate follow-up demonstrated a significant impact on the proximal junctional angle change, lumbar lordosis and sagittal vertical axis at the ultimate compared to the preoperation

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Introduction: To compare the various sagittal parameters according to the thoracic kyphosis changes in adolescent idiopathic scoliosis (AIS) following posterior segmental spinal instrumented fusion with a minimum 2-year follow-up.

Methods: Radiographic measurements of 397 AIS patients (average age 14.7 years) who underwent posterior only segmental spinal instrumentation and fusion (lowest instrumented vertebra: L2 or above) at 3 institutions with a minimum 2 years postoperative follow up were analyzed. Thoracic kyphosis increase > 10 degree (Group 1, n=102), Thoracic kyphosis change < 10 degree (Group 2, n=206), and thoracic kyphosis decrease > 10 degree (Group 3, n=89) at the ultimate follow-up to preoperation were compared.

Results: The sagittal thoracic kyphosis angle (T5-T12) demonstrated significant differences at ultimate follow-up and significant changes at ultimate follow-up compared to preoperation (16 degree increase in Group 1 vs 1 degree increase in group 2, 17 degree decrease in group 3, $p<0.0001$). The proximal junctional angle demonstrated significant difference at ultimate follow-up ($p=0.001$) and significant changes at ultimate follow-up compared to preoperation ($p<0.0001$). The lumbar lordosis (T12-S1) demonstrated significant differences at ultimate follow-up ($p=0.014$) and significant changes at ultimate follow-up compared to preoperation (8 degree increase in Group 1 vs 1 degree increase in group 2, 8 degree decrease in group 3, $p<0.0001$). Sagittal vertical axis (distance between C7 plumb and posterior superior end plate of S1) demonstrated significant changes at ultimate follow-up compared to preoperation (9mm decrease in Group 1 vs 3mm decrease in group 2, 10mm increase in group 3, $p=0.006$).

Conclusion: Thoracic kyphosis change at ultimate follow-up demonstrated a significant impact on the proximal junctional angle change, lumbar lordosis and sagittal vertical axis at the ultimate compared to the preoperation.

Significance: Surgical technique on intraoperative thoracic kyphosis change is important to determine proximal junctional angle change, lumbar lordosis and sagittal vertical axis at the ultimate compared to the preoperation.

99. Comparison of Different Weights in the Use of Intra-Operative Skull-Skeletal Traction for Correction of Adolescent Idiopathic Scoliosis

Sooyong Chua; Doron Rabin, MD; Ahmed Al-Jahwari, MD; Sarah Bacon; Randolph J. Gray, MD, FRACS; Reinhard D. Zeller, MD; Sofia Magana; Stephen J. Lewis, MD, MSc, FRCSC
Canada

Summary: Retrospective study of 121 AIS patients treated with either high, low or no weight intra-operative skeletal traction. The high traction group had higher magnitude curves and greater intra-op and post-op correction. A higher rate of EP monitoring changes occurred in the high traction group. We recommend the use of reliable EP monitoring if considering high weight intra-op skeletal traction.

Introduction: Intraoperative skull-skeletal traction (IST) facilitates curve correction in AIS. The aim of this study is to compare the radiographic results and safety of different IST weights.

Methods: Retrospective study of three AIS cohorts (high IST, low IST, no IST). Indications for IST were based on surgeon preference. One surgeon used high IST (50% body weight) for curves >70, lumbar curves requiring correction and cases with type C and D pedicles. The other surgeon routinely used low IST with cranial traction of 13 lbs. and femoral traction of 26 lbs. Pre-op, benders, traction, and post-op Cobb angles and electrophysiological (EP) monitoring events were recorded. No osteotomies or anterior releases were performed. A two-way, non-paired ANOVA, with adjustment for between group differences was made. EP changes between groups were assessed by a Chi-square test. Odds ratios were estimated

Results: 44 high IST, 41 low IST and 36 no IST patients were analyzed, with mean preop curves of 76.6 (44-112), 69.3 (50-85) and 57.3 (42-75)degrees respectively ($p=0.02$). Flexibility index was stiffer in the high IST group than low IST group (0.19 vs. 0.3, $p=0.05$). Intra-op curve correction in traction was greater in the high IST group (47% vs 34%, $p=0.001$). Postop curve correction was 64.7%, 60.8% and 68.4% for the high IST, low IST and no IST groups respectively. Lumbar curves had significantly better final correction with high IST ($p=0.019$)than the low IST group. High IST was more likely to produce EP changes compared to low IST (Odds Ratio 3.8; $p=0.006$), though this was not significant when adjusting for curve severity (OR 3.6; $p=0.27$). The no IST group had no EP changes.

Conclusion: High IST allows for improved intraop curve correction and postop lumbar curve correction than low IST. High IST introduces a higher risk of EP changes with larger curves, and is not recommended without reliable intraop EP monitoring. IST was not required for smaller curves.

Significance: High IST improves intraop curve correction with higher risk of EP changes. Improved corrections are achieved in larger magnitude curves with high IST.

100. What Dose of Interbody rhBMP-2 is Optimal for TLIF? Large Study Complications and Outcomes

Jason Datta, MD; Dennis Crandall, MD; Ryan McLemore, PhD; Jan Revella, RN; Michael S. Chang, MD; Terrence Crowder, MD
United States

Summary: 282 patients underwent fusions at 485 disc levels using rhBMP-2 at various dosing between 4mg-12mg. Prospective data for 2-4 years follow-up was reviewed to evaluate the relationship between dose and clinical outcomes, fusion rates, and complications. All patients had significant improvements in VAS and ODI scores at 12 and 24 months. 4mg dosing lead to equivalent fusion rates and had lower complication rates related to rhBMP-2 than higher levels.

Introduction: TLIF with a PEEK cage is acommon technique for anterior column support and arthrodesis. The optimum interbody dose of BMP however is yet undetermined. A few smaller series describe varying doses of BMP used in TLIF, but the small numbers have not provided convincing technical guidelines. This study examines the affect of interbody BMP doseage on on fusion rates and complications.

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Methods: Prospective data on 282 consecutive adults undergoing posterior fusion with pedicle screw instrumentation and TLIF with rhBMP-2 at 485 discs (L1-S1) was reviewed, with 4 years follow-up (24-76 months). Average age 60 years(19-88 years); diagnosis was degenerative in 124, spondylolisthesis in 92, and deformity in 66. BMP dosing averaged 8.4mg/disc level: 4mg- 29, 6mg- 146, 8mg-159, 10mg-9, and 12mg-142 discs. Complications and outcomes (VAS, Oswestry) were followed for each dosage group.

Results: All patients had significant improvements in their ODI and VAS scores at 12 months and 24 months. A total of 6 disc levels developed nonunions during follow-up for a 1.24% non-union rate per disc level. These nonunions occurred in 6 patients of 282 for an overall patient based nonunion rate of 2.13%.

4 nonunions occurred at the L5-S1 disc level, and 1 each at L4-5 and L3-4 disc levels. Dosing of the nonunion levels demonstrated 4 levels treated with 8mg, and 1 level each treated with 6mg and 4mg. Smoking was a factor in 2 nonunion patients.

Complications related to BMP usage were seen in 5 of 282 patients 1.77%. 2 patients developed seroma (6mg and 8mg dosing), 3 had boney overgrowth into foramen (6mg and 8mg dosing).

Other complications included 5 infections, 7 painful hardware requiring removal, and 101 adjacent degeneration (only 17 required revision), 19 adjacent fractures (only 7 required revision), 2 cases of arachnoiditis. No cage subsidence was seen.

Conclusion: BMP used in TLIF application appears to be safe and effective in fusion with a low complication rate. Dosing between 4mg/disc level appears to have less complications and better fusion rate than 6mg-12mg.

Significance: This study demonstrates that 4mg dosing of rhBMP-2 in TLIF application demonstrates equivalent fusion rates with higher dosing with less complications related to rhBMP-2.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

101. Transforaminal Lumbar Interbody Fusion with rhBMP-2 followed Four Years: A Large Series with Diagnosis-Based Outcomes and Complications

Dennis Crandall, MD; Eric Huish, BS; Ryan McLemore, PhD; Jan Revella, RN; Jason Datta, MD; Michael S. Chang, MD; Terrence Crowder, MD
United States

Summary: This is the largest series of TLIF with PEEK cage and interbody rhBMP-2 in the literature, 282 consecutive adults followed 48 months (24-76 months). Arthrodesis was noted in 98% across a variety of spinal disorders (degenerative disease-124, spondylolisthesis-92, scoliosis-62, kyphosis-4). Most complications occurred with deformity patients. Five BMP-related complications occurred, 2 seromas and 3 with bony overgrowth, all resolving with surgical decompression. Off-label BMP used with TLIF appears highly effective for a variety of spinal disorders.

Introduction: TLIF provides improved fusion rates and anterior column support. Off-label use of rhBMP-2 with TLIF is common. Reliable fusion rates and complications have been reported(largest series:86 patients followed 27mo). This is the largest report of TLIF with BMP, with analysis of complications and outcomes across the spectrum of spinal disorders.

Methods: Prospective outcomes were reviewed on 282 consecutive adults undergoing open posterior instrumented fusion(PSF) with TLIF, PEEK cage, rhBMP-2 average 8.4mg/disc(4-12mg/disc) at 485 discs, and followed 48 months(24-76mo). Dx: degenerative-124, spondy-92, scoliosis-62, kyphosis-4. Age ave 60years(19-88yrs), 23 smokers, 109 had prior decompression/fusion. PSF ave 3.4 levels(1-16 levels); TLIF ave 1.7 levels(1-4 levels), 1 level-126, 2 levels-112, 3 levels-41, 4 levels-3. Outcomes included VAS pain scores, Oswestry Disability Index(ODI), pain medication records, and radiographic imaging pre-op, 1 year, 2 years, and latest follow-up. Fusion was defined as bridging interspace bone, no loosening of instrumentation, no motion on flex-ext radiographs.

Results: Nonunions: 6 patients(6/485 discs; 4 scoliosis, 1 spondy, 1 degen), 4/6 at L5-S1. Nonunion BMP dose: 8mg-4, 6mg-1, 4mg-1. Revision surgery for BMP-related problems: seroma-2, bony overgrowth into foramina-3, all resolved. Other complications: adjacent degeneration-106(17 revised), adjacent fracture-17(9 scoliosis, 7 revised), infection-4, late instrumentation removal-7. Osteolysis and cage subsidence were not seen. Significant improvement was noted in VAS (pre-op-6.3, 1yr-2.9, 2yr-3.0, $P<.001$) and ODI(pre-48, 1yr-25, 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: Off-label use of interbody BMP with TLIF, PEEK cages and PSF with instrumentation achieves reliable clinical and radiographic outcomes.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

102. Comparison of the Incidence of Radiculitis and Radiographic Adverse Event Following Minimally Invasive Lumbar Transforaminal Interbody Fusions (MIS-TLIF) With and Without the Use of Bone Morphogenetic Protein (BMP)

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Canada

Summary: In this observational cohort study 121 consecutive 1-2 level MIS-TLIFs the use of low dose rhBMP2 (n=82) compared to local autologous bone (n=39), does not seem to result in an increase incidence of radiculitis, but is associated with a greater incidence of radiographic findings of uncertain clinical significance.

Introduction: Adverse events related to BMP use remains an ongoing concern. The purpose of this study is to ascertain the incidence of lumbar radiculitis and radiographic complications associated with the use of rhBMP2 in MIS-TLIF.

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Methods: Observational cohort study performed by one surgeon in a single institution. Outcome measures were clinical (Pain Scale (NPRS), SF-36 and ODI) and radiographic (CT). 4.2 mg rhBMP2/per disc was used in the BMP group (n=82) and local autologous bone was used in the control group (n=39). An independent observer reviewed all charts, radiographs and 6 mth postoperative CT retrospectively. Clinical outcome measures were prospectively collected.

Results: There was no significant difference in age, BMI, ASA, diagnosis (spondylolisthesis > 80%) and baseline outcomes between groups. At 6-weeks follow up, new symptoms suggestive of radiculitis was found in 5 (6.1%) vs. 2 (5.1%) patients in the BMP and control group respectively (p=0.65). At 6 months, this had reduced to 2 and 0 respectively. CT evidence of continuous interbody bony bridging was seen in 78.4% vs. 82.8% of the BMP and control group respectively (p=0.8). No definitive non-unions seen in either group. Peridiscal osteolysis, cage subsidence and heterotopic ossification (HO) was seen in 24% vs. 8% (p=0.07), 67 vs. 82% (p=0.11) and 53 vs. 25% (p=0.008) of BMP group vs. control group respectively. There was no correlation between HO and radiculitis. There was a significant improvement in outcome scores at 2 years follow-up in both groups (p<0.0001). No significant difference between the two groups in pain at 1.5, 3, 6, 12, 24 months and ODI/SF-36 scores at 6,12,24 months (p>0.2).

Conclusion: The use of low dose BMP in MIS-TLIF does not seem to result in an increase incidence of radiculitis, but is associated with a greater incidence of potentially significant radiographic findings of HO and osteolysis.

103. Perioperative Neurologic Events from a Multicenter Consecutive Series of Pediatric Vertebral Column Resection: Nature, Frequency and Outcomes

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Summary: In a multicenter, consecutive series of 147 pediatric VCRs, the overall postoperative neurologic deficit rate was 13%, most of them spinal cord-level. Common risk factors included kyphotic deformities, congenital abnormalities, revision surgery and preop neurologic deficit. All but one deficit recovered fully at an average of 3.5 months postoperatively and there were no patients with complete, permanent paraplegia. Neuromonitoring is mandatory when signals are obtainable.

Introduction: Vertebral column resection (VCR) for the treatment of severe pediatric spinal deformity is a powerful method of correction, but carries with it a high risk of neurologic injury. The purpose of this study was to report the nature, frequency and outcomes of neurologic injuries that occurred after this procedure.

Methods: A retrospective review of 7 pediatric spinal surgeons' consecutive experience with VCR was performed and all neurologic events were recorded. 147 pts (74 females/73 males) at an average age of 13.7 years underwent a total of 184 procedures and had an average of 1.6 (1-5) vertebrae resected. Intraoperative multimodality neurophysiologic monitoring (IONM) was attempted in all cases.

Results: 42/147 patients had an abnormal neurologic finding preoperatively. 39 patients (27%) had an intraoperative neurologic event (IONM change or failed wake-up test), but no patient sustained complete, permanent paraplegia. 19/147 patients (13%) had a clinically evident neurologic deterioration postoperatively from their preoperative status; 15 were spinal cord deficits and 4 were nerve root deficits. All deficits except one (radiculopathy) were detected intraoperatively by a change in monitoring and/or an abnormal wake up test. All deficits, but one, recovered by an average of 3.5 months postoperatively (range: 1 day to 12 months). Risk factors identified in these 19 cases include kyphotic deformities (16), congenital abnormalities (9), revision surgeries (9), myelopathy (5), unreliable monitoring (5) and intraoperative hypotension (2). Six patients with abnormal preoperative neurologic exams (myelopathy or LE weakness) improved after the VCR.

Conclusion: Many pediatric patients with complex spinal deformities undergoing a VCR have pre-existing neurologic deficits. The VCR procedure carries with it a 13% rate of postoperative neurologic deficit, most of them thoracic cord level. Nerve root injuries may be seen in lumbar-level resections. Fortunately, there is a high rate of neurologic recovery when corrective action is taken intraoperatively to realign or decompress the vertebral canal appropriately following neurophysiologic monitoring changes, and monitoring should be employed in all cases when potentials can be elicited.

104. Clinical Outcomes and Complications Following Spinal Deformity Correction with Smith-Petersen Osteotomies

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Summary: We performed a retrospective review of the clinical records of 92 patients undergoing Smith-Petersen osteotomies with over 2 years follow-up. We found that estimated blood loss averaged 1419 mL and was higher in older patients and patients with more levels instrumented, but not higher in patients with more osteotomies. Early and late complications each occurred in 20.7% of patients (some experienced both). Oswestry and SRS-30 scores both improved significantly.

Introduction: While studies have elucidated the outcomes from pedicle subtraction osteotomy (PSO) and vertebral column resection (VCR), relatively less research has focused on Smith-Petersen osteotomy (SPO). We sought to improve our understanding of these osteotomies.

Methods: We reviewed the clinical records of 92 consecutive adult and pediatric patients undergoing posterior spinal fusion with SPOs with minimum 2 year follow-up. We excluded those with concomitant PSO or VCR, or anterior releases at SPO levels.

Results: 92 patients with avg. age of 35.3 ± 21 years underwent 4.1 ± 2.1 SPOs and 14.4 ± 3 levels of instrumentation. Avg. follow-up was 35.3 ± 15 months. SPOs were performed purely for kyphosis correction in 48 (52%), for scoliosis correction in 14 (15%), and for both purposes in 30 (33%). Avg.

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estimated blood loss (EBL) was 1419 ± 867 mL; it was higher in patients ≥ 21 years than in those < 21 (1793 ± 896 mL vs 1020 ± 633 mL, p<0.0001) and in patients with more instrumented levels (Spearman correlation 0.42, p<0.0001); the number of SPOs did not correlate with higher EBL. Early complications occurred in 23 patients (25%), including 4 (4.3%) with neurologic complications. 19 (20.7%) patients suffered late complications, with 5 (5.4%) instrumentation failures. 38 (41.3%) suffered any complication. No associations were found between early or late complications and clinical or demographic variables, though the number of levels fused was non-significantly associated (p=0.08 for each). 5 patients (5.4%) lost monitoring signals intraoperatively; Scheuermann's kyphosis patients showed a non-significant trend towards greater risk of lost monitoring (p=0.07). Oswestry Disability Index (ODI) scores improved significantly pre- vs. postop (n=42, 34.2 ± 17 vs. 23.4 ± 16, p<0.0001), as did normalized SRS-30 scores (n=58, 64.8 ± 13 vs. 77.8 ± 13, p<0.0001).

Conclusion: SPOs are a relatively safe means of augmenting posterior deformity correction, as the number of SPOs did not correlate with increased EBL or complications in this sample. EBL was higher in older patients or those with more levels fused. Overall complication rate was 41.3%, with a 4.3% rate of neurologic complications. Significant improvements in ODI and SRS-30 scores were obtained.

105. The Impact of Obesity on the Incidence of Adverse Events Following Spine Surgery

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Canada

Summary: In this large observational cohort study, multivariable regression analysis suggests that obesity does not pose an increased risk for intraoperative or postoperative complications following elective spinal surgery.

Introduction: Whether increased risk of adverse events (AEs) in spine surgery is directly associated with obesity, remains controversial. This study aimed to examine the effect of obesity on the incidence of AEs following spine surgery.

Methods: For this retrospective observational cohort study, patient data was retrieved from a prospective surgical registry. Intraoperative and postoperative AEs were documented independently for all consecutive patients who underwent elective inpatient and day surgery at a tertiary care center over a 4 year period. Patients were classified into obese (BMI > 30 kg/m2) or non-obese (BMI < 30 kg/m2) cohorts and the incidence of intraoperative (n=1948) and inpatient postoperative (n=1314) AEs were determined.

Results: Of the 1948 patients enrolled, 591 (30.3%) met the criteria for obesity. Mean BMI in non-obese and obese groups were 25.0 (range 13.7-29.9) and 34.9 (range 30.0-65.4) respectively. 67 (3.4%) patients were morbidly (BMI > 40 kg/m2) obese. There were 177 (13.0%) intraoperative and 140 (10.3%) postoperative AEs in the non-obese cohort compared to 77 (13.0%) intraoperative and 65 (11.0%) postoperative AEs in the obese cohort. The cohorts were similar with respect to age, gender, ASA score, estimated blood loss, length of stay and preoperative presence of neurological deficits (p>0.1). There were significant differences in primary diagnosis (p≤0.01) and number of operated levels (p=0.01). Logistic regression found no statistically significant relationship between BMI and both intraoperative (OR 0.97, 95% CI 0.72-1.31) and postoperative complications (OR 1.06, 95% CI 0.76-1.47).

Conclusion: The findings from this large, prospectively collected AE dataset, suggest that obesity (which was modest in this cohort) does not pose an increased risk for intraoperative or postoperative complications following elective spinal surgery. However, we are unable to comment on impact of morbid obesity.

106. Prospective Analysis of Primary Pyogenic Infection of the Spine in Intravenous Drug Users

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Canada

Summary: This is the first prospective report of primary pyogenic infection of the spine in intravenous drug users. Presentation is of sepsis and acute cervical quadriplegia. Significant neurological improvement expected in the majority of patients.

Introduction: Primary pyogenic infection in the Intravenous drug user presents a complex and challenging problem, with no guidance available in the current literature. The purpose of this study was to evaluate the demographics, presentation, treatment and outcomes of spinal infection in a population of Intravenous Drug Users.

Methods: Data on all patients with primary pyogenic spinal infection presenting to a quaternary referral center was collected in a prospectively maintained database.

Results: 102 patients were treated for Primary Pyogenic Infection of the Spine of which 51 were Intravenous Drug Users (IVDU). There were 34 males. Mean age 43years (range 25 - 57). 23 had HIV, 43 Hepatitis C and 13 Hepatitis B. All were using cocaine, 26 also Heroin and 44 more than 3 recreational drugs. 30 patients had axial pain, mean duration 51 days. 31 were ASIA D or worse with 8 ASIA A. Mean Motor Score was 58.6. Most common Motor Level was C4. Mean duration of neurological symptoms was 7 days. None had previous surgery for spinal infection. Mean presenting Temperature was 37.4 degrees C(range 35.9 - 39.9, 19 > 37.5C), mean ESR 60.8 (range 6 - 140, 43 > 20), mean CRP 87.75 (1.5 - 253, 46 > 20), mean WCC 10.2 (range 3.7 - 30.4, 14 > 11) and 33 patients had positive blood cultures (19 MSSA, 9 MRSA). 44 patients were treated surgically. 32 cervical spine, 9 Thoracic and 3 Lumbar. 22 had posterior approach alone, 13 anterior only, 9 required combined. Mean operative time 263 mins (range 62 - 742). 13 required tracheostomy. 7 early revision for hardware failure and 2 for surgical wound infection. 17 had MSSA and 17 MRSA. At discharge 28 patients had neurological improvement (mean 20 ASIA points, range 1-55), 11 had deterioration (mean 13, range 1-50) and 5 unchanged. There were no in-hospital deaths. At 2 years after index admission 13 patients were dead and none were available for follow-up.

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Conclusion: Primary pyogenic spinal infection in IVDU's typically presents with sepsis and acute cervical quadriplegia. Significant neurological improvement expected in the majority of patients.

Significance: This is the first report of prospectively collected clinical data on primary pyogenic infection of the spine in the uniquely challenging population of intravenous drug users.

107. Spine Adverse Events Severity System (SAVES-V2): Multicenter Development with Inter-Intra Observer Reliability Assessment

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Canada

Summary: The Spine AdVerse Events Severity system (SAVES-V2) was developed using best evidence and consensus expert opinion methodology. This system proved to be reliable and required minimal education and training for use.

Introduction: In the surgical literature the definition of an adverse event (AE), the severity of an AE and the reporting of AEs are at best inconsistent. The purpose of this study was to assess the reliability of a simple severity classification system for AEs associated with spinal surgery.

Methods: This was a prospective, multicenter, consensus based development and reliability study. Best evidence and consensus expert opinion methodology was utilized to develop a Spine AdVerse Events Severity system (SAVES-V2) within the spine trauma (STSG) and degenerative spine study groups (DSSG). AE was defined as any event that is due to management (not to the underlying disease or injury) that leads to harm or requires additional monitoring or treatment. SAVES consists of a 6 grade AE severity classification, and 6 categories estimating the impact of AE(s) on length of stay (LOS). 10 case vignettes with single or multiple AEs within the same patient where presented at the DSSG and repeated 6 months later. Inter and intra-observer reliability assessment using intraclass correlation (ICC) and kappa statistics was performed regarding four questions: Did an AE occur? What was the specific AE(s)? What was the severity of the AE? and What was the impact on LOS?

Results: Inter and intra-observer reliability from 17 and 8 DSSG members respectively was obtained. Overall there was nearly 100% agreement on presence of and AE. There was substantial inter-observer agreement wrt to number of AEs, severity and impact on LOS, however only fair agreement regarding the specific type of AE (Table 1). There was moderate to substantial intra-observer agreement on all aspects.

Conclusion: The SAVES system is reliable and required minimal education and training for use. Fair reliability in denoting the specific type of AE was most likely a result of not using (logistical barrier) definitions for the specific AEs listed on the SAVES form and should be improved by the provision of a data dictionary.

108. Assessment of Factors Predictive Of Post-Operative Infection in 941 Spinal Deformity Patients

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Summary: Age, BMI, levels fused, Lenke 3-4 curve type, osteotomy, and comorbidities were predictors of infection. Of these, Lenke 3-4 and neuromuscular comorbidity correlated with deep infection.

Introduction: Post-operative infection occurs following spinal surgery in 1 to 15% of cases varying with patient factors and type of procedure performed. This study aimed to identify patient and surgery related factors associated with an increased risk of infection from a single surgeon database.

Methods: Retrospective review of 941 patient records from a single-surgeon database of deformity patients treated from 2000-07. Demographic (age, gender, body mass index (BMI), comorbidities), surgical (prior surgery, approach, type and number of procedures, etc), radiographic, and peri-operative complications were assessed. Infection was classified as deep, superficial, or possible. Deep infection always required operative irrigation and debridement, while superficial infection was treated non-operatively. Patients restarted on antibiotics for wound drainage without fever, positive culture, or abnormal laboratory values were categorized as a possible infection.

Results: There were 13 deep (1.4%) and 17 superficial infections (1.8%). Patients were treated with an anterior (n=193), posterior (n=590), or combined (n=140) approach with the following procedures: spinal fusion (n=873), growth rod distraction (n=23), revision (n=145), vertebral column resection (n=32), and osteotomy (n=162). Predictors of infection were: age, BMI, number of levels, Lenke 3-4, osteotomy, and number of comorbidities ($p<0.001$ to $p<0.05$). Lenke types 3- 4, combined approach, number of levels, and kyphosis correlated with superficial infection ($p<0.001$ to $p<0.05$). Lenke 3-4 and neuromuscular comorbidity was predictive of deep infection ($p<0.001$).

Conclusion: Age, BMI, number of levels, Lenke 3-4 curves, osteotomy, and number of comorbidities were found to be predictors of any infection. Of these, only Lenke 3-4 and neuromuscular comorbidity was correlated with deep infection.

109. Incidence and Risk Factors of DVT and PE Following Major Spinal Surgery

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United States

Summary: A retrospective review of 1502 spine procedures showed a 1.1% combined DVT and PE rate. Major patient risk factors identified through statistical analysis were previous history or DVT or PE, active malignancy, estrogen replacement therapy, discharge to rehabilitation center, major depressive disorder, hypertension, renal disease, congestive heart failure, and benign prostatic hypertrophy ($p<0.05$).

Introduction: DVT prophylaxis must be balanced with the risks for post-operative

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bleeding and epidural hematoma following spinal surgery. Epidural hematoma is a unique complication to spinal surgery. It can result in neurologic deficit as severe as paralysis. Blood loss and wound complications are also associated with chemical prophylaxis. Due to these risks most spine surgeons use only mechanical prophylaxis.

Methods: A retrospective chart review on 1502 surgeries from 2001-2009 was performed. The surgeries included cervical, lumbar and thoracic as well as anterior and posterior approaches. Patients received mechanical prophylaxis only. Pertinent medical history and details of the procedures were analyzed using relative risk analysis. Data points recorded included: gender, body mass index, smoking history, age, medical comorbidities, DVT risk factors, DVT prophylaxis employed, length of stay, procedure type, number of levels addressed, and discharge location.

Results: The rate of thromboembolic event was 1.1% with 0.4% being DVT and 0.7% being a PE. Relative risk calculations showed that previous history or DVT or PE, active malignancy, estrogen replacement therapy, discharge to rehabilitation center, major depressive disorder, hypertension, renal disease, congestive heart failure, and benign prostatic hypertrophy ($p<0.05$). Smoking, multiple procedures within 30 days, obesity, gender, GERD, hyperlipidemia, and sleep apnea were all not significant risk factors in our study population ($p>0.05$).

Conclusion: Major depressive disorder, renal disease, hypertension, congestive heart failure and benign prostatic hypertrophy were identified as new risk factors for thromboembolic events during spinal surgery. Patients with these conditions may benefit from additional prophylactic measures.

Significance: Identifying risk factors for thromboembolic events in spinal surgery may allow surgeons to tailor prophylactic measures to maximize treatment while balancing the risk of DVT/PE with epidural hematoma and other wound complications.

110. Prospective Side by Side Comparison of Hydroxyapatite Coated Collagen Matrix vs. Iliac Crest Autograft in Lumbar Arthrodesis

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United States

Summary: Ten patients were prospectively treated with autograft on one side of the spine and hydroxyapatite coated collagen matrix soaked in bone marrow on the other side in a single level or two level lumbar arthrodesis procedure. Results showed minimal bone formation on the hydroxyapatite coated collagen matrix side with solid bridging bone on the autologous iliac crest side.

Introduction: Spinal surgeons are constantly seeking to find ways to avoid the complications and time cost of harvesting iliac crest bone graft for lumbar spinal arthrodesis. Dozens of alternatives exist, but few have proven as efficacious as autologous iliac crest graft. Hydroxyapatite coated collagen matrix is a hydroxyapatite coated, collagen cross-linked sponge that is mixed with autologous bone marrow which is used as an autologous bone graft substitute

Methods: Patients were prospectively studied. Informed consent was obtained. Lumbar fusion was performed at either one or two levels from L2 to S1. Before harvesting iliac crest bone graft during the operation, a small entry was made into the iliac crest at the level of the posterior superior iliac spine. An 11 gauge jamshidi needle was inserted into the iliac crest into at least five different sites and bone marrow was harvested, 5 cc's for single level fusions, and 10 cc's for two level fusions. The marrow was mixed with the Hydroxyapatite coated collagen matrix sponge then placed along the transverse processes on one side after decortication. Autologous iliac crest bone was then harvested and placed on the opposite side. An interbody fusion was also performed with local graft and an interbody cage or allograft. Pedicle screws were placed for immobilization.

Results: Postoperative radiographs were evaluated at 6 month intervals up to 2 years, then yearly as available. Average follow-up with radiographs was 4.3 years. All 10 patients had bridging solid bone along the transverse processes on the autologous iliac crest side. Only one patient had bridging solid bone on the side that was grafted with Hydroxyapatite coated collagen matrix. The remaining nine patients had minimal or no bone along the transverse processes on the side grafted with Hydroxyapatite coated collagen matrix.

Conclusion: At this time, without other comparative studies, Hydroxyapatite coated collagen matrix mixed with autologous bone marrow cannot be recommended for use as a stand-alone substitute for posterolateral arthrodesis.

111. Outcomes of Revision vs. Primary Transforaminal Interbody Fusion in 282 Patients

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United States

Summary: The clinical outcome of transforaminal lumbar interbody fusion (TLIF) in revision surgery is uncertain. The clinical outcomes of 109 consecutive patients undergoing TLIF as part of a revision procedure were compared with 173 consecutive patients undergoing TLIF as a primary operation. Despite having significantly worse ODI and VAS scores at all time intervals, revision patients demonstrated similar overall improvement in their functional outcome scores. Complication rates were also similar between the two groups.

Introduction: Transforaminal lumbar interbody fusions (TLIFs) have reliable rates of fusion and well-documented complications. However, the clinical benefit TLIFs offer patients in revision surgery, which often yields worse outcomes with higher complication rates, is uncertain.

Methods: 282 consecutive patients at one center underwent TLIF at 485 levels as a primary procedure (n= 173) or as part of a revision operation (n= 109). Diagnoses were spondylolisthesis (n= 94), scoliosis (n= 65), and other degenerative spinal disorders (n= 128). Clinical outcomes were obtained prospectively by the visual-analog pain scale (VAS) and the Oswestry Disability Index (ODI) at pre-op, 1 year, 2 year, and latest follow-up.

Results: Revision patients had significantly worse clinical scores compared with primary patients at all time intervals, for both VAS (pre-op: 6.8 vs 6.1, p=0.046; 1yr: 3.6 vs 2.9, p=0.002; 2yr: 3.5 vs

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2.7, p=0.016) and ODI (pre-op: 54 vs 45, p<0.0001; 1yr: 33 vs 20, p<0.0001; 2yr: 34 vs 25, p=0.005). However, clinical improvement at 2 years was significant and similar between revision and primary patients for both VAS (3.2 vs 3.4, p=0.221) and ODI (20 vs 20, p=0.706). Complications between revision and primary groups were similar and included non-union (1[0.9%] vs 5[2.9%]), adjacent level fracture (10[9.2%] vs 8[4.6%]), infection (1[0.9%] vs 3[1.7%]), foot drop (1[0.9%] vs 3[1.7%]), implant failure (2[1.8%] vs 2[1.2%]), seroma (1[0.9%] vs 1[0.6%]), symptomatic implant (3[2.8%] vs 4[2.3%]), spinal imbalance (2[1.8%] vs 4[2.3%]), arachnoiditis (1[0.9%] vs 2[1.2%]), ileus (2[1.8%] vs 1[0.6%]), and revision for junctional kyphosis (4[3.7%] vs 16[9.2%]). There were no cases of PE, stroke, or MI in either group.

Conclusion: Posterior spinal fusion (PSF) with TLIF produces significant clinical improvement at 2 years. Despite having worse initial ODI and VAS scores, revision patients benefit from TLIF procedures as much as patients undergoing primary surgeries, with similar complication rates.

Significance: TLIF procedures produce significant functional improvement in patients at 2 years post-op, even in revision scenarios.

112. XLIF at L4-5 and the Protective Effect of Prophylactic Dexamethasone

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Summary: Neural deficits were tracked in a single site series of XLIFs including the L4-5 level. After the fourth deficit occurred, we began to administer dexamethasone prophylactically in all XLIF patients in whom the L4-5 level was to be approached. Since the use of dexamethasone, no additional neural deficit developed, a statistically significant difference.

Introduction: It has been reported that XLIF procedures performed at the L4-5 level have a higher incidence of postoperative motor deficits compared to other lumbar segments, and must occasionally be aborted to due anatomic constraints.

Methods: In our single-site consecutive series of 783 XLIF patients, 468 (60%) included the L4-5 level. Clinical and radiographic data were prospectively collected and reviewed to assess XLIF procedure at the L4-5 level.

Results: Age averaged 62.0 years (24-88 years). 81.2% had one or more comorbidities. 31.0% had prior lumbar surgery. All procedures were successfully completed. Hospital stay averaged 1.2 days. Average VAS pain scores improved from 8.8 at pre-op to 2.4 at 12 months and 2.2 at 24 months follow-up. Lenke fusion scores of 1-2 were present in 96.7% at 6 months, and 98.6% at 12 months.

Neural complications included 4 (0.6% of all cases, 0.9% of L4-5 cases) transient lower leg weaknesses (3 quads, 1 anterior tibialis; all resolved within 3 months). After the fourth postoperative motor deficit, we began to administer dexamethasone (10mgIV prior to skin incision) prophylactically in all XLIF patients in whom the L4-5 level was to be approached. Since the use of dexamethasone, no additional neural deficit developed, a statistically significant difference (p=0.0245).

Conclusion: The incidence of postoperative motor deficits following XLIF at L4-5 is low. The prophylactic administration of dexamethasone results in a statistically significant reduction in motor deficits.

113. Complications Associated with Axial Lumbar Interbody Fusion

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Summary: We retrospectively reviewed complications associated with AxiaLIF surgery. Complications occurred in 15 of the 67 patients (22.4%) and included superficial infection, deep infection, pseudoarthrosis, sacral fracture, pelvic hematoma, failure of wound closure, and rectal perforation. Many of these complications can likely be avoided with proper patient selection and operative planning.

Introduction: Axial Lumbar Interbody Fusion (AxiaLIF) is a novel minimally invasive approach for fusion of the L5 vertebra to the sacrum. This technique uses the presacral space for percutaneous access to the anterior sacrum. AxiaLIF has the potential to decrease patient recovery time, length of hospital stay, and overall occurrence of surgical complication. It can be used alone or in combination with minimally invasive or traditional open fusion procedures. The purpose of this study was to evaluate complications of the AxiaLIF procedure.

Methods: Patients who underwent AxiaLIF surgery between October 2005 and June 2009 at the authors' two institutions were identified. We retrospectively reviewed these patients' charts, including operative reports and postoperative medical records, to determine what complications were encountered.

Results: Of the 67 patients, 52 (77.6%) experienced no complications and 15 (22.4%) patients had a total of 16 complications. The patients with complications included eight males and seven females, with a mean age of 55.6 years. These complications included superficial infection (4.5%), deep infection (1.5%), pseudoarthrosis (6.0%), sacral fracture (1.5%), pseudoarthrosis and sacral fracture (1.5%), pelvic hematoma (3%), failure of wound closure (1.5%), transient right S1 nerve root irritation (1.5%), and rectal perforation (1.5%).

Conclusion: The complication rate associated with AxiaLIF in the present study was relatively low (22.4%) and was lower than previously published complication rates for transforaminal lumbar interbody fusion (33.6%) and anterior lumbar interbody fusion (38.3%). The most common complications were superficial infection and pseudoarthrosis. We had one case of rectal perforation that required exploratory laprotomy and a loop colonoscopy for repair of the perforation.

Significance: It is important for surgeons to be aware of the potential for these complications. Many of these complications can likely be avoided with proper patient selection and operative planning. Pre-operative MRI, a detailed patient physical and history, adequate bowel preparation, improved access instrumentation, and the use of live fluoroscopy can all help to prevent complications with the otherwise successful AxiaLIF surgery.

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114. Complications in 783 XLIF Surgeries

W. B. Rodgers, MD; Edward J. Gerber, PA-C; Jody A. Rodgers, MD, FACS
United States

Summary: A series of 783 XLIF outcomes were reviewed; complications are noted.

Introduction: The XLIF procedure allows for less invasive placement of a large anterior graft, disk height and alignment restoration, and indirect decompression.

Methods: Our single-site consecutive series of 783 XLIF outcomes were reviewed. Surgical and postoperative complications were documented.

Results: 783 cases included patients aged 22-89 years (average 62 years) for a variety of conditions. 79% had one or more comorbidity. 43% had prior lumbar surgery. 51% were obese or morbidly obese. 976 levels were treated: 80% single-level; 60% at L4-5. All but 5 included supplemental instrumentation. LOS averaged 1.2 days.

61 complications were reported: (7.8% complication rate): 3 wound (herniamsubcutaneous hematoma, and infection); 3 hematologic (1 transfusion, 1 DVT, 1 FUO); 9 GI (8 ileus, 1 gastric volvulus); 5 renal (2 urinary retention, 1 peritoneal catheter occlusion, 1 UTI, 1 kidney stone); 1 mental status (delirium); 8 respiratory (5 pneumonia, 2 pulmonary embolism, 1 re-intubation); 7 cardiac (6 atrial fibrillations, 1 MI at 6 wks post-op); 4 neural (3 quad weakness, 1 anterior tibialis weakness); 13 vertebral body fractures (1 endplate fracture, 1 osteophyte fracture requiring reoperation, 1 subsidence requiring reoperation, 2 sacral fractures (1 requiring reoperation), 7 compression fractures at an adjacent level requiring vertebroplasty, 1 hnp at an adjacent level); 1 iatrogenic HNP (requiring laminectomy at 4 wks); 1 hnp at an adjacent level (requiring discectomy), and 6 hardware failures (3 cage fractures on insertion, 1 screw that penetrated the endplate, 1 fractured rod at 6 months, 1 fractured screw at 1 year). Reoperation rate was 72/775 (9.3%) (8 vertebroplasty, 8 axiaLIF, 24 XLIF, 12 PLIF, 2 ALIF, 15 laminectomy, 1 hardware revision, 1 hematoma drainage, and 1 stimulator implant,). Average VAS scores, radiographic measures, and fusion scores were not different between the complications group and the total series.

Conclusion: XLIF is a safe, effective treatment for multiple thoracolumbar degenerative conditions. XLIF surgery can be performed in many conditions with a low complication rate.

115. Can Intraoperative Spinal Cord Monitoring Reliably Help Prevent Paraplegia during Posterior VCR Surgery?

Samuel K. Cho, MD; Lawrence G. Lenke, MD; Shelly Bolon, BS, CNIM; Joshua M. Pahys, MD; Woojin Cho, MD, PhD; Matthew M. Kang, MD; Lukas P. Zebala, MD; Linda Koester
United States

Summary: The prevalence of intraoperative spinal cord monitoring data deterioration during VCR surgery was 14.1% (10/71), most of which occurred during rod compression (6/10) and osteotomy (5/10). All patients had return of data with immediate intervention (mean 10.3 min, range 1-60) and had intact lower extremity neurologic function postoperatively.

Introduction: Posterior vertebral column resection (VCR) is an increasingly common technique to treat severe adult and pediatric spinal deformity but carries a potentially high risk of major spinal cord deficits.

Methods: Analysis of 71 consecutive adult and pediatric pts (mean age 23.7 yrs, range 7.5-74.0) who underwent VCR at or above L1 (spinal cord level) with detectable intraoperative spinal cord monitoring (SCM) data for severe spinal deformity was performed. All surgical procedures were performed between 2002-2009 by 1 surgeon at 1 institution. The electrophysiologic monitoring (both DNEPs and SSEPs) records, surgeon's operative reports, and radiographic studies were used.

Results: 10 pts (6M/4F; mean age 14.3 yrs) out of 71 (14.1%) had either loss of SCM data (n=8) or degradation to meet warning criteria (n=2) during surgery. Diagnoses included 6 kyphoscoliosis, 2 global kyphosis, 1 angular kyphosis, and 1 severe scoliosis. 6 were revisions. Mean operative time was 449 min and EBL was 975 mL. The avg pre- and postop scoliosis for these 10 pts were 99.8o (11-152o) and 44.7o (0-76o), respectively. The avg pre- and postop kyphosis were +110.5o (60-170o) and +57.0o (32-100o), respectively. 6 pts had SCM change during rod compression, requiring partial release of correction in 2, larger cage insertion in 2, correction of subluxation in 1, and removal of pedicle screw in 1 pt. SCM fluctuated during osteotomy on 5 occasions that stabilized with elevation of blood pressure in all cases, in addition to correction of subluxation in 1, anterior spinal cord decompression in 1, and lessening traction in 1 pt. 1 pt experienced SCM changes during rod placement/removal and another due to hypothermia. All 10 pts had return of SCM data following prompt intervention (mean 10.3 min, 1-60) and awoke with intact lower extremity neurologic function.

Conclusion: The prevalence of intraop SCM data change during VCR surgery was 14.1%, most of which occurred during osteotomy and rod compression. All pts had return of data with immediate intervention and had intact lower extremity neurologic function postop. These SCM "saves" strongly emphasize the importance of using multimodal neurophysiologic monitoring during such high risk cases to minimize postop paraplegia.

Age (yrs)	Dx	Additional Diagnoses	Osteotomy Level(s)	Maneuver at Time of SCM Change	Intervention	Interval for Return (min)
8	KS	Prune belly syndrome	T10-11	Osteotomy	Correct subluxation/elevate BP	1
				Rod compression	Partial release of correction	4
10.1	KS	Neurofibromatosis, Noonan syndrome	T7-9	Bilateral rod placement	One rod removal	4
				After one rod removal	Correct subluxation	1
				Rod compression	Insert larger cage	1
11.3	AK	Congenital dislocation T12-L1	L1	Rod compression	Insert larger cage	3
13.2	KS	Congenital hypokyphosis	T10-11	Rod compression	Correct subluxation/further decompression/elevate BP	18
14.2	KS	Dandy-Walker syndrome	T7	Osteotomy	Lessen anterior spinal cord compression by correct kyphosis/elevate BP	5
				Rod compression	Remove pedicle screw	7
15.5	KS	VATER syndrome	T7-9	Osteotomy	Elevate BP	13
15.9	GK	Syringomyelia	T5	Osteotomy	Elevate BP/lessen traction	6
18.1	KS	Idiopathic scoliosis	T10	Osteotomy	Elevate BP	14
18.3	SS	Idiopathic scoliosis	T9	Patient found to be hypothermic	Elevate temperature	60
18.6	GK	Congenital kyphosis	T10	Rod compression	Partial release of correction/elevate BP	3

KS=kyphoscoliosis, AK=angular kyphosis, GK=global kyphosis, SS=severe scoliosis, BP=blood pressure

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116. Dual Motor Monitoring Using Transcranial Motor Evoked Potentials and Neurogenic MEP's During Spinal Deformity Surgery May Offer the Best of Both for Challenging Deformity Surgery

Daniel J. Sucato, MD, MS; Jessica Wingfield, BA; Anna McClung, RN; Steven Sparagana, MD; Patricia Rampy, MS
United States

Summary: Dual motor monitoring using transcranial MEP and neurogenic MEP was reviewed in a series of 101 patients with severe spinal deformity demonstrating complimentary identification of critical changes resulting in no neurologic deficits.

Introduction: Despite good success reported with neurogenic motor evoked potential (NMEP) monitoring in spine deformity, transcranial MEP (TcMEP) have taken on a greater role because of perceived theoretical true monitoring of motor tracts only. The purpose of our study was to evaluate the combination if NMEP and TcMEP monitoring on a group of patients who had both modalities utilized in addition to SSEP.

Methods: A retrospective review of a consecutive series of patients undergoing spine deformity surgery using NMEP, TcMEP and SSEP at a single institution was reviewed. The likelihood of obtaining baseline values and the incidence of critical changes in all 3 modalities was studied.

Results: There were 101 patients with 105 surgeries, 62 female, 39 male at 14.5 years operated over a 2 year period. The diagnoses were AIS-45, neuromuscular-22, syndromic-12, juvenile IS-6, revision-7, other-9. The preoperative curve averaged 75.8° (43 to 141°) and 11.5 (7-17) levels were fused. Successful baseline data were obtained in 88 (87.1%) patients and 92 surgeries (87.6%). Critical changes occurred in 7 of 92 (7.6%) surgeries- 5 of 7 were identified by TcMEP and NMEP. Two patients had transient motor deficits, both identified by TcMEP and NMEP. TcMEP detected 6 of 7 (4 false positives) while NMEP identified 3 of 7 with 1 false positive and was stable in 3 of the cases in which TcMEP changed. TcMEP identified critical changes 6.12 minutes faster than NMEP ($p<0.05$).

Conclusion: Dual modality motor monitoring using TcMEP and NMEP (in combination with SSEP) may be a more effective method than either one alone since TcMEP identifies earlier critical changes allowing for prompt responses. NMEP adds important information especially in cases they remain stable when TcMEP are lost.

117. Prompt Response to Critical Spinal Cord Monitoring Changes During Vertebral Column Resection Results in a Low Incidence of Permanent Neurologic Deficit

Daniel J. Sucato, MD, MS; Suken A. Shah, MD; Lawrence G. Lenke, MD; Peter O. Newton, MD; John B. Emans, MD; Harry L. Shufflebarger, MD; Paul D. Sponseller, MD
United States

Summary: In a group of 147 consecutive patients undergoing vertebral column resection for severe deformity, 27% had intraoperative neurologic events, however, only 13% had immediate postoperative neurologic deficits and only 1 (0.7) patient had a permanent decline in neurologic status. The acute response to intraoperative changes (decreasing correction, resecting more bone, shortening the spine and raising blood pressure) were critical to preserving neurologic function.

Introduction: Vertebral Column Resection (VCR) is a powerful procedure used to treat severe spinal deformity that carries potentially high neurologic risk. There are no studies analyzing risk factors and incidence of intraoperative neuromonitoring (IONM) changes comparing them to postoperative neurologic deficit.

Methods: A multi-institution retrospective database of consecutive VCR procedures was analyzed. The risk factors for the development of intraoperative IONM changes were identified and strategies to prevent permanent neurologic deficit were reviewed.

Results: Of the 147 patients, 39 (27%) had an intraoperative neurologic event (critical neuromonitoring change or failed wake up test). All deficits except one (radiculopathy) were detected intraoperatively by a change in monitoring and/or an abnormal wake-up test. The risk factors included: younger age (11.5 vs 14.3 years, $p<0.01$), smaller weight (32.0 vs 43.6 kg, $p<0.01$), longer operative time (516 vs 453 min, $p<0.05$), type of preoperative deformity (angular kyphosis had greatest risk) thoracic or thoracolumbar level VCR (T-31% vs TL-33% vs L-5%, $p<0.05$) and the # vertebrae resected (≤2: 24% vs >2- 64%, $p<0.01$). The intraop events occurred during: resection-43%, correction-43%, implant placement- 3%. The primary intraoperative response was: decrease correction 32%, resect more bone 27%, shorten the spine 13%, raise blood pressure 16%. Immediately postoperatively 19 (13%) had some change in neurologic status;15 were spinal cord deficits and 4 were nerve root injuries. 18 of these deficits resolved over and average of 3.5 months (1 day to 12 months). Only 1 patient (0.7%) had a permanent decrease in neurologic function. Six patients with abnormal preoperative neurologic exams (myelopathy or LE weakness) improved after the VCR.

Conclusion: Despite a high incidence of intraoperative neurologic events during a VCR, the likelihood of permanent neurologic deficits is very low with the use of multimodality spinal cord monitoring and prompt responses to critical changes. Surgeons should consider less correction, more bone resection, shortening the spine and raising blood pressure when monitoring changes are noted to avoid neurologic deficits.

118. Cost-Effectiveness of Total Disc Replacement vs. Lumbar Fusion

Alexander Tuschel, MD, MSc, MBA; Michael Meissl; Michael Ogon
Austria

Summary: At 18 months follow up, total disc replacement seems to be the dominant strategie when compared to lumbar fusion, from a health care system's perspective in Austria.

Introduction: Chronic low back pain caused by degenerative disc disease is one of the most common causes for doctor visits in western industrial countries and presents an immense economic burden both to the individual and to society. In many cases, surgery can be a treatment

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option. For some indications, lumbar disc arthroplasty may be an innovative alternative to the current gold-standard (lumbar fusion) and recent clinical studies have shown at least its non-inferiority for short- and midterm follow-up. The aim of this investigation was to analyse cost-effectiveness of "lumbar disc arthroplasty" versus "lumbar fusion" from a health care system's perspective in Austria.

Methods: A decision model including treatment paths and associated direct costs (surgery, inpatient stays, outpatient visits, GP and orthopaedic consultations, x-ray, medication, rehabilitation and physiotherapy) over a 18-months time horizon was developed. Main outcomes were clinical success (measured by Oswestry-Disability-Index (ODI) and SF-36 at 1 year follow-up) and costs in Euros (€). Clinical input data was derived from a recently performed matched-cohort-study and a meta-analysis of trials comparing the two treatment options. Costs were derived from standard Austrian price lists and from hospital's cost unit accounting.

Results: Disc arthroplasty showed comparable outcome-scores at 1.5 year-follow up, while at the same time caused lower costs than lumbar fusion: Costs per improved ODI-point were 954€ in the fusion group and €645 in patients treated with lumbar disc arthroplasty. Costs for one gained SF36-point were €1645after fusion and €954 after disc arhroplasty.

Conclusion: For a period of 18 months after surgery, this study suggests that lumbar disc arthroplasty is a cost-effective treatment compared with lumbar fusion from a health care system's perspective in Austria. Further studies, including longer follow-up and indirect-costs, are necessary for the assessment of cost-effectiveness from the societal perspective.

Significance: Level of evidence: III

119. Cost Comparison of Total Disc Replacement vs. Fusion in Patients with Insurance Denial for Disc Replacement

Donna Ohnmeiss, PhD; C. Shane Hume, DO; Scott L. Blumenthal; Richard D. Guyer, MD; Jack E. Zigler, MD
United States

Summary: Eight patients were identified who received a prescription for lumbar total disc replacement (TDR) but instead underwent fusion due to insurance denial for TDR. Eight TDR patients were matched to the fusion group based on level(s) operated, surgery date, and all procedures were performed at the same hospital. The total billed, and the total payment received, by the hospital were 50% greater for fusion. This study, comparing rigorous matched fusion and TDR patients, found fusion was more expensive than TDR.

Introduction: New technology must not only be evaluated for outcome but also for cost. For total disc replacement (TDR) some comparisons have been made within the confines of rigorous trial protocols, but not with well-matched cohorts outside of a study setting more representative of typical practice. The purpose of this study was to compare hospital costs of TDR to fusion in patients not enrolled in device trials, whose insurance denied payment for TDR.

Methods: Eight patients were identified for whom TDR was recommended, but were denied insurance coverage for it and subsequently underwent fusion. Hospital costs were compared to 8 TDR patients matched to 8 fusion patients based on level(s) operated (exact match), date of surgery (<25 days between matched procedures), and all performed at the same hospital. Both groups had five single-level cases and three two-level cases. Seven fusions were combined anterior/posterior procedures. Cost data included total billed and total actually received. Costs were further subclassified and compared by category.

Results: The cost for each cost category as well as the total billed and total received are provided in Table 1. The total cost billed as well as the categories of hospital room, pharmacy, sterile supplies, operating room, and anesthesia costs were significantly greater for fusion compared to TDR ($p<0.05$). There were trends for the total actually paid, intravenous supplies and implants and related supplies to be greater in the fusion group. The only cost significantly greater in the TDR group compared to fusion was radiology services. Costs were similar in the two surgery groups for nonsterile supplies and recovery room.

Conclusion: Although this study had a small sample, denial of TDR and patients electing fusion provided an opportunity to evaluate unusually well matched comparative groups with surgery for same indication, same level(s), same time frame, and same hospital. Both the total amount billed and amount actually paid for fusion were approximately 50% greater than TDR.

Significance: The hospital costs of fusion (performed in patients for whom TDR was recommended) were greater than for TDR.

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120. Comparison of Radiographic Findings of Total Disc Replacement vs. Anterior Cervical Fusion: 24-Month Follow-Up from a Prospective, Randomized, Controlled, Multicenter Trial

David Musante, MD; Richard D. Guyer, MD; Dom Coric, MD; Charley Gordon; Pierce D. Nunley, MD; Cameron N. Carmody, MD
United States

Summary: This prospective, randomized FDA IDE trial comparing radiographic analysis of cervical total disc replacement to anterior cervical fusion found that disc replacement resulted in significantly increased range of motion compared to pre-operative values. Also, the degree of adjacent segment disc degeneration was significantly less in the arthroplasty group than in the fusion group.

Introduction: The clinical results of anterior cervical fusion (ACF) are generally good, but there is a potential for accelerated degenerative changes at the level(s) adjacent to the fusion. If cervical TDR allow motion of the operated segment, this may have a protective effect on the adjacent segments compared to fusion. The purpose of this prospective randomized FDA IDE study was to evaluate a new cervical TDR implant by analyzing radiographic findings of range of motion (ROM) and deterioration of the adjacent segment and compare those data to ACF.

Methods: A total of 269 patients from 21 centers, all treated for single-level cervical disc problems, were randomly assigned to either cervical TDR (n=136) or to ACF (n=133; performed using autograft

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and a cervical plate). Anteroposterior (AP), neutral lateral, and flexion/extension radiographs were made pre-operatively and at 3, 6, 12, and 24 months after surgery. Segmental ROM was determined by measuring the rotation from flexion/extension images. The extent of degeneration at the segment adjacent to the operated level was classified as: none, mild, moderate, or severe.

Results: The mean segmental ROM of the TDR level significantly decreased at 3 months (from 8.2 to 7.2 degrees), but was significantly greater than the pre-operative mean at 12- and 24-month follow-up (9.6 and 9.8 degrees respectively). ROM in the ACF group was less than 2 degrees at all follow-up periods. At 24-month follow-up more patients in the ACF group had greater grades of adjacent segment disc degeneration than seen in the TDR group ($p<0.01$; see figure).

Conclusion: This study found that cervical TDR significantly improved ROM. At 24-month follow-up adjacent segment degeneration was less common in the TDR group than the ACF group. These findings support that the mobility allowed by TDR may facilitate prevention of adjacent segment degeneration which may occur with fusion.

Significance: This study supports that TDR increases ROM at the operated level and was associated with less adjacent segment degeneration compared to fusion. These findings support TDR as a viable alternative to ACF.

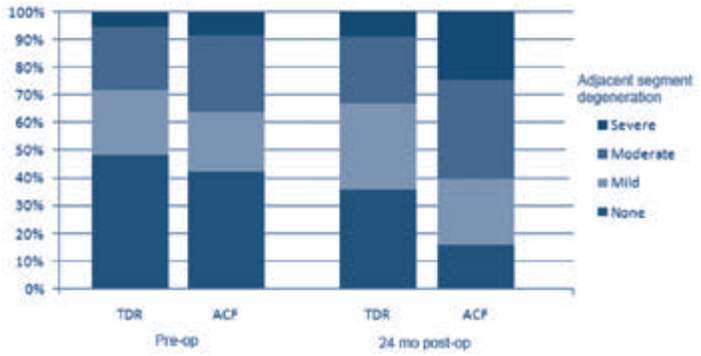

Figure 1. At 24-month follow-up ACF patients had greater grades of degeneration than the TDR group ($p<0.01$).

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121. Does an Electronic Conductivity Device Contribute to the Safety of Pedicle Screw Insertion in Scoliosis Surgery?

Elisha Ofiram, MD, Akiva S. Korn, MMedSc; Dror Ovadia, MD
Israel

Summary: Retrospective analysis of Idiopathic/Congenital/Neuromuscular scoliosis patients was performed comparing 121 (Group I) who were operated without the use of an electronic conductivity device (ECD) (2003-2007) and 92 (Group II) in whom the device was used (2008-2009). Both groups were operated by a single surgeon and continuously monitored intraoperativly. Clinically relevant misplacement of pedicle screws was established by monitoring alarms concomitant with screw insertion.

The use of an ECD significantly reduced the incidents of clinically-relevant misplacement of pedicle screws in all variety of scoliosis surgery.

Introduction: The implantation of pedicle screws in spinal deformity correction surgery has become the most common technique for thoracic and lumbar fixation.

Classic methodologies for verification of optimal placement of pedicle screws include intraoperative fluoroscopy, triggered electromyography, intraoperative image-based navigation, and most recently, the use of a handheld ECD. The goal of the current clinical study is to evaluate the contribution of the ECD device to the safety of thoracic and lumbar pedicle screws placement.

Methods: Retrospective analysis of 213 scoliosis patients (Idiopathic/Congenital/Neuromuscular) was performed comparing 121 patients (Group I) who were operated without the use of ECD (2003-2007) and 92 patients (Group II) in whom the device was used (2008-2009). Data pertaining to pedicle screws were compared including screw position relative to spinal apices and concomitant neuromonitoring alarm. The two groups were matched by age, gender, etiology and surgical criteria. Hybrid instrumentation was initially used in group I, while in group II pedicle screws alone were used.

Both groups were operated on by a single surgeon (DO) and continuously monitored with intraoperative muiltimodal evoked potentials (SSEPs, MEPs, EMG) by a single neurophysiologic team (AK). Clinically relevant misplacement of pedicle screws was established by monitoring alarms concomitant with pedicle insertion.

Results: 1270 pedicle screws were analyzed in group I compared with 1400 in group II. Neuromonitoring events concomitant with screw placement were recorded in 10 patients from group I (8.9%) compared with 3 in group II (3.2%).

The contribution of the electronic device to the safety of pedicle screw was found to be statistically significant by Fisher's exact test ($p=0.048$). 69% of the monitoring alarms were associated with implantation adjacent to the apex of the spinal curve.

Conclusion: The use of an ECD significantly reduces the incidence of clinically-relevant misplaced pedicle screws in all variety of scoliosis surgery.

122. Prospective, Randomized, Controlled, Multicenter FDA IDE Trial Comparing Cervical Total Disc Replacement to Anterior Cervical Fusion: 24-Month Follow-Up

David Musante, MD; Richard D. Guyer, MD; Dom Coric, MD; Charley Gordon; Pierce D. Nunley, MD; Cameron N. Carmody, MD
United States

Summary: This was a prospective randomized controlled trial evaluating cervical TDR by comparing it to anterior cervical fusion. There were no differences between groups based on operative time, blood loss, or length of hospitalization. Both groups improved significantly on clinical outcome measures with the TDR group having a greater overall success rate.

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Introduction: Anterior cervical fusion (ACF) results have generally been favorable, but improvement is possible, which has led to the development of total disc replacement (TDR). The purpose of this prospective, randomized, multicenter FDA IDE trial was to evaluate a new cervical TDR implant by comparing it to ACF.

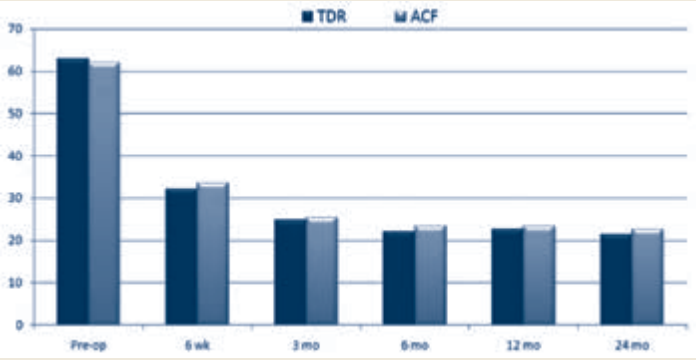
Methods: A total of 269 patients from 21 centers, treated for single-level cervical disc problems, were randomly assigned to either cervical TDR (using the Kineflex|C; Spinal Motion; n=136) or to ACF (using autograft and an anterior plate; n=133). The primary clinical outcome measures included the Neck Disability Index (NDI), visual analog scales (VAS) assessing pain, and an overall measure of success. Patients were evaluated pre-operatively and 6 weeks, and 3, 6, 12, and 24 months after surgery. Overall success for a patient was defined to be at least 25% improvement on the NDI, no device failure, no index surgery failure, and no major adverse event.

Results: There were no significant differences between the TDR and ACF groups when comparing operative time (80.2 vs. 74.7 min), blood loss (40.6 vs. 41.1 cc) or length of hospital stay (2.1 days in both groups, calculated as day of discharge minus day of surgery plus one), or re-operation rate at the index level (4.4% vs. 5.3%). The overall success rate was significantly greater in the TDR group (84.0% vs. 70.7%; $p<0.01$).

In both surgical groups, the mean NDI scores (see figure), as well as the VAS pain scores, improved significantly by 6 weeks after surgery and remained significantly improved throughout 24-month follow-up ($p<0.01$). At no evaluation period was there a significant difference in NDI mean score or VAS pain scores when comparing the two groups.

Conclusion: This prospective, randomized study found that TDR had a significantly greater overall success rate compared to ACF with similar values on peri-operative measures, NDI, and VAS.

Significance: This study supports that TDR is a viable treatment alternative to ACF, producing a significantly greater overall success rate and similar peri-operative data.



Mean NDI scores improved significantly in both groups by 6 weeks ($p<0.01$) with no signifncant differences between groups.

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123. Relationship between Global Range of Motion and Clinical Outcomes in Lumbar Disc Arthroplasty Patients

Megan Gornet; John H. Peloza, MD; Elizabeth A. Jones, MD; John A. Hipp, PhD; Francine W. Schranck, BSN
United States

Summary: Increased spinal motion after lumbar disc arthroplasty (LDA) helps to explain improved clinical outcomes.

Introduction: A goal of LDA is to restore and/or maintain normal lumbar spinal motion for patients with degenerative disease. Thus, improved global range of motion (GROM) following LDA may be a simple metric for overall functional benefit, but an association with other accepted clinical outcome scores is not well documented.

Methods: At a single center, 96 LDA patients from the prospective randomized IDE (n=38), the continued access (n=43), and the continued access metal ion (n=15) studies for a metal-on-metal lumbar disc prosthesis. Follow up to 5 years is ongoing. ODI, numeric back and leg pain scores, total rotation (L1 to S1) during a flexion-extension test, intervertebral rotation, disc height and lordosis (disc angle) were measured at pre-op, 2 and up to 5 years using validated, computer-assisted methods.

Results: There were highly significant improvements in all outcome scores ($P<0.0001$), with 81% of patients having >15 point improvement in ODI at 5 years. There was a highly significant improvement in GROM from 31 +/-18 degrees at pre-op to 49 +/-14 degrees at 5 years ($P<0.002$). Using the lower limit of the 95% CI for GROM measured in an independent study of 161 asymptomatic volunteers as a reference (<33 degrees is abnormal), 59% of patients had abnormally low pre-op motion; only 4% had low motion 5 years post-op. At 2 years, 36% of patients had below normal range of motion. On a per-patient basis, the change in GROM was significantly greater at 36 and 60 months compared to the change measured at 24 months ($P<0.0001$), with no significant differences between 36 and 60 months($P>0.99$, Figure 1). There were significant ($P<0.04$) but weak ($R2<0.15$) negative correlations between back pain and leg pain scores and global ROM at the 5-year follow up. This suggests that patients with less back and leg pain have greater overall ROM. There was no significant relationship between ODI and GROM at 5 yrs post-op ($P=0.09$).

Conclusion: Lumbar disc arthroplasty can dramatically improve global range of motion, although this improvement may take several years in some patients. There is also a significant negative association between overall motion and pain scores post-operatively, although this association can explain only a small part of the improvement in clinical outcomes.

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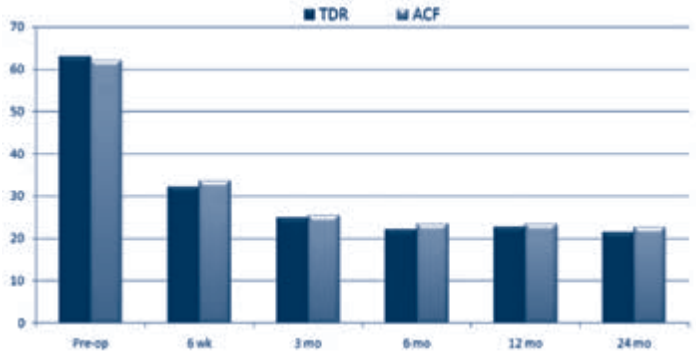

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124. Demographics, Clinical and Radiographic Results of Kyphoplasty. Follow Up from Two Weeks to Five Years

Vivek Mohan, MD, MS; Fernando Techy, MD; Robert C. Ryu, MD; Charles C. Paik, MD; Anis Mekhail, MD
United States

Summary: Retrospective case series of 82 patients that looks at the demographics, radiographic and clinical outcomes, time for improvement, recurrent fractures and other complications of kyphoplasty.

Introduction: In spite of recent prospective, randomized, placebo controlled studies showing no difference between vertebroplasty and a sham operation, vertebral filling for osteoporotic fractures continues to be widely used with excellent results. This study was performed to better understand the demographics and outcomes of kyphoplasty, identify risk factors for complications, understand the timing of symptom improvement after the procedure, and correlate vertebral height correction with clinical improvement.

Methods: Eighty-two patients underwent kyphoplasty and were followed clinically and radiographically at 2, 4, 9 weeks and 1 year. SF-36 scores were collected 3 to 5 years post-operatively. Several variables were then analyzed to better understand the demographics, clinical and radiographic outcomes, risk factors for new fractures and other complications. Data analysis utilized the student's t-test.

Results: Maximal improvement in the VAS was seen at 2 weeks in 90% of patients, and at 9 weeks, 100% reached maximal improvement. After 1 year, 50% of patients had passed away or were unreachable. At 1 year follow up, 27% of patients had recurrence of back pain (24 % new vertebral fractures and 3% back pain with no associated new fracture). Fractures at the adjacent level accounted for 50% of the new onset fractures. Female gender was a significant risk factor for recurrent back pain at 1 year. Age, number of levels, and location of level did not show significant correlation with recurrent back pain after 1year. Females responded better to the treatment (VAS scores) ($p=0.0095$), and recovered faster overall ($p=0.0082$). Older patients had more recurrent fractures ($p=0.0172$) and fractures at more caudal levels ($p=0.004$). Finally, the amount of radiographic reduction after kyphoplasty did not correlate with clinical outcome.

Conclusion: This study enables us to better understand the demographics and outcomes of kyphoplasty, identify risk factors for recurrence of back pain, and discern the timing for symptom improvement after the procedure. It also showed no correlation between the amount of vertebral height correction and clinical outcomes.

Significance: Level of Evidence: IV. Case Series. This study helps to better understand the demographics and outcomes of kyphoplasty.

125. Post-Operative Improvement In Health Related Quality Of Life: A National Comparison Of Surgical Treatment For Focal (1-2 Level) Lumbar Spinal Stenosis Compared To Total Joint Replacement For Osteoarthritis (OA)

Y. Raja Rampersaud, MD, FRCSC; Eugene K. Wai, MD, MSc, CIP, FRCSC; Edward Abraham, MD, FRCSC; David I. Alexander, MD, FRCSC; Roderrick Davey, MD, FRCSC; Marcel F. Dvorak, MD; Joel Finkelstein, MD, FRCSC; Charles G. Fisher, MD, MHSc; Rajiv Gandhi, MS, MD, FRCSC; Stephen J. Lewis, MD, MSc, FRCSC; Nizar Mahomed, MD, ScD, FRCS(C); William Oxner, MD FRCSC; Albert Yee, MD, FRCSC
Canada

Summary: The results of this national cohort study demonstrate that significant improvement in physical health related quality of life (pHRQOL) following surgical treatment of focal lumbar spinal stenosis (FLSS) is consistently achieved nationally. Furthermore, the overall improvement is equivalent to knee replacement, but inferior to hip replacement.

Introduction: The results of highly controlled studies or small single centered studies are often not generalizable on a national perspective. The primary purpose of this study is to nationally compare the relative improvement in quality of life after surgical intervention for focal lumbar spinal stenosis (FLSS) compared to hip and knee OA.

Methods: A multicenter retrospective cohort study was performed. The primary outcome measure was change in SF-36 - Physical Component Summary (PCS) score. A cohort of primary 1-2 level spinal decompression (n=389) with (n=224 /389) or without instrumented fusion for FLSS (n=179 with degenerative spondylolisthesis) with a minimum of 2 year follow-up were compared to a cohort of primary THA(n= 178) and TKA(n=235) for OA(n=413) using multivariable regression modelling.

Results: Mean age (yrs) / percent females for spine; hip; knee groups were 63.3/58.5; 66.0/46.9; 65.8/64.3 respectively. All groups had significant improvement of baseline PCS ($p<0.001$). (Table 1) Unadjusted change in PCS was superior for hips, however, there was no difference in knee compared to spine outcomes. Univariate predictors ($p<0.01$) of greater PCS change included younger age, higher baseline MCS, lower baseline PCS, fusion, spondylolisthesis and geographic site. No one specific site was better than the other and the difference between sites was not clinically significant. Multivariable regression analysis revealed that THA resulted in superior change in PCS, spines were equivalent to TKA. Similar finding was noted regarding the number of patients reaching minimal

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clinical important difference (MCID) and substantial clinical benefit (SCB).

Conclusion: Significant improvement in HRQOL following surgical treatment of FLSS is consistently achieved nationally. The overall change in PCS for FLSS is equivalent to TKA, but inferior to THA.

126. Identifying Predictors of Worsening ODI Scores after Lumbar Spine Fusion

Jeffrey D. Stimac, MD; Leah Y. Carreon, MD, MSc; Steven D. Glassman, MD
United States

Summary: Net deterioration of ODI after lumbar fusion occurred in only 28 of 1054 patients (2.6%). This may be related to smoking, depression, worker's compensation, nonunion and the presence of other disease processes in the spine.

Introduction: Physicians are often asked "What are the chances that a patient could be worse after surgery?" Although deterioration after surgery is not defined by a single parameter, an absolute decrease in ODI may be a reasonable definition. To our knowledge, patients who had a worsening in ODI following spinal fusion to determine characteristics that may lead to this poor outcome have not been studied.

Methods: From 1054 patients who had a lumbar fusion for degenerative spine conditions from a single spine clinic who had prospectively collected outcome scores with a minimum two year follow-up, patients who had a worsening of ODI scores from pre-op to two years post-op were identified. ODI worsening was defined as a negative net change in score. Data evaluated included age, sex, diagnosis, duration of symptoms, comorbidities, BMI, surgical history, work status, smoking history and psychosocial stressors.

Results: 28 patients (2.6%) had a worsening of ODI at two-years post-op with 13 males and 15 females, mean age of 43.3 yrs. 50% were smokers. The mean change in ODI was -8.4 (range -2 to -30). Mean duration of symptoms was 40 months. Common medical comorbidities included obesity (26%) and hypertension (43%) with a mean Charleson Co-morbidity Index of 2.2. Mean BMI was 26.3 kg/m2. 50% were on worker's compensation. 32% of patients reported psychosocial stressors. 54% of patients had prior spine surgery. Peri and post-operative complications occurred in 57%. Pseudoarthrosis was the most common complication (28%). Other complications included wound infection (7%), dural tear (7%) and nerve root injury (4%). 75% of patients required an additional intervention, including epidural injections (39%), refusion (42%) and cervical spine fusion (28%).

Conclusion: ODI Net deterioration after lumbar fusion occurred in 28 of 1054 patients (2.6%). Pre-operative risk factors such as smoking, depression and worker's compensation were common. Pseudoarthrosis requiring revision was also common, as well as a relatively high frequency of cervical fusions. In conclusion, it is rare that a patient is worse after surgery and this may be related to smoking, depression, worker's compensation, nonunion and the presence of other disease processes in the spine..

127. Instrumented Lumbar Corpectomy and Spinal Reconstruction Comparing rhBMP-2/Compression Resistant Matrix (CRM), rhBMP-2/Absorbable Collagen Sponge (ACS)/Ceramic Granules Mixture and Autograft in Two Different Devices- A Sheep Study

David G. Schwartz, MD; Jeffrey M. Toth, PhD; Jean-Pierre Mobasser, MD; Joseph Riina, MD; Eric Potts; Shane Rose; Kathy Flint, MSN
United States

Summary: A sheep lumbar corpectomy model was used to determine the fusion capabilities of rhBMP-2 and autograft in a titanium mesh or PEEK conduit. Four treatment groups were used and fusions were evaluated based on radiographic, CT and histology results. The rhBMP-2/CRM and rhBMP-2/ACS/granules mixture had the highest fusion rate (100%) compared to autograft (75%).

Introduction: The purpose of this study was to compare the fusion capabilities of two different formulations of rhBMP-2 to autograft in a sheep lumbar corpectomy model using two different conduits.

Methods: Twenty-four mature sheep were divided into 6 equal treatment groups and received lumbar corpectomy via lateral retroperitoneal trans-psoas approach. Spines were reconstructed with either autograft, rhBMP-2 on a Compression Resistant Matrix (CRM) (total dose: 2.15 mg rhBMP-2; 2.5 mL of 0.86 mg/mL rhBMP-2 solution on 5 cc CRM) or rhBMP-2 on an Absorbable Collagen Sponge (ACS) mixed with ceramic granules (15%Hydroxyapatite/85% β-Tricalcium Phosphate) (total dose: 1.08 mg rhBMP-2; 2.5 mL of 0.43 mg/mL rhBMP-2 solution on ACS mixed with 2.5 cc Ceramic Granules). Grafting material was distributed on either a titanium mesh or PEEK conduit in spines with internal fixation. Spines were evaluated by radiography, CT scan and histology with corresponding microradiography. Radiographs and CT scans were evaluated by 4 spine surgeons and 1 neuroradiologist. Radiographic fusion was defined as continuous bone followed on CT endplate to endplate. Histologic fusion was defined as continuous bony bridging (cranial to caudal endplate) and compared the treatment effect on histologic fusion, tissue type within the corpectomy cages and amount and extent of incorporation of bone graft and graft substitutes into the fusion mass.

Results: Reconstruction with either formulation of rhBMP-2 resulted in 100% fusion regardless of conduit and continuous bone formation from endplate to endplate. Spines reconstruction with autograft achieved a 75% fusion rate.

Conclusion: Both formulations of rhBMP-2 achieved a higher fusion rate compared to "gold standard" autograft. Bone quantity was greatest in the 2.15 mg rhBMP-2/CRM group.

Significance: rhBMP-2 and autograft was able to reconstruct the spine. Ceramic granules used with rhBMP-2 were almost completely incorporated. Using either concentration of rhBMP-2 resulted in the length of the defect (4-6 cm) filling with solid bone.

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128. The Use of a Bipolar Sealer For Haemostasis in Spinal Surgery

Viviana F. Paliotta, MD
Italy

Summary: The bipolar sealer system used in spinal surgery is an excellent tool to reduce intraoperative blood loss , tissue damage and smoke production in major spinal surgery leading to faster recovery of the patient, better wound healing and lower complication rates .

Introduction: Authors used a new bipolar sealer system (for electrocoagulation in major orthopaedic surgery such as total hip and knee arthroplasty and spinal surgery.The bipolar sealer is an electrosurgical device which delivers radiofrequency energy to saline for haemostatic sealing and coagulation of soft tissue at the operative site providing haemostasis at much lower temperatures than conventional electrocautery (<100°C).

Methods: Since October 2004 through June 2007 the authors conducted a randomized study on 200 patients to compare the clinical outcomes in two groups. In the study cohort the bipolar sealer device was used, in the matching group conventional electrocautery. Both cohorts were evaluated for intraoperative blood loss, transfusion rate, postoperative drainage, number of transfusions and haemoglobin levels. Patients with known coagulation and peripheral circulation disorders were excluded. No preoperative autologous blood donation was utilized.

Results: All patients recovered without complications and no re-operations became necessary in both groups. A significant reduction in post-operative and total blood loss (p=0.05 and p=0.02, respectively) occurred, as well as absence of tissue charring and smoke production in the bipolar sealer group. The mean decline in haemoglobin was significantly lower for the treatment group compared to the control group. The allogenic blood transfusion rates were extremely low in both groups (4.4% control vs. 0% treatment group). The mean volume of post-operative drainage was 451milliliters (range, 1500 to 815milliliters) for the standard electrocautery group and 256milliliters (range, 0 to 743milliliters) for the bipolar sealer group (p=0.002).

Conclusion: Results suggest that use of this bipolar sealing device is at least as effective as standard cautery devices and may reduce blood loss, tissue damage and smoke production in major orthopaedic surgery without affecting outcome.

Significance: Lesser bleeding results in faster recovery of the patient, better wound healing and lower complication rates

129. Metabolic Syndrome (MetS) Increases the Risk of Prevalent Spine Osteoarthritis

Rajiv Gandhi, MS, MD, FRCSC; Kenneth Woo; Y. Raja Rampersaud, MD, FRCSC
Canada

Summary: In this observational cohort study of 1502 patients (referred for surgical consultation), the associated risk factors of metabolic syndrome of MetS where found to are more prevalent in those with spinal OA causing neurological symptoms compared to those with spondylosis causing axial pain.

Introduction: Metabolic syndrome (MetS) has been shown to be a risk factor for chronic diseases such as osteoarthritis (OA). Moreover, the MetS risk factors (central obesity, diabetes, hypertension and dyslipidemia) are known to have independent relationships to degenerative joint disease. The relationship between spinal OA and the MetS has not been studied previously. The purpose of this study was to determine if the prevalence of severe spinal osteoarthritis (OA) increases with the number of metabolic syndrome (MetS) risk factors.

Methods: This retrospective, cross-sectional study used data from a single surgeon, high volume, spine surgery practice between the years of 2002-2007. Primary outcome measures were demographic data including the components of the MetS risk factors. Prevalent severe OA was defined as degenerative spondylolisthesis or cervical or lumbar stenosis causing neurologically based symptoms, and early OA as those with lumbar and cervical spondylosis causing axial pain only. Logistic regression modeling was used to determine the odds (adjusted for age and sex) of having severe spine OA with an increasing number of the MetS risk factors.

Results: In our cohort of 1502 patients, there were 839/1502 (55.9%) patients defined as severe spinal OA and 663/839 (44.1%) patients with early OA. The overall prevalence of MetS was 30/1502 (2.0%), 26/839 (3.1%) in the severe OA group and 4/663 (0.6%) in the early OA group.(p= .001) Logistic regression showed that those with all 4 MetS risk factors had almost 4 times greater odds of having severe OA as compared to those with no MetS risk factors [OR 3.9,(1.4, 11.6), p= .01].

Conclusion: The components of MetS are more prevalent in those with severe spinal OA causing neurological symptoms compared to those with spondylosis causing axial pain. Future work should examine for an association between MetS and incident of spine OA in the symptomatic general spine population.

130. Spine Surgery at an Ambulatory Surgery Center

Kenneth A. Pettine, MD; Lukas Eisermann, BS
United States

Summary: Spine surgeries performed at an ASC were evaluated for safety and efficacy.

Introduction: Every spine surgery performed at an ASC from spring 2005 through 2008 was prospectively evaluated.

Methods: Cervical surgeries (257) included posterior cervical fusion (7), artificial disc replacement (57) one, two, and three level cervical fusions (193). Lumbar surgeries (733) included anterior fusion (9), posterior fusion (298), artificial disc replacement (83), SI joint fusion (6)and decompression\discectomy (377). Lumbar oswestries (ODI), neck disability indexes (NDI) and visual analog scale (VAS) were evalutated pre and post op. Minutes in the operating room, recovery room and convalescent center were also evaluated.

Results: Cervical fusions had no perioperative complications or unplanned transfers with statistically significant improvement in NDI and VAS scores (p<0.01).

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Cervical artificial disc replacements had statistically significant improvement in NDI and VAS at two-year follow-up (p-value<0.02) with no complications or unplanned transfers. Lumbar artificial disc replacements had one arterial thrombosis requiring transfer to the hospital for thrombectomy and two patients returned to the OR. The change in the patients' ODI and VAS was statistically significant (p-value<0.001) at three-year follow-up.

Non-instrumented lumbar surgery resulted in one patient returning to the OR. All patients undergoing an anterior cervical fusion, cervical and lumbar artificial disc replacement and non-instrumented lumbar spine surgery were released home within 24 hours of their surgery.

Posterior lumbar fusion performed with pedicle screws, TLIF and posterolateral fusion had an overall 4.3% complication rate including return to the OR (3), unplanned hospital transfers (5), unplanned rehab transfers (2) and three post operative complications. Patients stayed in the convalescent center attached to the ASC for an average of 48 hours. They did experience statistically significant improvement in post operative follow-up (p-value<0.03).

Conclusion: All spine surgeries reviewed can be safely performed with efficacy at an ASC. Lumbar fusion performed with pedicle screws required a 48-hour stay. All other surgeries were discharged within 24 hours.

Significance: These findings have potentially signigicant implications in the future of spine care.

131. The 15-Year Evolution of the Thoracoscopic Anterior Release: Does it Still Have a Role?

Rattalerk Arunakul; Alexander B. Peterson; Eric S. Varley, DO; Peter O. Newton, MD
United States

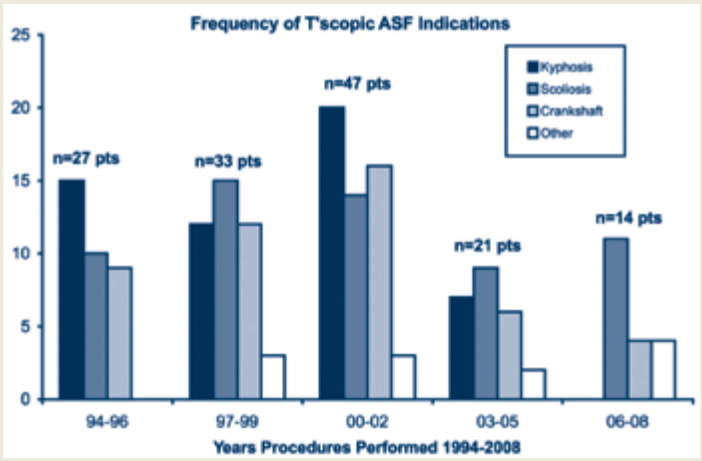
Summary: 142 pediatric spinal deformity patients from 1994-2008 who received thoracoscopic anterior release/fusion demostrated a decline in the frequency of the procedure over time. Hyperkyphosis as an indication for the technique has been eliminated. Crankshaft prevention and large scoliotic deformities remain indications for thoracoscopic release/fusion at our center.

Introduction: Prior to the advent of segmental pedicle screw fixation, anterior release was performed for severe spinal deformity. The thoracoscopic approach significantly reduced the morbidity compared to open thoracotomy procedures. While a decrease in the frequency its use has been obseerved, A single site's experience was reviewed to determine the indications for anterior thoracoscopic release and fusion have evolved over time.

Methods: A retrospective single-center chart and radiograph review of pediatric spinal deformity patients from 1994-2008 undergoing thoracoscopic anterior release/fusion (with subsequent posterior instrumentation) was performed. Indications for the thoracoscpic procedure were assigned to one of four categories: hyperkyphosis, large/stiff scoliosis, crankshaft prevention, and "other" (e.g. pseudoarthrosis prevention, thoracic lordosis). Indications were grouped into three-year intervals and a descriptive analysis was performed to determine how the indications for this procedure have evolved over the past 15 years.

Results: A total of 142 patients (age: 15 years, 2-28) underwent the procedure. These patients had 172 identified indications for their thoracoscopic procedures. The frequency of performing a thoracoscopic anterior release has decreased after reaching a peak in the years 2000-2002. Initially, hyperkyphosis was the most frequent indication and since 2006 this has not been an indication for the procedure. The use of thoracoscopy to prevent crankshaft has also declined, but remains an indicaiton for the most imature cases. Severe (ave. 81°, 70 -110°) or rigid scoliosis (bend > 50°) continues as an indication at our center, with this now the most common reason for performing a thoracoscopic release/fusion.

Conclusion: The indications for a thoracoscopic anterior release/fusion have evolved as both our understanding of this procedure and posterior fixation with pedicle screw instrumentation have improved. While less common than in the past decade, there remains an important role for thoracoscopy in select spinal deformity patients.



132. Scoliosis Surgery in Patients with Adolescent Idiopathic Scoliosis Does Not Alter Lung Volume: A Three-Dimensional CT Based Study

Terry Amaral, MD; Etan P. Sugarman, MSIV; Adam L. Wollowick, MD; Beverly Thornhill, MD; Vishal Sarwahi, MD
United States

Summary: CT scans were used to determine pre- and post-operative lung volumes. Significant changes were noted in the posterior hemithoracic asymmetry ratio and the convex to concave lung height ratio. The difference in total lung volume was not significant.

Introduction: CT-based studies of lung volume in AIS patients have previously shown differences in total lung volume and convex-to-concave lung volume ratio compared to normal patients. PFT's in patients with AIS are abnormal before surgery and improve after surgery. The anatomical basis of this is unclear. To date, no study exists that has used CT scans to analyze these parameters following AIS surgery.

Methods: A retrospective chart and image review was conducted to assess changes in lung volume and lung size following AIS surgery. CT scans were performed on either a 64-slice scanner (0.625 mm slice thickness) or a 16-slice scanner (2 mm slice thickness). The raw

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data obtained was reformatted on the Aquarius Workstation followed by three-dimensional lung volumetric reconstruction using TeraRecon software.

Results: Twelve patients met criteria for inclusion in the study (average age 14.8 years). The mean Cobb angle was 49.4°preoperatively and 9.5° postoperatively (p = <0.0001). The mean number of levels fused was 11.5. The mean lung volume was 1898 cc preoperatively and 1815 cc postoperatively (p = 0.326). The left to right lung volume ratio was 0.85 preoperatively and 0.89 postoperatively (p = 0.084). The mean posterior hemithoracic asymmetry ratio was 0.60 preoperatively and 0.67 postoperatively (p = 0.0001). The mean concave to convex lung height ratio was 0.93 preoperatively and 0.99 postoperatively (p = 0.018). We did not find a significant correlation between change in lung volume and change in Cobb angle, kyphosis, or apical vertebral rotation.

Conclusion: Improvement in pulmonary function following posterior spinal fusion for AIS is likely due to restoration of thoracic and lung symmetry with improvement in the mechanics of respiration as opposed to an improvement in total lung volume or left to right lung volume ratio.

Significance: The reasons for improvement in pulmonary function following AIS surgery are unclear. This study provides a novel, CT-based explanation for this finding which challenges traditional theories.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an 'off label' use).

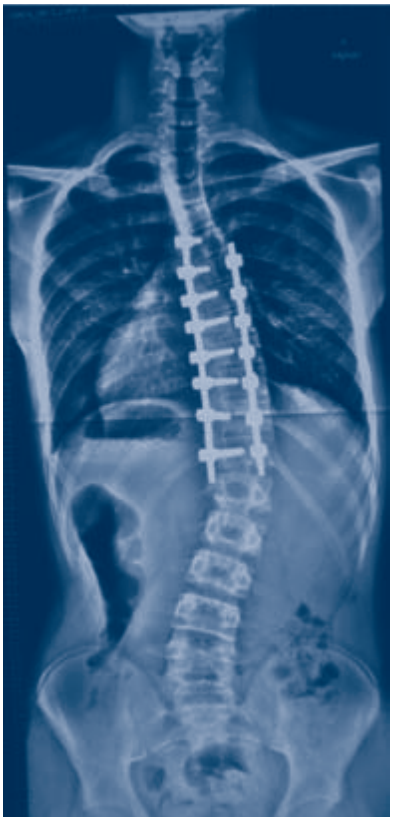
133. Instrumenting Proximal to the Left Bending Stable Vertebra in Lenke IA and IB Adolescent Idiopathic Scoliosis Predicts Adding On

Hossam Salah, MD, FRCS; Hazem B. Elsebaie, FRCS , MD; Ahmed Ezz
Egypt

Summary: A retrospective analysis of Lenke IA and IB AIS cases was performed. The lower end vertebra, the stable vertebra, the neutral vertebra, the left bending stable vertebra and lower instrumented vertebra were recorded. Latest x-rays were sought for adding on. Instrumenting proximal to the left bending stable vertebra had an 83% incidence of adding on.

Introduction: Adding on denotes the inclusion of additional vertebra into the major curve distal to the lower instrumented vertebra. Selection of the distal level of fusion seems to be a key factor in the prevention or otherwise of this phenomoenon.

Methods: 56 patients with Lenke IA and IB adolescent idiopathic scoliosis had their radiographs retrospectively reviewed. There were 52 females and 4 males. The mean age at the time of surgery was 14.2 years. The following data were documented: the lower end vertebra(LEV), the stable vertebra(SV), the neutral vertebra (NV), the most proximal lumbar vertebra bisected by a central sacral perpendicular line in the supine left side bending films, we designated the left bending stable vertebra(LBSV), and the lower instrumented vertebra(LIV). The presence of adding on below the fused segment was searched for in the latest follow up radiographs. The mean follow up was 35.4 months with a minimum of 26 months.



Results: the LBSV was proximal to the SV in 42 patients (75%). Five patients (9%) showed adding on in their latest radiographs. All patients that had their LIV at or distal to the LBSV were balanced without adding on. On the other hand, five out of the six patients (83%) who had their LIV proximal to the LBSV developed adding on at the latest follow up.

Conclusion: The assessment of the left bending stable vertebra (LBSV) can be used as a guide to determine the lower instrumented vertebra in the Lenke IA and IB AIS. This can allow saving levels in the proximal lumbar spine while achieving coronal balance and avoiding the risk of adding on.

Significance: A guide to selecting the lower instrumented vertebra in Lenke IA and IB AIS and a predictor of adding on is presented in this series.

3 year postop xray showing the development of adding on distal to the fusion. Earlier xrays showed neutral lumbar vertebrae without tilting distal to the instrumentation.

134. Melatonin Modulates the Proliferation and Differentiation of Human Growth Plate Chondrocytes

Guangquan Sun, PhD; Hiu Yan Yeung; Wei-jun Wang; Kwong-man Lee, PhD; Zhen Liu; Yong Qiu, MD; Jack C. Cheng, MD
Hong Kong

Summary: Girls with adolescent idiopathic scoliosis (AIS) were shown to have abnormal systemic skeletal growth during peripubertal period. Reports have suggested that melatonin might play an important role in bone formation and could be related to the etiopathogenesis of AIS.

Introduction: Though melatonin receptors were found in resting and hypertrophic chondroctyes, the role of melatonin in chondrocytes and endonchondral ossification is not clear. We hypothesize that melatonin may play a role in modulating chondroctye activity which in turn could affect the process of endochondral ossification. The present pilot study was aimed to investigate the role of melatonin on the proliferation and differentiation of human growth plate chondrocytes (GPC).

Methods: Growth plate chondrocytes were isolated from aborted human fetus after obtaining

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proper consent. Melatonin receptor expressions (MT1 and MT2) on GPCs were detected by immunofluorescence technique. Effect of melatonin on the proliferation of GPC were studied under different concentrations of melatonin in the presence/absence of melatonin antagonist (pertussis toxin and 4P-PDOT). The effect of melatonin on differentiation was assessed through collagen type X gene and alkaline phosphatase gene expression in GPCs after treated with different concentration of melatonin for 2 weeks. The levels of mRNA expression of the two genes were determined by RT-PCR.

Results: Both MT1 and MT2 receptors were expressed in isolated GPCs. The GPC proliferation was significantly inhibited by melatonin. The inhibitory effect was blocked partially by pertussis toxin and 4P-PDOT. Melatonin increases the mRNA level of collagen type X and alkaline phosphatase in differentiated GPCs.

Conclusion: These findings indicated that melatonin could inhibit the proliferation and stimulate differentiation of GPC in human. Both MT1 and MT2 membrane receptors in GPC were involved in mediating the proliferative effect of melatonin.Based on the present findings, further studies are warranted to further uncover the pathophysiological mechanism on how melatonin modulates endochondral ossification.

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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: Biomechanical Comparison of Force Levels in Spinal Instrumentation Using Monoaxial vs. Multi Degree of Freedom Post-Loading Pedicle Screws
Xiaoyu Wang, PhD; Carl-Eric Aubin, PhD, PEng; Hubert Labelle, MD; Dennis Crandall, MD
Canada

#203: Less-Invasive Anterior Correction and Fusion for Idiopathic Thoracolumbar Scoliosis
Hitoshi Kono; Hironobu Watanabe; Naobumi Hosogane; Masafumi Machida, MD; Masashi Saito; Shinjiro Kaneko; Kiyohiro Nakamichi
Japan

#204: Surgical Treatment of Spinal Deformities Due to Neurofibromatosis (NF) with a Ten-Year Follow-Up
Yuji Matsubara; Noriaki Kawakami, MD; Yoshitaka Suzuki; Taichi Tsuji, MD
Japan

#205: Clinical and Radiographic Outcome of the NeoDisc Cervical Total Disc Replacement (TDR) at Two-Year Follow-Up
Kenneth A. Pettine, MD
United States

#206: Effect of Multi-Rib Osteotomy on Pulmonary Functions after Correction of Adolescent Scoliosis
Abla M. Hamed, MD; Youssry El Hawary
Egypt

#207: Distal Stop at T12 vs L1 for Posterior Spinal Instrumented Fusion in Adolescent Idiopathic Scoliosis; Are they different?
Yongjung J. Kim, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Oheneba Boachie-Adjei, MD; Jean-Luc Clement, MD; Youngbae B. Kim, MD, PhD; Samuel K. Cho, MD
United States

#208: Postoperative Left Shoulder Elevation in Patients with Non-Structural Proximal Thoracic Curves: Can it be Prevented in Patients with Preoperative Right Shoulder Elevation?
Ahmet Alanay, MD; Cagatay Ozturk, MD; Selhan Karadereler; Levent Ulusoy; Meric Enercan; Azmi Hamzaoglu, MD
Turkey

#209: Stable Vertebra for Surgical Management of Thoracic Adolescent Idiopathic Scoliosis (Lenke Type 1 and 2): How Much Stable is Enough?
Yongjung J. Kim, MD; Lawrence G. Lenke, MD; Keith H. Bridwell, MD; Munish C. Gupta, MD; Oheneba Boachie-Adjei, MD; Jean-Luc Clement, MD; Samuel K. Cho, MD; Thomas D. Cha, MD, MBA; Charla R. Fischer, MD
United States

#210: Reproducibility of 3D Reconstruction from Biplanar Radiographs for Severe Scoliosis Above 50°
Jean-Sébastien Steffen; Jean M. Vital; Jean Dubousset; Wafa Skalli, PhD
France

#211: Analysis of Adjacent Segment Re-Operation Following Lumbar Total Disc Replacement
Scott L. Blumenthal; Scott Rainey; Richard D. Guyer, MD; Jack E. Zigler, MD; Donna Ohnmeiss, PhD
United States

#213: Defining Two Components of Shoulder Imbalance: Clavicle Tilt and Trapezial Prominence
Takashi Ono, MD; Tracey Bastrom, MA; Peter O. Newton, MD; Harms Study Group
Japan

#214: The Changes of Relative Position of the Aorta to the Vertebra after Posterior Instrumentation in AIS with Right Thoracic Curve
Yoshiyuki Okada; Koki Uno, MD, PhD; Hiroshi Miyamoto, MD; Yoshihiro Inui; Teppei Suzuki; Takuto Kurakawa; Minoru Doita, MD
Japan

#216: Assessment of Pedicle Screw Placement Using Intraoperative Computed Tomography in Complex Adult Deformity Patients
Lukas P. Zebala, MD; Jacob M. Buchowski, MD, MS; Woojin Cho, MD, PhD; Keith H. Bridwell, MD
United States

#218: Cervical Pedicle Screw Placement Using O-Arm Based Navigation System
Tokumi Kanemura, MD; Yoshimoto Ishikawa; Go Yoshida; Zenya Ito; Ryoji Tauchi; Akio Muramoto, MD; Shuichiro Ohno
Japan

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Exhibit Hall Floorplan & Booth Numbers

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Alphatec Spine, Inc.	603/605
Apatech	304
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Biospace Med	606
Brainlab	601
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Spine View, Inc.	303
Stryker	401/403/405
Trans1	300
Vexim SAS	302
X-Spine	502
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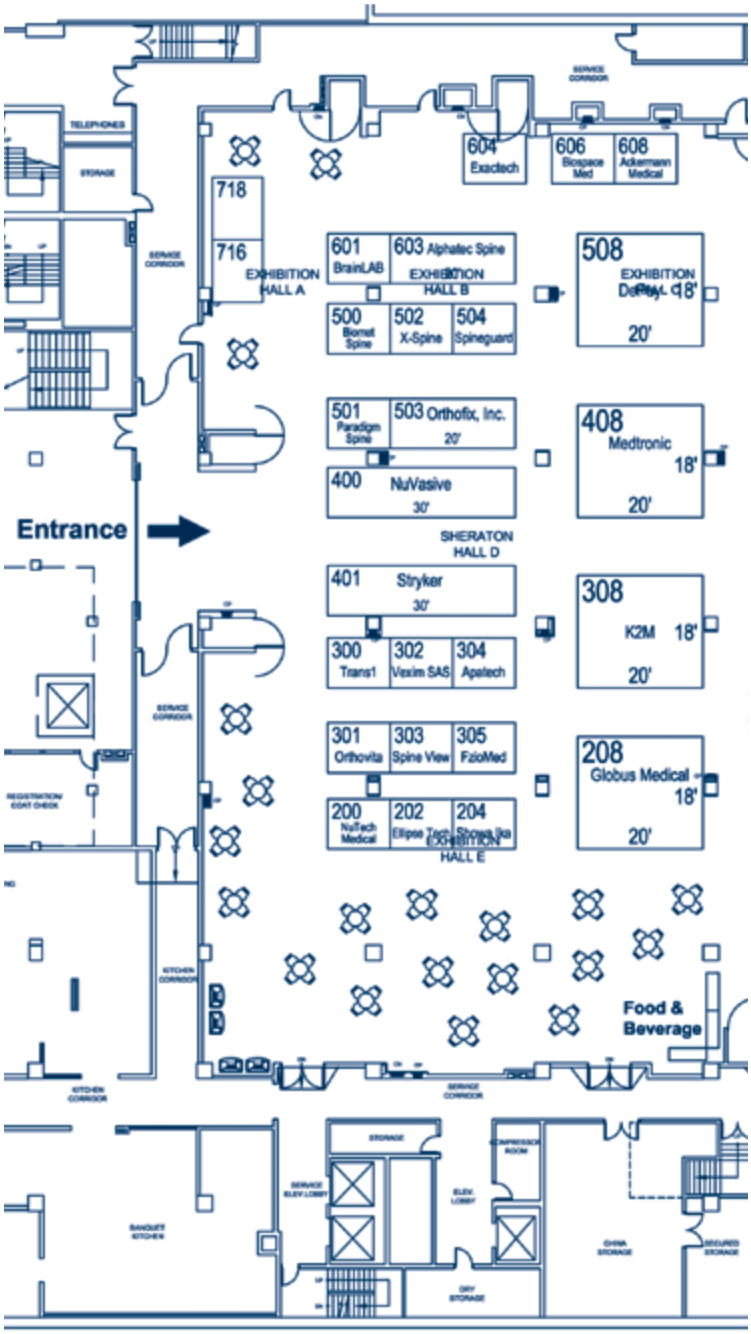

Exhibits and Hands-On Sessions

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From its modest beginnings over 50 years ago, Ackermann Instrumente has grown into an instrument company well placed to become a market leader in its product fields. The name of Ackermann Instrumente is inseparably linked to surgical technology and remains at the forefront of tomorrow's technological breakthroughs. Ackermann has over five decades experience in serving the human community, focused and striving towards a perfect environment of medical science and technology. The medical equipment manufactured by Ackermann results from a close collaboration between practicing surgeons and specialists, working together in concert, to establish the most effective directions for the company's continual process of development. Thus, Ackermann Instrumente is focused on several international markets, and has successfully obtained a range of unique products. In addition to continuous R&D, the company prides itself on an extremely short product to market cycle, which has brought Ackermann a significant market share in thefast changing medical device market.

Alphatec Spine, Inc.

5818 El Camino Real
Carlsbad, CA 92008
USA
Tel: 1-760-494-6720
Fax: 1-760-431-1624
www.alphatecspine.com

Alphatec Spine's mission is to be the leading global independent, full-line spine company, with a focus on solutions for the aging spine. Our goal is to improve the aging patient's quality of life. The recent acquisition of Scient'x increases our global reach to include distributors in over 50 countries, including a direct sales force in France, Italy and the UK, making Alphatec Spine the largest independent spine company outside of the US and the seventh largest spine company globally. Collectively, Alphatec Spine and Scient'x have over 20 years of experience developing innovative spine solutions:

- Isobar® Dynamic Rod System – implanted in 7,000+ patients
- Discocerv ® Ceramic Cervical Disc – implanted in 3,000+ patients
- OsseoFix™ Spinal Fracture Reduction System – implanted in 1,000+ patients

ApaTech

2 Hampshire Street
Foxborough, MA 02035-2896
USA
Tel: 1-508-543-0700
Fax: 1-508-543-5551
www.apatech.com

ApaTech® is a world leader in bone graft technologies that specializes in the development, manufacturing and commercialization of synthetic bone graft technologies. It has operations in London, England; Foxborough, Massachusetts, USA and Berlin, Germany, and sells its products in over 33 countries around the world. The company developed Actifuse®, a 100% synthetic osteostimulative bone graft substitute based on a patented silicate substitution process, for accelerated bone formation. As an alternative to autograft, Actifuse® is ready to use without the need for a secondary surgical site. Actifuse® can be used in a variety of surgical procedures including posterior lateral fusions and is available as a microscopic granule (Actifuse® Granules and Actifuse® Microgranules), easy to use putty formulations (Actifuse® ABX and Actifuse® E-Z-Prep), and a ready to use moldable formulation (Actifuse® Shape) and in an MIS applicator system (Actifuse® MIS System) that provides precise placement and an extended reach.

Biomet Spine

100 Interpace Parkway
Parsippany, NJ 07054
USA
Tel: 1-973-299-9300
Fax: 1-973-299-0391
www.biometspine.com

Biomet Spine is on the cutting edge worldwide, with innovative products that help surgeons reduce pain and improve mobility. Engineering excellence is our heritage and our passion and we are committed to providing the most complete product offering in the industry. Our portfolio of products features breadth of line and depth of experience across all segments of spine applications… Thoracolumbar: Deformity, Posterior and Anterior; Cervical: Anterior and Posterior; Spacers: Cervical and Thoracolumbar; Minimally Invasive Surgery: Lumbar; Bone Growth Technologies: Stimulation, Synthetics, DBM and Allograft; Vertebroplasty: Material Delivery; and Bracing: Thoracolumbar and Cervical. Biomet Spine continues to build strong relationships with surgeons around the world and we invite you to visit our exhibit booth to learn more about our products while discovering how we can address individual surgeon concerns promptly, with an outstanding level of service. In the US, call 1-800-526-2579 to contact your local Biomet Spine representative. Outside the US, call 973-299-9300.

Exhibits and Hands-On Sessions

Biospace Med
10 Rue Mercoeur
Paris 75011
FRANCE
Tel: +33-0-1-5525-6060
Fax: +33-0-1-5525-6061
www.biospacemed.com

Founded by Nobel Prize winner Georges Charpak, Biospace Med has developed a breakthrough in osteo-articular imaging with EOS, an ultra low dose 2D|3D imager designed to address the needs of orthopaedic and paediatric doctors. EOS can simultaneously capture digital bi-planar, full-body X-rays with dramatic reductions in radiation. From the two planar images, EOS can generate a 3D skeletal image of the patient in a weight bearing position and automatically calculate more than a hundred clinical parameters. EOS is the result of a close and multidisciplinary interaction between Biospace Med, its academic partners, and internationally recognized experts such as spine specialist Jean Dubousset, paediatric radiologist Gabriel Kalifa and Nobel Prize winner Georges Charpak.

Brainlab
3 Westbrook Corporate Center, Suite 400
Westchester, IL 60154
USA
Tel: 1-708-409-1343
Fax: 1-708-409-1619
www.brainlab.com

Brainlab develops, manufactures and markets software-driven medical technology that enables procedures that are more precise and less invasive than traditional treatments. Among the core products are image-guided systems that provide highly accurate real-time information used for navigation during surgical procedures. This utility has been further expanded to serve as a computer terminal for physicians to more effectively access and interpret diagnostic scans and other digital medical information for better informed decisions.

Brainlab solutions allow expansion from a single system to operating suites to digitally integrated hospitals covering all subspecialties from neurosurgery, orthopedics, ENT, CMF to spine & trauma and oncology. With 3,300 systems installed in over 75 countries, Brainlab is a market leader in image-guided technology. The Brainlab group, founded in 1989, is headquartered in Munich, Germany, and employs 1,000 people in 16 offices worldwide. For more information, visit www.brainlab.com

DePuy Spine
325 Paramount Drive
Raynham, MA 02767
USA
Tel: 1-508-828-2820
Fax: 1-508-828-3027
www.depuyspine.com

DePuy Spine, Inc., a Johnson & Johnson company, stands at the forefront of the worldwide spine market offering a broad portfolio of patient-focused products and solutions backed by a robust pipeline, world-class evidence-based research, education, training and customer service. The Company has a rich heritage of partnering with leading clinicians, researchers and thought leaders to pioneer new technologies, techniques and concepts that have advanced spinal care and have helped to improve the lives of millions of people with spinal disorders. The Company, headquartered in Raynham, Massachusetts, is guided by its mission to be the most trusted and respected spine company in the world. www.depuyspine.com

Ellipse Technologies, Inc.
13844 Alton Parkway #130
Irvine, CA 92618
USA
Tel: 1-949-837-3664 ext. 20
Fax: 1-949-837-3664

Ellipse Technologies, Inc. has developed the MAGEC (MAGnetic Expansion Control) Technology for minimally invasive, and ultimately non-invasive, orthopedic deformity prevention and management. MAGEC Technology is a breakthrough medical device technology capable of non-invasively adjusting (expandable and reversible) implants from outside the body via remote control. The first application for this technology is for the treatment of spinal scoliosis in children. In addition, Ellipse plans to expand the MAGEC Technology platform to include innovative and state-of-the art treatments for a broad spectrum of orthopedic deformity uses including broad spinal applications, orthopedic trauma and genetic diseases and has filed numerous patent applications for use of MAGEC Technology for this broad range of clinical applications. Ellipse Technologies, Inc. is a privately-held medical device company located in Irvine, California.

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905 King Street West, 4th Floor
Toronto ON MGK 3G9
CANADA
Tel: 1-416-644-7090
Fax: 1-416-255-5456
www.elsevier.ca

Exhibits and Hands-On Sessions

Exactech, Inc.
2320 NW 66th Court
Gainesville, FL 32653
USA
Tel: 1-352-377-1140
Fax: 1-352-378-2617
www.exac.com
Based in Gainesville, Fla., Exactech develops and markets orthopaedic implant devices, related surgical instruments and biologic materials and services to hospitals and physicians. The company manufactures many of its orthopaedic devices at its Gainesville facility. Exactech's orthopaedic products are used in the restoration of bones and joints that have deteriorated as a result of injury or diseases such as arthritis. Exactech markets its products in the United States and Australia, in addition to more than 25 countries in Europe, Asia and Latin America. Additional information about Exactech, Inc. can be found at www.exac.com.

Globus Medical, Inc.
2560 General Armistead Avenue
Audubon, PA 19403
USA
Tel: 1-610-415-9000
Fax: 1-610-415-9144
www.globusmedical.com

Globus Medical, Inc. is the largest privately held spinal implant manufacturer in the world and is based in Audubon, Pa. The company was founded in 2003 by an experienced team of spine professionals with a shared vision to create products that enable spine surgeons to promote healing in patients with spinal disorders. Additional information can be accessed at www.globusmedical.com.

K2M, Inc.
751 Miller Drive, SE
Leesburg, VA 20175
USA
Tel : 866-K2M-4171 (866-526-4171)
Fax : 866-862-4144
www.K2M.com

K2M, Inc. is an innovative spinal device company committed to the research, development, and commercialization of simplified solutions for the treatment of complex spinal pathologies and procedures. The company is recognized as a worldwide leader in providing unique technologies for the treatment of deformity, degenerative, trauma, and tumor spinal patients. K2M's complete portfolio of next generation products includes: spinal stabilization systems, minimally invasive systems, and other advancing technologies such as motion preservation, annular repair, and nucleus replacement. K2M's dedication to the advancement of science in the area of complex spinal pathologies is represented by its development and support of the Complex Spine Study Group (CSSG), a research team of surgeon thought leaders dedicated to advancing patient care in the complex spine arena. For additional information on K2M, please visit www.K2M.com.

Medtronic Spinal & Biologics
2600 Sofamore Danek Drive
Memphis, TN 38132
USA
Tel: 1-901-399-2220
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 #408.

NuTech Medical
174 Oxmoor Road
Birmingham, AL 35209
USA
Tel: 1-205-908-8261

Nutech Medical, a biological company, specializes in innovative allograft based products. Nutech distributes conventional and machined allograft. NuCel is a proprietary adult progenitor product offering high quality cells. NuTech also developed and markets the NuFix facet fusion system as well as the spinous process interspinous fusion system, SPIF.

NuVasive
7475 Lusk Blvd
San Diego, CA 92121
USA
Tel: 1-858-909-1832
Fax: 1-858-909-2032
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: NeuroVision® 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.

Exhibits and Hands-On Sessions

Orthofix, Inc.
1720 Bray Central Dr.
McKinney, TX 75069
USA
Tel: 1-469-742-2724
Fax: 1-469-742-2722
www.orthofix.com

Orthofix's Orthopedics, Spine and Sports Medicine divisions offer innovative treatment options for adult and pediatric deformity correction, internal and external fracture fixation, biologics, bone growth stimulation, and protective and post-operative bracing.

Orthovita
77 Great Valley Parkway
Malvern, PA 19355
USA
Tel: 1-484-478-1176
Fax: 1-866-205-0146
www.orthovita.com

Paradigm Spine
Eisenbahnstrasse 84
Wurmlingen, 78573
GERMANY
Tel: +49-7461-963599-0
Fax: +49-7461-963599-20
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 features 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).

Showa IKA
8-7 Haneinishimachi
Toyohashi, Aichi 441-8025
JAPAN
Tel: 81-53-232-1543
Fax: 81-53-232-1106
www.showaika.com

Showa Ika, founded in Japan more than thirty-five years ago, is committed to coordinating the development, design, manufacturing and global distribution of spinal device systems as an assistance for better surgery. Our purpose is to provide solutions for our surgeon customers in their endeavor to improve the quality of life for patients suffering from spinal disorders. We achieve this purpose by advancing knowledge of the spine and through the engagement of our knowledgeable, experienced, professional team in an environment that fosters the core values of integrity, individual commitment, and personnel development.

SpineGuard, Inc.
301 Howard Street
Suite 970
San Francisco, CA 94105
UNITED STATES
Tel: 1-415-512-2500
Fax: 1-415-512-8004

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.

Spine View
48541 Warm Springs Boulevard, Suite 507
Sunnyvale, CA 94539
USA
Tel: 1-510-623-1931
Fax: 1-510-490-1753
www.spineview.com

Spine View, Inc. is committed to the development and commercialization of novel, minimally-invasive technologies aimed at improving spinal decompression and fusion procedures. We are introducing our next-generation enSpireTM Surgical Discectomy System, which is designed to facilitate more complete discectomies and accelerate tissue removal in interbody fusion.

Exhibits and Hands-On Sessions

Stryker
2 Pearl Court
Allendale, NJ 07401
USA
Tel: 1-866-987-7463
www.stryker.com

Stryker Spine, one of the fastest growing divisions within Stryker Corporation, invents, manufactures, and sells a full range of spinal implants for use in spinal surgeries world-wide. 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 and Instruments, to offer a comprehensive set of solutions to our surgeon customers worldwide.

TranS1
301 Government Center Drive
Wilmington, NC 28403
USA
Tel: 1-910-332-1700
Fax: 1-910-332-1701
www.trans1.com

TranS1®, Inc. is a medical device spine company focused on minimally invasive surgical procedures for the spine, designed to improve patient outcomes and surgical ease-of-use. Our primary technology is AxiaLIF, a minimally invasive access and fusion system that enables lumbar fusion to be performed with complete preservation of the annulus and all paraspinal soft tissue structures. We specialize in bringing innovative spine solutions to market including AxiaLIF and AxiaLIF 2L, technologies that allow surgeons to perform lower lumbar fusions that 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 "REBALANCING SPINE." Vexim is a European company dedicated to bring clinically and scientifically proven solutions to minimal invasive treatment of patients suffering from spinal trauma disorders. Vexim aims to develop a complete portfolio of innovative solutions to prevent and treat causes, symptoms and consequences of vertebral compression fractures. Our mission is to relieve pain, restore healthier anatomy, and to rebalance spine.

X-Spine
452 Alexandersville Road
Miamisburg, OH 45342
USA
Tel: 1-800-903-0640
Fax: 1-937-847-8410
www.x-spine.com

X-spine is a global spinal implant company dedicated to advancing spinal implant technologies that improve surgery outcomes and optimize surgeon experience. X-spine's principles of Invention, Integration and Intuition guide our product philosophy.

Zimmer Spine
7375 Bush Lake Road
Edina, MN 55429
USA
Tel: 1-800-655-2614
Fax: 1-952-832-5620

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.

Exhibits and Hands-On Sessions

Hands-On Demonstrations

Thursday, July 22, 2010

10:45 – 11:30 Hands-On Demonstrations 1A-E

1A Cervical Pathologies

K2M, Inc.	Products:	CASPIAN™ Spinal System
	Instructors:	Jacob M. Buchowski, MD, MS
		K2M will be demonstrating the latest K2M product innovation, the CASPIAN™ Spinal System and its clinical applications. The system is based on the revolutionary MESA® Zero Torque Technology and offers an all-inclusive answer for rigid posterior fixation for the occipito-cervico-thoracic regions of the spine.
Medtronic	Products:	Vertex Select, Atlantis Plates, Venture Plates
	Instructors:	David Sharp and Jared Shoup

1B Spondylolisthesis

Nuvasive	Products:	MAS®TLIF and ILIF:
	Instructors:	Juan Uribe, MD
		MAS®TLIF: Reproducible, pedicle-based minimally disruptive surgery; ILIF: The new prescription for lumbar spinal stenosis.
TranS1	Products:	AxiaLIF 360, AxiaLIF 2Lt, Avatar
	Instructors:	Isadore H. Lieberman, MD, MBA, FRCSC
		The AxiaLIF system is an ideal solution for L5/S1 Spondylolisthesis due to its ability to resist shear force. Because the AxiaLIF Rod is a dual, variable pitch screw, it provides distraction, stabilization, and shear resistance for Spondylolisthesis.

1C Early Onset Scoliosis I

1D Adult Deformity I: Degenerative

Stryker	Products:	Xia® 3 Ilios and Revision
	Instructors:	TBD
		This demonstration will focus on advanced techniques and solutions for adult degenerative deformity, using Ilios and Revision system. Participants will have the opportunity to practice different techniques, as well as to place iliac screws and will be able to evaluate new techniques for treatment, as well as discuss controversial and challenging issues.

1E Prinicples and Practice in the Treatment of Kyphotic Problems

Exhibits and Hands-On Sessions

Hands-On Demonstrations (continued...)

Thursday, July 22, 2010

13:30 – 14:15 Hands-On Demonstrations 2A-E

2A Options in Cervical Fixation and Motion

Medtronic	Products:	Prestige Discs, Bryan Disc
	Instructors:	David Sharp and Jared Shoup
Stryker	Products:	CerviCore®
	Instructors:	Henry Ahn, MD, FRCSC
		This demonstration provides a concentrated review of patient indication, surgical techniques, and the clinical results of the FDA approved US IDE trial for the CerviCore Intervertebral Disc through practical workshops.

2B Lumbar Posterior Motion Sparing

Medtronic	Products:	X-Stop
	Instructors:	Rick Thiele

2C Adolescent Idiopathic Scoliosis I

Stryker	Products:	SUK™ DVR Instrumentation and Xia® 3
	Instructors:	Se-Il Suk, MD, PhD
		This demonstration will focus on advanced techniques and solutions for correcting Adolescent Idiopathic Scoliosis using SUK™ DVR and Xia® 3. Participants will have the opportunity to practice different corrective techniques and will be able to evaluate new techniques for treatment, as well as discuss controversial and challenging issues.

2D Adult Deformity II

Globus Medical	Products:	REVERE™ Deformity, Sacral Iliac and Coupled Derotators
	Instructors:	TBD
		This HOD will review of the latest techniques and instrumentation in deformity correction featuring coupled derotation and sacral iliac fixation.
Medtronic	Products:	CDH Legacy + VCM, Illiac, PSO, MRC
	Instructors:	TBD

2E Principles and Practice in the Treatment of Metastatic Spine Disease

Exhibits and Hands-On Sessions

Hands-On Demonstrations (continued...)

Friday, July 23, 2010

8:30 – 9:15 Hands-On Demonstrations 3A-E (with refreshments & snacks)

3A Cervical Trauma

Medtronic	Products:	Vertex Select, Atlantis Plates, Venture Plates
	Instructors:	David Sharp and Jared Shoup

3B Lumbar Posterior Fusion Options/Instrumentation (Degenerative)

Globus Medical	Products:	TRANSITION® Stabilization System
	Instructors:	TBD
		TRANSITION® delivers semi rigid posterior fixation providing a unique biomechanical profile depending on its application. This HOD will highlight the technology and surgical technique of the TRANSITION® Stabilization System.
Medtronic	Products:	MAST TLIF & Sextant
	Instructors:	TBD
Stryker	Products:	Xia® 3
	Instructors:	Daryll Dykes, MD
		This demonstration will focus on solutions for degenerative lumbar posterior fusion using Xia® 3. Participants will have the opportunity to practice different techniques, and will be able to evaluate new techniques for treatment, as well as discuss controversial and challenging issues.

3C Early Onset Scoliosis

3D Adult Deformity III: Decision Making Relative to the Sacrum Pelvis

K2M, Inc.	Products:	RANGE® Spinal System
	Instructors:	Sean Molloy, MBBS, MSc, FRCS, DC
		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.
TranS1	Products:	AxiaLIF 360, AxiaLIF 2Lt, Avatar
	Instructors:	Neel Anand, MD
		AxiaLIF is the least invasive solution for the L4/5-L5/S1 fusion and is an elegant option for anchoring the base of a long construct. AxiaLIF at the lumbosacral junction provides the following benefits: • Biomechanically superior anterior interbody • Technique can be performed quickly with little blood loss • Implanted during same operative setting • Preserves original posterior fixation • Minimizes exposure time-potentially reducing infection rates • Eliminates the need for patient repositioning and draping

3E Thoracolumbar Trauma

Exhibits and Hands-On Sessions

Hands-On Demonstrations (continued...)

Friday, July 23, 2010

12:30 – 13:15 Hands-On Demonstrations 4A-E

4A Infection and Post Infectious Deformity

4B Lumbar Anterior Fusion Options/Instrumentation (Including Lateral Anterior Approaches)

Alphatec Spine	Products:	Access Instrumentation System
	Instructors:	Carl Lauryssen, MD
		Demonstration of the ARC Portal Access System
Globus Medical	Products:	MARS™3V Retractor, TransContinental® Implants and Instrumentation
	Instructors:	TBD
		The MIS lateral approach has been refined with the combination of the MARS™3V retractor and the TransContinental® Spacer system. This HOD will review lateral approach techniques utilizing the latest technologies from GLOBUS.
Orthofix, Inc.	Products:	Pillar™ SA
	Instructors:	TBD
		Demonstration of anterior lumbar interbody fixation using sawbones and a surgical technique video. Case studies featuring the Pllar™ SA will be shown as well.

4C Adolescent Idiopathic Scoliosis II

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

K2M, Inc.	Products:	SERENGETI® Minimally Invasive Retractor System
	Instructors:	Richard Guyer, MD
		K2M will be demonstrating the SERENGETI® Minimally Invasive Retractor System and its clinical applications. It is a screw-based 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.
Medtronic	Products:	DLIF & Longitude
	Instructors:	TBD
Stryker	Products:	MANTIS®
	Instructors:	Jeffrey Roh, MD
		Minimally invasive spine surgery is evolving exponentially. This workshop will focus on advanced techniques and solutions for MIS deformities using the MANTIS® system. Participants will have the opportunity to practice different corrective techniques for treatment, as well as discuss controversial and challenging issues.
TranS1	Products:	AxiaLIF 360, AxiaLIF 2Lt, Avatar
	Instructors:	Gary Fleischer, MD
		AxiaLIF is the least invasive solution for L5/S1 fusion and is an attractive option for the base of a long construct. Used in conjunction with an MIS lateral approach and MIS pedicle screws, adult deformity can now be done in far less time and with less blood loss than traditional approaches.

4E The Osteoporotic Spine: Fixation Challenges and Solutions

Exhibits and Hands-On Sessions

Hands-On Demonstrations (continued...)

Saturday, July 24, 2010

8:30 – 9:15 Hands-On Demonstrations 5A-E

5A Cervical Degenerative Techniques

5B Lumbar Disc Replacement

5C Adolescent Idiopathic Scoliosis III

K2M, Inc.	Products:	RANGE® Spinal System
	Instructors:	Greg Mundis, MD
		K2M will be demonstrating the RANGE® Spinal System and its clinical applications for treating Adolescent Idiopathic Scoliosis 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.

5D Treatment of Vertebral Compression Fractures

Orthovita, Inc.	Products:	Cortoss (Bone Augmentation Material)
	Instructors:	Troy Wilford and Andy Barnes
	Objective:	Educate on the benefits of Cortoss and demonstrate the simplicity of the system, including: • System Overview • Material Preparation • Review of the IDE study data

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

Exhibits and Hands-On Sessions

Hands-On Workshops

Thursday, July 22 • 11:30 – 12:15

Multiaxel Correction Techniques for AIS

Presented by: K2M

Instructors: Behrooz Akbarnia, MD and Kamal N. Ibrahim, MD, FRCS(C), MA

Room: Civic Ballroom

K2M will be demonstrating the RANGE® Spinal System and its clinical applications for treating multi-directional 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.

The Role of Minimally Invasive Surgery in Adult Degenerative Deformity

Presented by: Medtronic

Instructors: TBD

Room: Dominion Ballroom North

Presentation and discussion regarding surgical application of minimally invasive technologies and techniques in adult degenerative deformity.

Zero Profile Technology

Presented by: Synthes Spine

Instructors: Christopher M.J. Cain, MB, BS, MD (Adel), FRACS (Orth), FA (Orth A)

Room: Dominion Ballroom South

An introduction to cervical and lumbar zero profile stand-alone interbody fusion devices.

Thursday, July 22 • 14:15 – 15:00

XLIF® Indication Specific Treatment Options

Presented by: Nuvasive

Instructors: Behrooz Akbarnia, MD; Luiz Pimenta, MD, William Smith, MD

Room: Civic Ballroom

XLIF® Indication specific treatment options; Degenerative, deformity, trauma applications.

Advanced Techniques in Treating AIS

Presented by: DePuy Spine

Instructors: Peter O. Newton, MD and Harry Shufflebarger, MD

Room: Dominion Ballroom North

This hands-on-workshop is designed for surgeons who want to learn about prognostic genetic testing and advanced techniques in treating AIS. This session will include a presentation on current use and clinical utility of the SCOLISCORE™ AIS Prognostic Test and an overview of the latest available technology and techniques for treating AIS including vertebral body derotation.

TITLE

Presented by: DePuy Spine

Instructors: TBD

Room: Dominion Ballroom South

Exhibits and Hands-On Sessions

Hands-On Workshops (continued...)

Friday, July 23 • 13:15 – 14:00

Sacropelvic Correction Techniques

Presented by: K2M

Instructors: Khaled Kebaish, MD and John Kostuik, MD

Room: Civic Ballroom

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.

Revisions and Realignment: Addressing the Complex Spine

Presented by: Medtronic

Instructors: TBD

Room: Dominion Ballroom North

Presentation and discussion regarding pre-operative planning and surgical techniques, strategies and pearls in treating deformity pathologies and possible revisions.

Expanding the Limits of MIS: Comprehensive Deformity Correction Techniques

Presented by: DePuy Spine

Instructors: TBD

Room: Dominion Ballroom South

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 an overview of the latest available technology and techniques for deformity correction through percutaneous fixation and the lateral approach to interbody fusion.

Author Index

The Scoliosis Research Society
gratefully acknowledges the following companies
for their support of the Hands-On Demonstrations:

Alphatec Spine, Inc.
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Presentation Key
1C, 2E, 3B = Instructional Course Lectures
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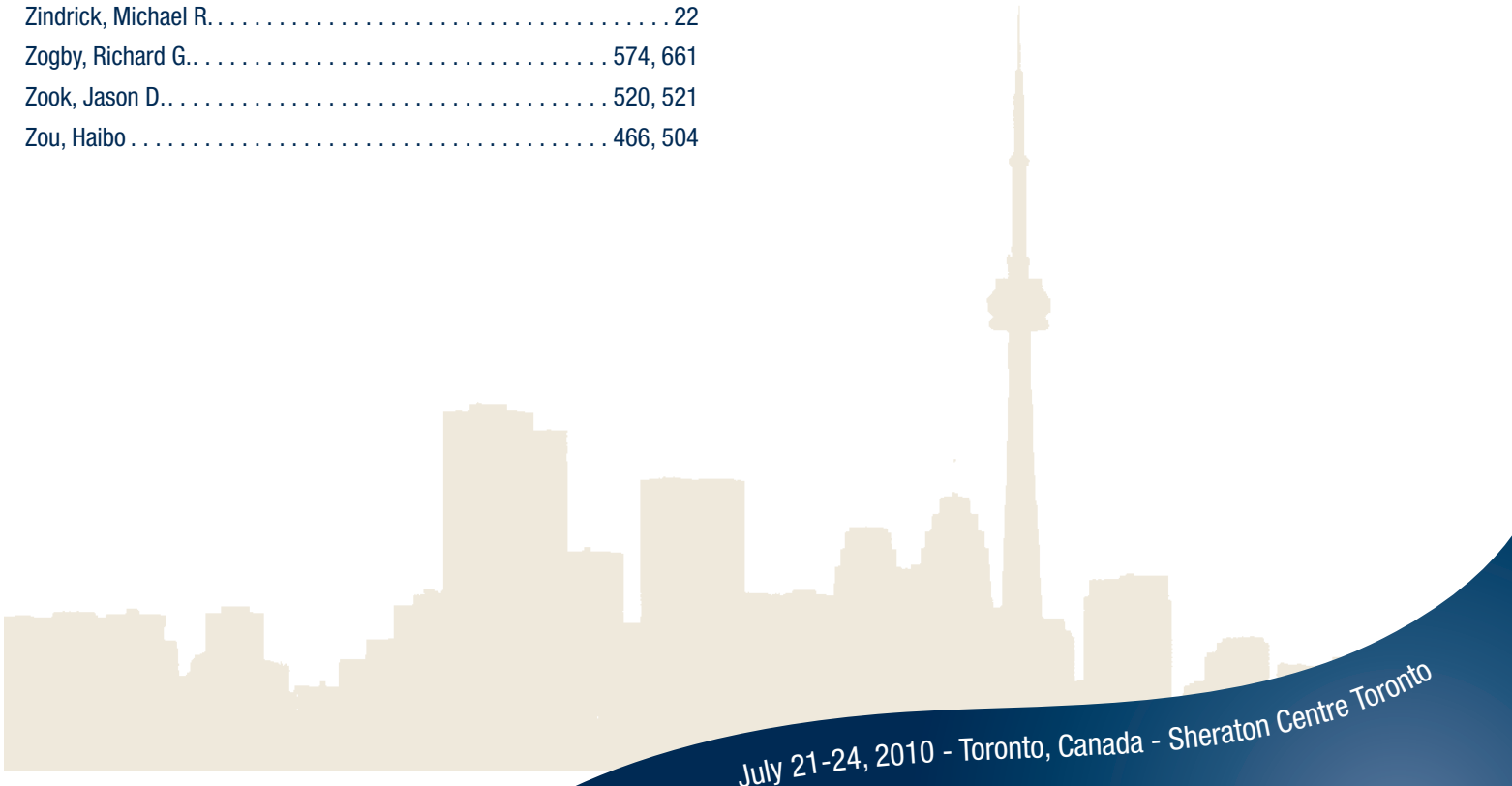

About SRS

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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Scoliosis Research Society

Save the Dates

Future Educational Events

45th Annual Meeting & Course
September, 21-24, **2010**
KYOTO, JAPAN

18th IMAST
July 13-16, **2011**
COPENHAGEN, DENMARK

Worldwide Conferences

Worldwide Conference
September 12-13
ACAPULCO, MEXICO

Scoliosis Research Society presents

IMAST

18th International Meeting on Advanced Spine Techniques

COPENHAGEN

DENMARK July 13-16, 2011

Abstract submission open - November 1, 2010

Abstract deadline - February 1, 2011

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